The development of a structure to evaluate petroleum fiscal systems in Africa

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Abstract

Petroleum fiscal systems are one of the main factors investors consider when making an investment decision. Host governments are tasked with being the custodians of their countries' natural resources and are therefore responsible for the design, evaluation and implementation of petroleum fiscal systems. It is one of the few real factors that host governments can influence to attract oil sector investment, since host governments cannot influence the geology of their country or the type of oil reserves they hold. Within this context, mineral taxation serves specific functions, while the oil sector's characteristics make petroleum taxation unique. Furthermore, the scarcity of non-renewable resources such as oil creates economic rent when the resource is extracted. The 'fair' division of this economic rent between the host government and the producer (international oil company) is a primary objective of petroleum taxation. Governments can use various taxation and non-taxation instruments to collect their share of economic rent. The different 'combinations' of taxation and non-taxation instruments used by host countries are controlled or organised by a country's petroleum fiscal system.

The objective of the host government is to maximise its revenues, while investors want to maximise profits in relation to the risks they take. This creates a trade-off between maximising government revenue and promoting investment. Therefore, oil producing countries face a trade-off between attaining a fair share of economic rent and providing sufficient incentive for upstream exploration and development by international oil companies. Within this context, African countries are in need of oil sector FDI to exploit their natural resources. Oil resources could hold the key to unlocking Africa's growth potential. However, Africa faces key competitive threats from competing oil producers. Africa must adapt to a range of changing global conditions in terms of the supply of oil resources: more exploration areas and countries are adding to the supply of exploration acreage, more regular bid rounds and growth in the farm-in/farm-out markets, competitive macro-economic conditions and enhanced protections for foreign investors. Accordingly, petroleum fiscal systems are a critical policy consideration.

From the government policy perspective (evaluation), the government-take statistic is most often used to evaluate and compare petroleum fiscal systems. The government-take is a measure of the government's share of economic profits, normally expressed as a percentage. Although data on individual fiscal systems are publicly available, there are no recent mapping and comparative analysis of petroleum fiscal systems between countries. For this reason, this thesis identified the need to conduct such a comparative analysis. Furthermore, the investor

perspective influences the government policy perspective in terms of attracting investment. For this reason, the Fraser Institute's annual survey of the perceived barriers to investment in upstream exploration and production is also considered as part of the comparative analysis. From the wide variation in systems, it is important to emphasise that there is not a one-size-fits-all system that can be applied for all countries. Individual circumstances differ between countries, particularly in terms of the oil sector's stage of development and the relative importance of the oil sector in comparison to the other sectors of a country's economy. These factors together with the specific government's approach to oil sector rents will all influence the specific make-up of the fiscal system. These differences also relate to a country's state of development, i.e. developed, emerging or developing economy. Considering the wide variation in factors that can affect a country's oil sector and petroleum taxation, it is difficult to be prescriptive on petroleum fiscal systems.

While the government-take statistic is most often used to evaluate and compare petroleum fiscal systems, it does not consider the oil sector's economy-wide impacts. Currently, there is no measurement instrument that considers the economy-wide impacts (benefits) of the upstream oil sector's activities, made possible by upstream investment. For this reason, this thesis identified the need to develop a specific tool called the STRUCTURAL TAKE INDICATOR (STI), based on the structure of a country's economy, which will expand the current limited focus on government take alone. The STI provides further clarity on the issues that are at stake. It is not only the government take (taxation) that is important, but also the extent of the oil sector's economy-wide impacts. The focus is specifically on petroleum fiscal systems in Africa, considering Nigeria, Angola, Algeria and Chad. Countries that receive significant economic benefits from their oil sector's activities could consider charging a lower government take, assuming this will promote further investment and with it further economic benefits in terms of the oil sector's economy-wide impacts. This thesis represents a new contribution to the field of knowledge on petroleum fiscal systems by providing a recent comparative analysis of petroleum fiscal systems as well as developing a specific tool to measure the impacts that are wider than the government take.

The oil sector's economy-wide impacts can most directly be measured by the oil sector's backward linkages, which embody the oil sector's purchases from other sectors to enable the production of oil sector output. It is possible to measure forward linkages, but this falls outside the scope of this thesis. The focus of this thesis is the oil sector's economy-wide (upstream) impacts, i.e. backward linkages. Social accounting matrices (SAMs) are used as the underlying database to analyse oil sector inter-sector linkages. The SAM data are used as input for calculating Leontief sector multipliers (multiplier decomposition) and extended by structural path analysis (SPA), which provides additional detail by tracing the various paths (sectors) through which the oil sector's multiplier impacts spread throughout the economy.

Based on the SAM and SPA analysis, the oil sector can influence the host country's economy in terms of three categories: the impact on other sectors (activities) through backward linkages, the use of factors of production (capital and labour), and the impact on households. Considering the relative importance of these three components, the components are assigned weights that are used to combine these impact components into a single indicator, i.e. the STI. The STI serves as an additional measure to government take when evaluating petroleum fiscal systems. The development of the STI is a unique contribution to the literature on petroleum fiscal systems. Therefore, the STI serves to enhance the evaluation of petroleum fiscal systems by filling the current gap in the field of petroleum fiscal systems.

Countries with a large (positive) STI score receive significant economic benefits from the oil sector's activities. In such cases, a slightly lower government take could be acceptable, assuming this will promote further investment and with it further economic benefits in terms of the STI. Therefore, such a host government may consider implementing a more lenient fiscal stance in order to promote upstream investment and reap more of the economy-wide benefits. In contrast, host countries with a relatively low (close to zero) STI will have to first consider policies to expand the oil sector's economy-wide impacts before opting for a more lenient fiscal stance. This is especially true for countries with an established oil sector and a long history of oil production. Within such a context (low STI score), the ancillary policy would be to focus more on the extent of government take, by attempting to increase the fiscal (tax) benefits for the host country until such time as the STI could be improved. However, in the case of countries with a nascent oil sector, still to make significant discoveries, the host government should take cognisance of the lack of proven reserves and production when interpreting their STI, since the sector is still in the start-up phase and still needs to be established before any significant sector linkages can form. Within this context, favourable tax policies tied to policies that stimulate the development of local supply networks (promoting backward-linkages) may be conducive to developing the oil sector and the potential for future economic benefits.

Furthermore, the current oil market outlook will affect exploration in the medium to long term. Host countries should incorporate such price fluctuations into their oil sector policy stance. In the current low price environment, the STI is especially important. Focusing on the oil sector's economy-wide impacts (as measured in the STI), host governments can accommodate investors with more favourable regimes, which can help to sustain investment during periods of oil price downturns. However, the policy should also allow for upward flexibility during periods of sustained price increases.

Keywords: Petroleum fiscal systems, upstream investment, economic rent, government take, Structural Take Indicator, structural path analysis, economy-wide impacts, oil sector in Africa, social accounting matrix

JEL classification: D57, Q43, Q48

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List of abbreviations

AC	Average Cost
AGR	Access to Gross Revenues
BT	Brown Tax
CIT	Corporate Income Tax
CS	Composite Score
CSSL	Contribuição Social sobre o Lucro Líquido
ERR	Effective Royalty Rate
E&P	Exploration & Production
EPSA	Exploration & Production Sharing Agreement
FC	Factor Component
FDI	Foreign Direct Investment
FDI-E	Foreign Direct Investment in Energy
FLI	Front-loading Index
GDP	Gross Domestic Product
GT	Host Nation Take (Government Take including NOC income)
GTE	Government Take (excludes NOC income)
GVA	Gross Value Added
HC	Household Component
HRIT	Higher Rates of Proportional Income Tax
IFPRI	International Food Policy Research Institute
IO	Input-Output
IOC	International Oil Company
IOCs	International Oil Companies
IRR	Internal Rate of Return
JVA	Joint Venture Agreement/Arrangement
LHS	Left Hand Side
MC	Marginal Cost
MET	Mineral Extraction Tax
NNPC	Nigerian National Petroleum Corporation
NOCs	National Oil Companies
NPV	Net Present Value
OPEC	Organization of the Petroleum Exporting Countries
PI	Profit-to-Investment Ratio (PI)
PPI	Policy Perception Index
PRRT	Petroleum Resource Rent Tax
PRT	Petroleum Revenue Tax
PSA	Production Sharing Agreement
PSC	Production Sharing Contract
PV	Present Value
RGI	Resource Governance Index
RHS	Right Hand Side
R/P	Reserves-to-production ratio
RRT	Resource rent tax
R/T	Royalty/Tax
SAM	Social Accounting Matrix
SAMs	Social Accounting Matrices
SC	Sector Component
SI	Savings Index
SNA	System of National Accounts
SNJDZ	Sao Tome and Principe/Nigerian Joint Development Zone
SPA	Structural Path Analysis
STI	Structural Take Indicator
UK	United Kingdom
USA	United States of America

Chapter 1: Introduction, problem statement and context for analysis

"The best way to become acquainted with a subject is to write a book about it." – Benjamin Disraeli.

1.1 Introduction

Petroleum fiscal systems are one of the main factors investors consider when making an investment decision (African Development Bank; 2009:80). It is one of the few real factors that host governments can influence to attract oil sector investment. Host governments cannot influence the geology of their country or the type of oil reserves they hold. The objective of the host government is to maximise its revenues, while investors want to maximise profits in relation to the risks they take (Tordo, 2007). Host governments are tasked with being the custodians of their countries' natural resources and are responsible for the design, evaluation and implementation of the country's petroleum fiscal system. Within this context, the fiscal system must secure a fair share of economic rent for the host country, while still being conducive towards attracting upstream investment. From the government policy perspective (evaluation), the government-take statistic is most often used to evaluate and compare petroleum fiscal systems. The government-take can be defined as the government's share of economic profits, normally expressed as a percentage (Johnston, 2003:345). However, it does not consider the oil sector's economy-wide impacts. Currently, there is no measurement instrument that considers the economy-wide impacts (benefits) of the upstream oil sector's activities, made possible by upstream investment. These impacts depend on the particular inter-sector linkages of a country's oil sector.

The aim of this thesis is to enhance the evaluation of petroleum fiscal systems by providing a measurement instrument (structure) that can incorporate the oil sector's economy-wide impacts as part of the evaluation process. The implications it holds for petroleum tax policy represent a new contribution to the field of knowledge on petroleum fiscal systems. The focus is specifically on petroleum fiscal systems in Africa, considering Nigeria, Angola, Algeria and Chad. There are two components linked to such an evaluation. Firstly, the country- and sector-specific linkages have to be identified and evaluated. The focus is specifically on the oil sector's backward linkages, which embody the oil sector's purchases from other sectors to enable production of oil sector output. Secondly, knowledge of these linkages can be used to develop a measurement instrument based on the structure of a country's economy, which can improve the evaluation of petroleum fiscal systems.

Although there have been studies that estimate the economic impacts from the oil sector, none of these studies have attempted to incorporate these outcomes into the evaluation and design of petroleum fiscal systems. Oil-producing countries face a trade-off between attaining a fair share of economic rent and providing sufficient incentive for upstream exploration and development by international oil companies (IOCs). Petroleum fiscal systems are the main mechanism that determines how oil wealth is shared between the host government and investors (IOCs). In addition to tax revenue, host governments must consider the oil sector's economy-wide impacts when balancing the trade-off between attaining a fair share of economic rent and providing sufficient incentive for upstream exploration and development. This is especially relevant within the context of the current oil price downturn of 2014/15. This trade-off between government take and investment incentive is particularly important for oil rich African countries.

Oil resources could hold the key to unlocking Africa's growth potential. Africa is reliant on foreign direct investment (FDI) and knowledge to successfully extract oil resources. Africa faces key competitive threats from competing oil producers in Latin America, Australasia, Asia, the Middle East, Central Asia, Eastern Europe and Russia (AIP, 2010). Furthermore, there are the established traditional players such as the North Sea, Europe, Gulf of Mexico and North America (AIP, 2010). Host countries must now consider the range of new technologies that have an impact on potential reserves, the commerciality of extracting these reserves and ultimately a higher level of competition from unconventional sources such as liquefied natural gas, gas-to-liquids and oil/shale (AIP, 2010). Africa must adapt to a range of changing global conditions in terms of the supply of oil resources: more exploration areas and countries are adding to the supply of exploration acreage, more regular bid rounds and growth in the farm-in/farm-out markets, competitive macro-economic conditions and enhanced protections for foreign investors (AIP, 2010).

It is important to note that the oil sector's economy-wide impacts, as discussed above, are separate from the question of economic impact and development connected with the allocation and expenditure of the tax revenue received by the host government. The thesis research question relates to the trade-off between achieving a 'fair share' for the host government and contractor (IOC), while still being conducive to upstream investment. The research question in this thesis is an issue of revenue collection and investment attraction as opposed to the question of revenue allocation and management.

To put the research of this thesis within context, it is important to provide the background to the oil sector; discuss the importance of oil for oil rich African countries, while setting the context for the rest of this thesis.

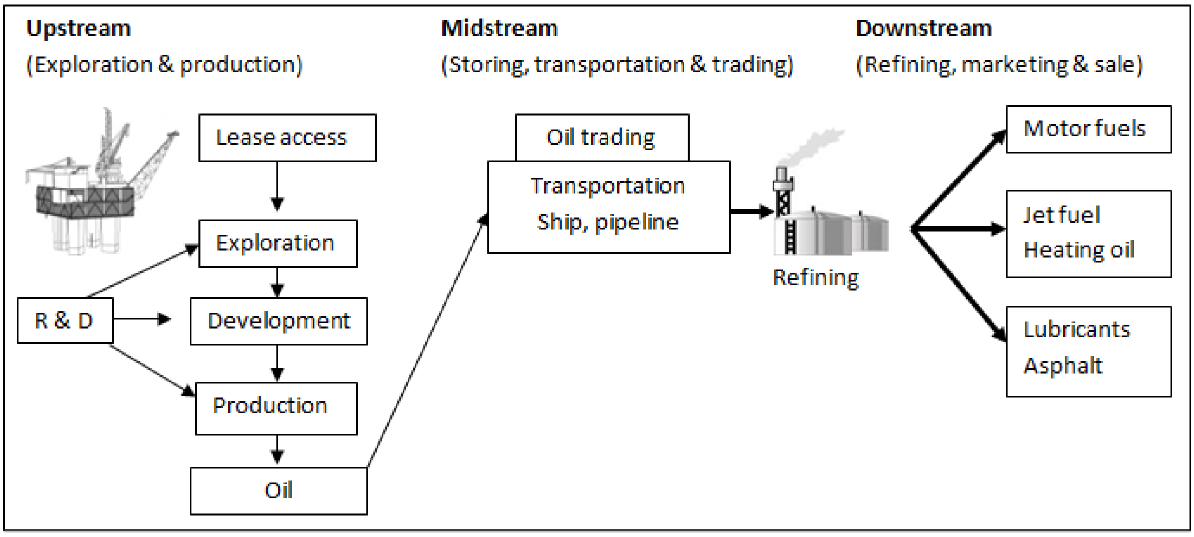
1.2 The oil sector

Oil is a significant element of the global energy mix (Finley, 2012). A small number of countries produce oil relative to all the nations in the world who consume products derived from the oil sector (Inkpen & Moffett, 2011:6). This section serves as important background information to put the oil sector within context. It reviews the oil sector value chain, the classification of oil reserves, the lifecycle of an oil project, the oil sector role players and the evolution of the oil exploration landscape.

1.2.1 The oil sector value chain

The oil sector consists of three-sub-value chains, namely the upstream, midstream and downstream (African Development Bank, 2009:34; Inkpen & Moffett, 2011:21-23). The upstream consists of the exploration for and production of oil, the focus of this thesis. The midstream consists of the storing, trading and transportation of crude oil. The downstream includes the refining, marketing and sale of petroleum products. High oil prices and perceptions of oil being in short supply will drive capital investment for exploration and production (E&P) (Favennec, 2001:38). The operating costs of oil fields tend to be low in comparison to the costs of exploration and development (Morse, 1999). The downstream is similarly capital intensive; refineries are costly to build, but once refining has started, the marginal cost of refining a barrel of oil is only slightly more than the cost of the crude oil itself. The majority of value creation rests with the upstream sector, which is the focus of this thesis. The oil sector value chain is illustrated in Figure 1.1.

Figure 1.1: The oil sector value chain



Source: Adapted from Inkpen & Moffett (2011:21)

Tordo (2007:3-4) identifies a number of stages in the lifecycle of an upstream oil project (discussed in detail in section 1.2.3). The stages include licensing, exploration, development, appraisal, production and finally abandonment. Exploration and development can only start once a lease has been acquired (Inkpen & Moffett, 2011:93). In most countries, with a few exceptions such as in the United States of America (USA) and Canada, mineral rights are held by the country's national government (Inkpen & Moffett, 2011:87). Private oil companies want to maximise profits, while host governments want to maximise their revenue from oil resources (Inkpen & Moffett, 2011:22). Licensing (lease) is the granting of exploration and development rights for a specific area to an oil company; the host government retains the ownership of the mineral resource (Tordo, 2007:3). Exploration and development rights are assigned through either a process of auctions, through an informal process of first-come-first-serve, or through a formal process known as 'beauty contests', where companies compete by submitting exploration and development plans (Crampton, 2007:114; Crampton, 2010:289; Inkpen & Moffett, 2011:102). A well-designed auction has the advantage of being both competitive and transparent (Crampton, 2010:289). The feasibility of an auction[1] will depend on the quality of the oil resources (Crampton, 2010:289).

[1] See Crampton (2010) and Crampton (2007) for a discussion of the best practices for auction design.

1.2.2 Classification of oil reserves

The oil sector is dependent on the discovery of new oil reserves to replace oil production (Inkpen & Moffett, 2011:5). There are various different definitions[2] of oil reserves. The Society of Petroleum Engineers and the Unites States Securities and Exchange Commission have been the most influential organisations to develop common reserve definitions and accounting practices (Inkpen & Moffett, 2011:100). The main difference lies in when, and at which price, oil can be recorded as 'reserves' in a company's balance sheet.

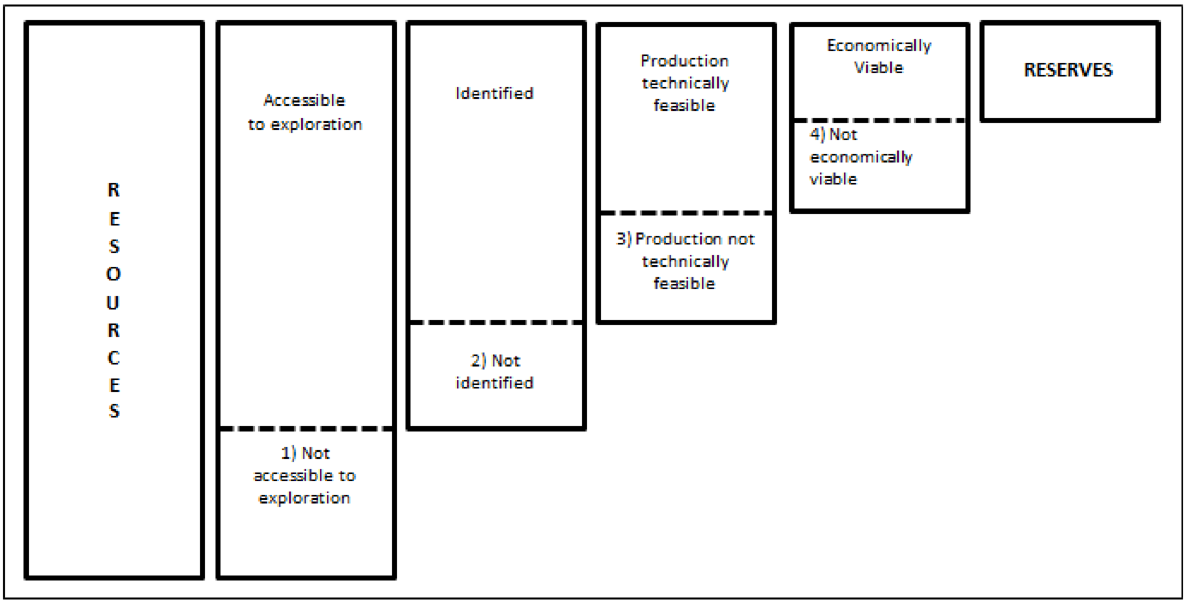
There is an important distinction between reserves and resources. Reserves refer to the volume of oil that can or will be economically recoverable, while resources or oil in place refer to the oil present in a reservoir (basin) regardless of its recoverability (Bret-Rouzaut & Favennec, 2011:95; Inkpen & Moffett, 2011:96; McKelvey, 1972). Resources can only be classified as reserves after passing a number of requirements; these are illustrated in Figure 1.2. Exploration activity searches for undiscovered oil and these prospective resources are referred to as prospects, leads or plays (Inkpen & Moffett, 2011:96).

Bret-Rouzaut and Favennec (2011:95) identify three possible barriers to exploration. They are political, technical and techno-economic constraints. A political barrier is the limited or partial access to exploration imposed by host governments on certain geographical areas. Some areas are subject to technical constraints where the current geological or geophysical methods are not yet sufficient. The techno-economic constraint is a combination of technical and economic constraints. For some resources, the technology needed for extraction does not exist or if the technology does exist, the extraction costs outweigh the possible income from selling the extracted resource.

Reserve estimates should be viewed with caution and interpreted according to the definition of reserves that is used; reserve estimates are often plagued by a lack of precision inherent in the quantitative definition of 'reserves' (Bret-Rouzaut & Favennec, 2011:95-96). Resources regarded as reserves are expected to be put into production within the short to medium term. For this reason, reserves are hypothetical volumes, subject to uncertainties, and are influenced by changes in technology as well as changing political and economic conditions.

[2] Comparing these definitions falls outside the scope of this thesis. For an overview, see Inkpen & Moffett (2011); Bret-Rouzaut & Favennec (2011) and SPE (2011).

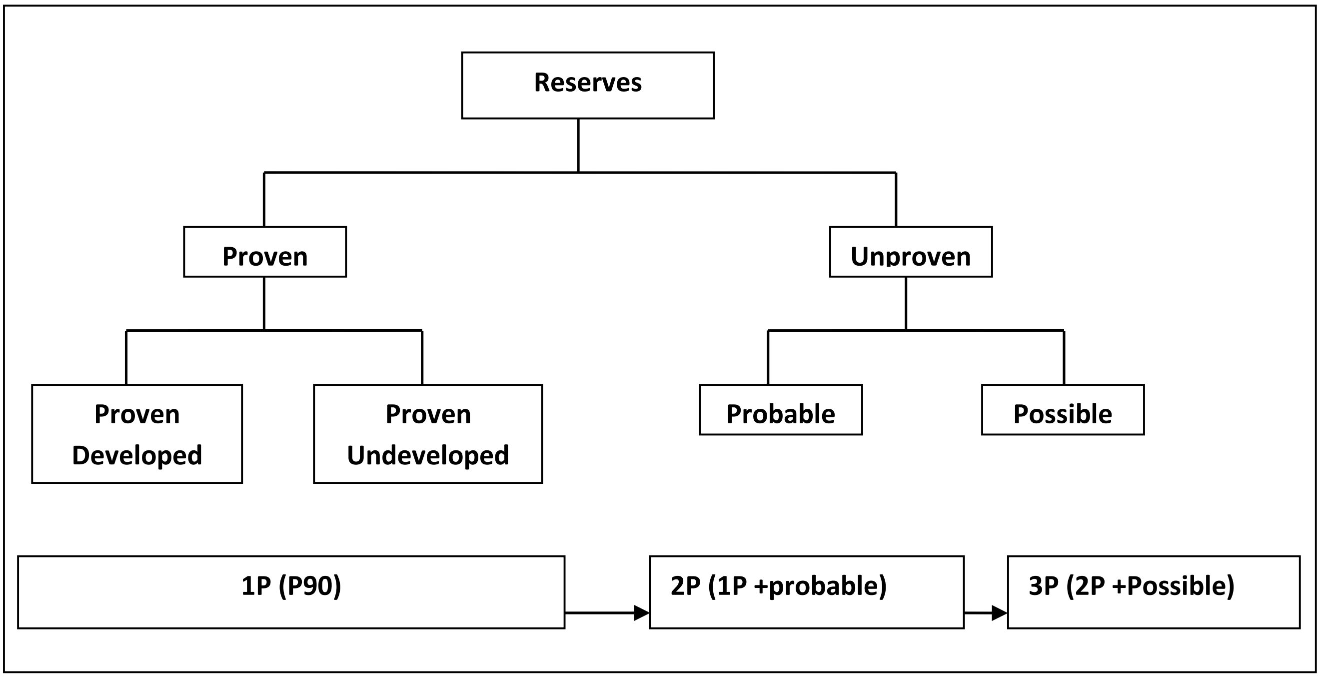
Figure 1.2: Classifying resources as reserves



Source: Bret-Rouzaut & Favennec (2011:96)

Oil reserves can broadly be classified in terms of proven and unproven reserves (Inkpen & Moffett, 2011:98-99). Proven reserves are further classified into developed reserves, which can presently be recovered with the existing infrastructure, and undeveloped reserves, which require further investment for exploitation. Unproven reserves are classified as either probable or possible reserves. BP (2012) provides the following definitions of proven, probable and possible reserves, based on the likelihood of the reserves being technically or economically recoverable. Proven reserves are defined as the estimated quantity of oil that can be recovered from a specific reservoir with reasonable certainty under the current economic and operating environment, based on the available geological and engineering data. Probable reserves are reserves with a more than fifty per cent chance of being technically and economically recoverable. Possible reserves are estimated to have a reasonable but less than fifty per cent chance of being technically or economically recoverable. Proven reserves are also referred to as 1P (proven) or P90 (90% probability of recovery) (Bret-Rouzaut & Favennec, 2011:98; Inkpen & Moffett, 2011:100). The combination of proven and probable reserves is referred to as 2P and the combination of proven, probable and possible reserves are referred to as 3P. Countries with known proven oil reserves will find it easier to attract bidders for exploration rights than countries with only probable reserves whom are auctioning exploration rights for speculative prospects (Crampton, 2010:289). The classification of reserves is summarised in Figure 1.3.

Figure 1.3: Reserve classification



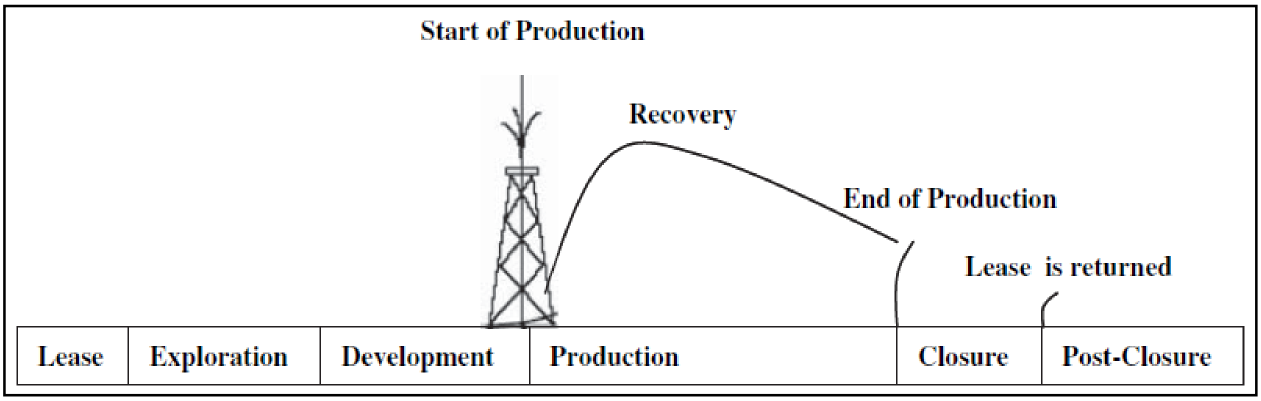
Source: Adapted from Inkpen & Moffett (2011:100)

1.2.3 The oil project lifecycle

The decision to start exploration is only made after considering the host country's petroleum fiscal system and any other external factors that will have an impact on costs (Van Vactor, 2010:120). Initially, oil exploration was conducted with only the right to explore and once oil was found a new and separate agreement would be negotiated between the company conducting exploration and the host government (Inkpen & Moffett, 2011:88). Today, all the arrangements regarding development, ownership, royalties, licence fees, and profit or cost oil splits are contained within the host country's petroleum fiscal system (Inkpen & Moffett, 2011:88).

In the exploration phase, the oil company conducts geological and seismic research to establish the potential for oil reserves before starting exploratory drilling (Tordo, 2007:3). Once oil is discovered, the economic feasibility is evaluated as part of the project appraisal. A favourable appraisal will lead to production and once the oil field has been depleted the project is decommissioned (Tordo, 2007:4). Figure 1.4 illustrates this lifecycle.

Figure 1.4: The oil project lifecycle



Source: Tordo (2007:4)

An oil project's risk profile will evolve as the project proceeds through the lifecycle (Tordo, 2007:4-5). There are three main types of risk; geological, financial and political. During the lifecycle, the relative bargaining power between the host government and investors will shift. Investors have already incurred sunk costs, in terms of the capital they invested, when production starts. Accordingly, geological risk tends to decline after oil has been discovered, but political and financial risks tend to increase. The profitability of an oil project is affected by a number of factors that host governments and investors cannot control; however, the host government can still reduce investors' uncertainty. This can be done by providing prospective investors with geological and geophysical data, improving macroeconomic and fiscal stability, and by providing a transparent economic environment that is conducive to private enterprise. Reduced uncertainty translates into lower costs and larger rents that can be taxed. Host countries hedge against risk by using flexible fiscal systems and by sharing a portion of the risk with oil companies. Risk management is an important function for oil companies, and accordingly companies hedge risk by using portfolio diversification for oil projects and by working with multiple partners (Favennec, 2001:5; Tordo, 2007:5).

1.2.4 The oil sector role players

The major actors in the upstream sector comprise the host governments that own oil resources, the national oil companies (NOCs) or licensing agencies involved in the development and administration of oil resources and the international investors responsible for transforming natural capital into productive capacity (Bressand, 2009:131; Clarke, 2010:373; Clarke, 2012). International investors consist of two groups, namely the small number of very large oil companies or IOCs and a very large group of smaller independent oil companies[3] (Bressand, 2009:131). The various types of oil companies are summarised in Table 1.1.

Table 1.1: Types of oil companies

Classification	**Description**
Independent	A non-integrated company focused on either upstream or downstream activities. This term is also used to refer to upstream producers, and excludes the downstream.
Integrated oil company (IOC)	Such firms are involved in the majority of the oil sector value chain. This includes upstream, midstream and downstream activities. The IOC term is often used to refer to large firms, but could include smaller firms.
International oil company (IOC)	Energy companies operating in oil and gas across borders and in cooperation with NOCs in the NOC's home country. Both international oil companies and integrated oil companies use the IOC acronym. This thesis uses the IOC term to refer to upstream companies involved in exploration, development and production.
Junior	Small firms producing between 500 and 10 000 oil equivalent barrels a day.
National oil company (NOC)	State-owned firms established to manage the host countries' oil resources. Many NOCs have partial ownership in the hands of private investors. Some NOCs only operate in their home country, while others have an international portfolio.
Oil major	Large non-state-owned oil and gas companies. They are typically publically traded, but may also be privately owned. This term is used interchangeably with IOCs
Super majors	The world's largest IOCs/oil majors: The world's five major oil companies are referred to as the 'super majors' and consist of ExxonMobil, Royal Dutch Shell, Chevron, Total and BP.

Source: Inkpen & Moffett (2011:11-12); Clarke (2012)
Note: The IOC acronym is used to describe both integrated oil companies and international oil companies. However, this thesis uses the IOC term to refer to international oil companies involved in exploration, development and production.

The oil sector's high capital entry costs limit the number of companies that can participate in the entire oil sector value chain (Favennec, 2001:6). High costs necessitate oil companies to collaborate on joint projects, form operating partnerships and work together financially. The smaller independent oil companies are often the leaders in the more risky frontier exploration

[3] These firms are also referred to as the 'super independents', for example ENI, COP and Repsol (Clarke, 2012).

areas. Once oil is discovered, these companies sell an operating share to the larger IOCs. The selling of acreage shares is referred to as a farm-out, while the purchasing companies perform a farm-in. Oil policies of host countries often necessitate oil companies to form such partnerships to ensure the optimal development of the countries' oil resources. The need for cooperation between oil companies, and between oil companies and host countries continuously changes as the scale of projects and the expectations of future crude oil prices fluctuate. There has been a shift in resource control from IOCs to host governments (Van Vactor, 2010:96). NOCs have in many instances supplanted IOCs in the development and management of the world's largest oil fields. However, NOCs often lack the necessary expertise to manage and develop these oil fields. For this reason, NOCs use oil field service companies such as Schlumberger, Haliburton and Baker Hughes.

The Organization of the Petroleum Exporting Countries (OPEC) is an important role player influencing production in the upstream oil sector. OPEC is an intergovernmental organisation with the goal of unifying the petroleum policies of its member countries in order to safeguard their individual and collective interests (OPEC, 2008). OPEC member countries operate under a quota system, limiting the level of oil output placed on the market and so attempt to prevent falling oil prices (Favennec, 2001:31). OPEC has a majority share (81%) of the world's proven oil reserves (OPEC, 2014). OPEC's market share in terms of production has been declining: it was 42% in 2010 in contrast with a peak in 1973 at 51% (Finley, 2012). OPEC's current share in production is estimated at 40% (EIA, 2015a). Historically, the NOCs from oil-producing countries, especially OPEC member countries, held control over the majority of the world's oil supply (Deloitte, 2012). For this reason, they can control oil prices by adjusting the supply of oil to the market. However, a new type of NOC has emerged in recent years, the NOCs from energy consuming countries (not members of OPEC) such as China. These companies derive market power from two sources, namely the flat or declining consumption of Western countries and secondly the financial support that these NOCs get from their governments, which allows for untraditional loans and investments not available from IOCs (Deloitte, 2012).

1.2.5 The evolving exploration landscape

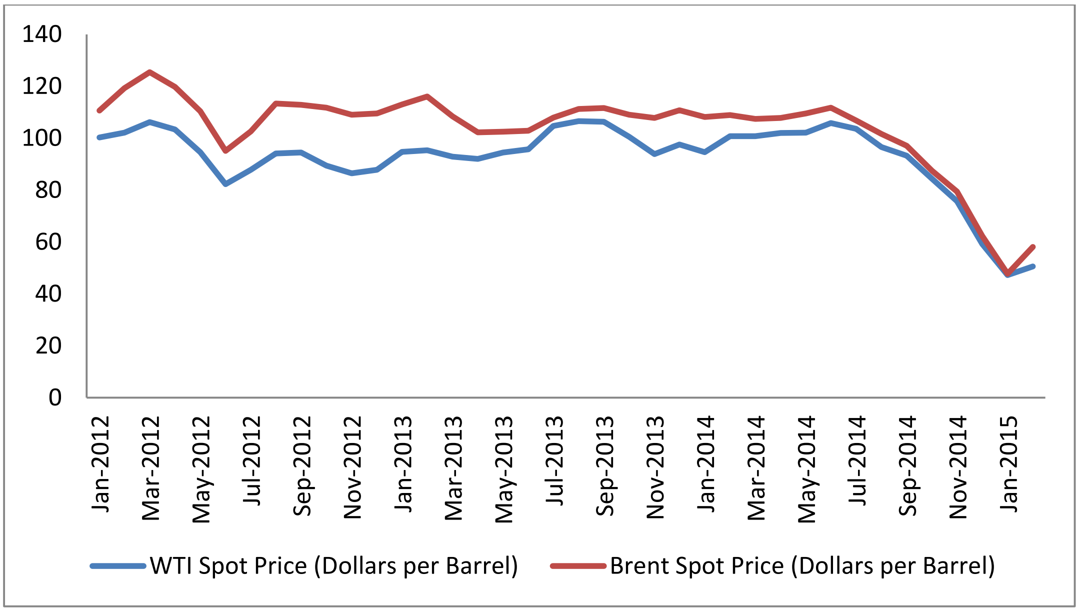
The exploration landscape has changed substantially since the start of commercial oil exploration and the establishment of the oil sector. Bressand (2009:117-119) identifies four eras in oil sector investment, or foreign direct investment in energy (FDI-E). The first era

(1859-1970) is called the Concessions Era where the so-called 'Seven Sisters' [4] had control of global oil E&P. The second era (1970s–mid 1980s) was characterised by the nationalisation of oil reserves and the first oil shock. The second era's impact is still present in today's oil sector with host governments and their national oil companies having a firm hold on oil reserves. As a result of the second era's nationalisation, E&P rapidly developed outside of the OPEC countries during the third era, spanning the mid-1980s to 2000. The third era was characterised by a low price environment (mid-1980s and 1990s), which translated into lower rent capture for host countries, while an open international environment allowed investors to choose among various alternatives. The fourth era started in the early 2000s. In this period, the abundant alternatives of the third era have been replaced with competition between investors for 'upstream acreage' and significant opportunities for rent capture by host countries.

Competition for acreage outside the OPEC countries was firstly induced by the limited acreage offered by OPEC countries; and secondly, by the combined impact of higher oil prices and a drive by IOCs to replace their falling reserves (Le Leuch, 2013). Companies were now willing to offer host countries more favourable terms than before. In some countries, host governments were inclined to demand a renegotiation of terms or to introduce tougher terms that were more in line with that generally imposed in other countries. This is in contrast to the previous two decades of falling oil prices, where IOCs were seeking improved fiscal terms or amendments to existing fiscal terms under the low price environment. However, the more recent (2014/15) oil price downturn may suggest the start of a fifth era. Globally, supply continues to exceed demand, leading to increased inventory accumulation. The main reasons for falling oil prices are the increased production of shale gas in the USA and lower demand from a slowing global economy. The falling price fundamentals are illustrated in Figure 1.5.

[4] The term 'Seven Sisters' is used to describe the companies that dominated the oil sector from its creation until 1970: Exxon, Royal Dutch Shell, Mobil, Socal (Standard Oil of California), Texaco, BP and Gulf (Favennec, 2001:33).

Figure 1.5: Crude oil spot prices, 2012-2015



Source: Compiled from data by (EIA, 2015b)
Note: WTI: West Texas Intermediate

Figure 1.5 illustrates the global oil spot price movements in terms of the two main price benchmarks, namely West Texas Intermediate (North America) and Brent (Europe). Oil prices have been falling since June 2014 and only showed a slight increase for the first time in February 2015. Should the oil price downturn prove to be more longer term in nature, this could signify the start of a fifth era similar to the third era of lower oil prices associated with lower rent capture for host countries. However, this will depend on the many variables influencing oil price fundamentals. It is important to note that future oil prices are subject to uncertainty.

1.3 The oil sector in Africa

Africa, as a continent, has a long history of oil E&P and currently has more than 500 companies that participate in upstream exploration (KPMG, 2013). West Africa was traditionally Africa's main oil-producing region. However, recent discoveries have drawn new attention to East Africa, in particular onshore oil for Kenya and Uganda and offshore gas for Mozambique and Tanzania. According to the IEA (2014), nearly 30% of global oil and gas discoveries over the last five years were made in Sub-Saharan Africa. According to PWC (2014), based on size, six of the top ten global discoveries for 2013 were made in Africa. Improvements in seismic and drilling technologies as well as improved business environments have helped African countries, with little or no current production, to achieve greater exploration results (IEA, 2014). Oil revenue is also a major source of government revenue for most of Africa's oil producers. The oil revenue figures used in this section are estimates from the Africa Economic Outlook (2014a). Based on data availability, Table 1.2 illustrates the oil sector's percentage share of gross domestic product (GDP) and government (oil) revenue for Africa's largest oil reserve holders.

Table 1.2: Oil reserves and share in GDP, 2013[5]

Country	Proven reserves (Thousand million barrels)	Reserves: share of world total	Government oil revenue, % of GDP	Oil sector % of GDP (estimates)
Libya	48.5	2.9%	43.6%	65.6%
Nigeria	37.1	2.2%	11.1%	14.4%
Angola	12.7	0.8%	35.0%	46.0%
Algeria	12.2	0.7%	26.0%	35.9%
Egypt (Arab Rep.)	3.9	0.2%	0.3%	16.9%
Gabon	2.0	0.1%	15.6%	43.7%
Equatorial Guinea	1.7	0.1%	30.9%	N/A
Rep. of Congo (Brazzaville)	1.6	0.1%	33.8%	64.6%
Chad	1.5	0.1%	14.7%	23.9%
Sudan	1.5	0.1%	3.0%	3.1%

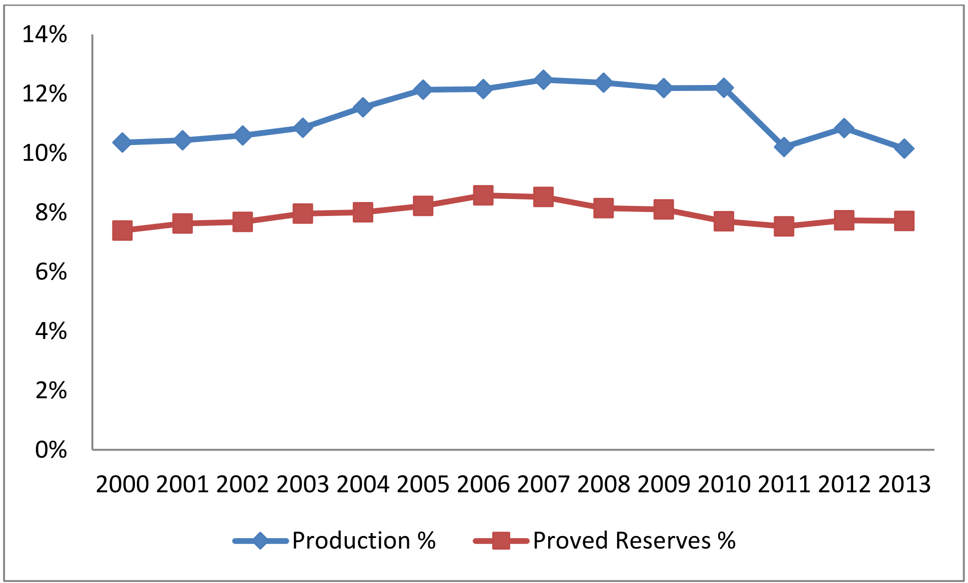
Source: Compiled from data by BP (2014) and Africa Economic Outlook (2014a)
Note: The highlighted countries (Nigeria, Angola, Algeria and Chad) are used for the analysis of petroleum fiscal systems in Africa

From Table 1.2, Libya is the largest reserve holder in Africa, followed by Nigeria, Angola and Algeria. However, these countries hold a very small share of the world's total reserves. For example, Libya holds 2.9%, Nigeria 2.2%, Angola 0.8% and Algeria 0.7%. Government dependence on oil revenue can vary with the size of the country's oil sector. The size of a country's oil sector (% of GDP) indicates the level of a country's dependence on the oil sector. It follows that large reserve holders should produce significant output and have a significant oil sector contribution to government revenue and GDP. However, this is not always the case. For example, Libya is Africa's largest reserve holder, but was ranked 4th in Africa in terms of 2013 production. Political instability and uncertainty have had a significant impact on Libya's oil sector in recent years. The oil sector's contribution to government revenue and GDP will also be influenced by the extent of economic diversification within the oil-producing country.

[5] The percentages of GDP for Libya, Angola and Algeria values are for 2012, while the oil revenue as percentage of GDP for Egypt is for 2012/2013.

Figure 1.6 illustrates Africa's share of the world total in terms of production and proven reserves for 2000 to 2013. Africa's share in proven reserves remained stable, while the share in production declined over the past three years.

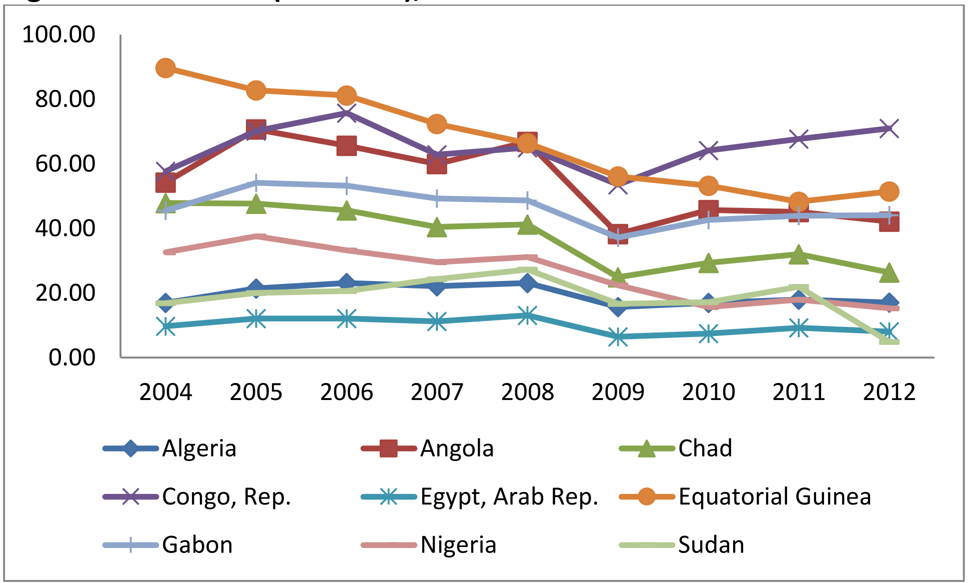
Figure 1.6: Africa's share of the world total: production and reserves, 2000-2013



Source: Compiled from data by BP (2014)

Figure 1.7 illustrates oil rents as a percentage of GDP. The rents are expressed as a percentage of GDP for Africa's largest oil producers.

Figure 1.7: Oil rents (% of GDP), 2004-2012

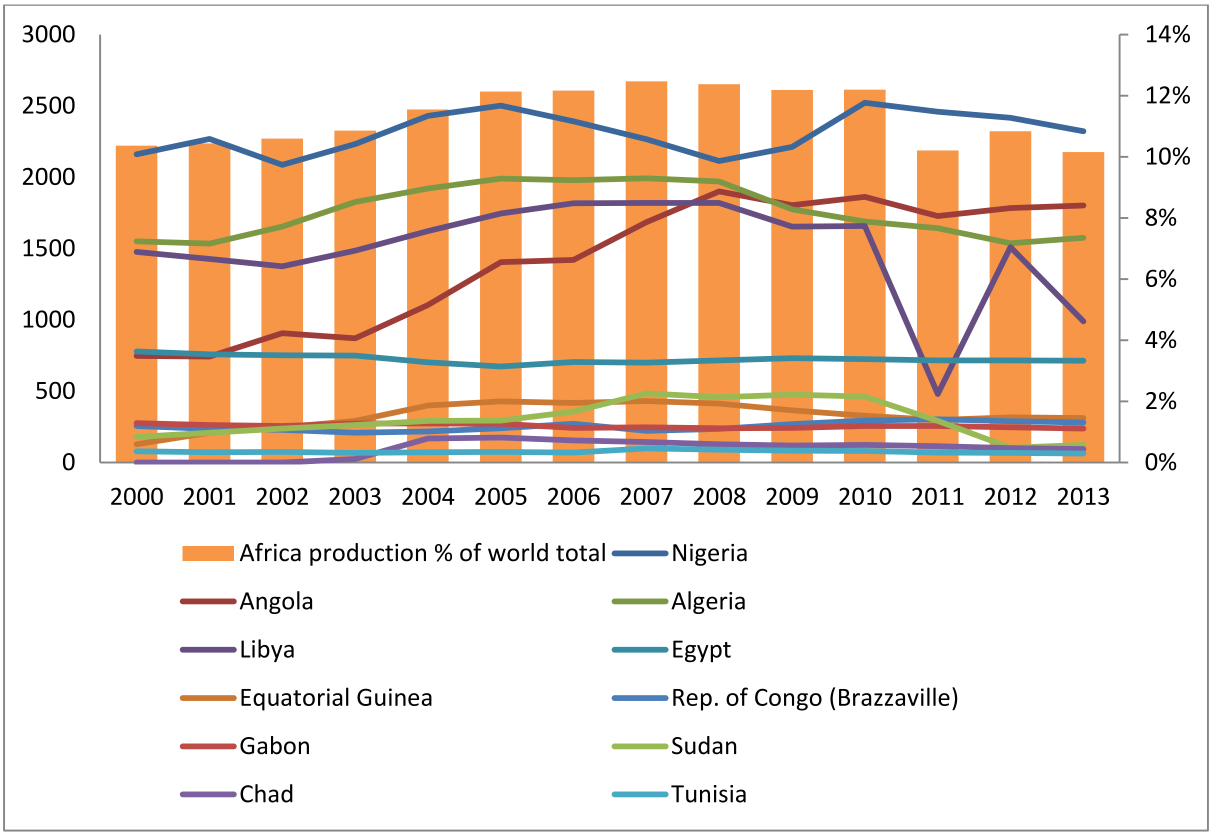


Source: Compiled from data by the World Bank (2014a)

The World Bank (2014a) defines oil rents as the difference between the value of crude oil production (at world prices) and the total cost of production. In Figure 1.8, the rents are expressed as a percentage of GDP for Africa's largest oil producers. These countries can be ranked by the share of oil rents in GDP, as follows: Republic of Congo, Equatorial Guinea, Gabon, Angola, Chad, Algeria, Nigeria, Egypt and Sudan. In terms of this ranking of nine countries, Angola is ranked 4th, Chad 5th, Algeria 6th and Nigeria 7th.

Figure 1.8 illustrates oil production from Africa's largest producers relative to Africa's (continent combined) share of the total world oil production.

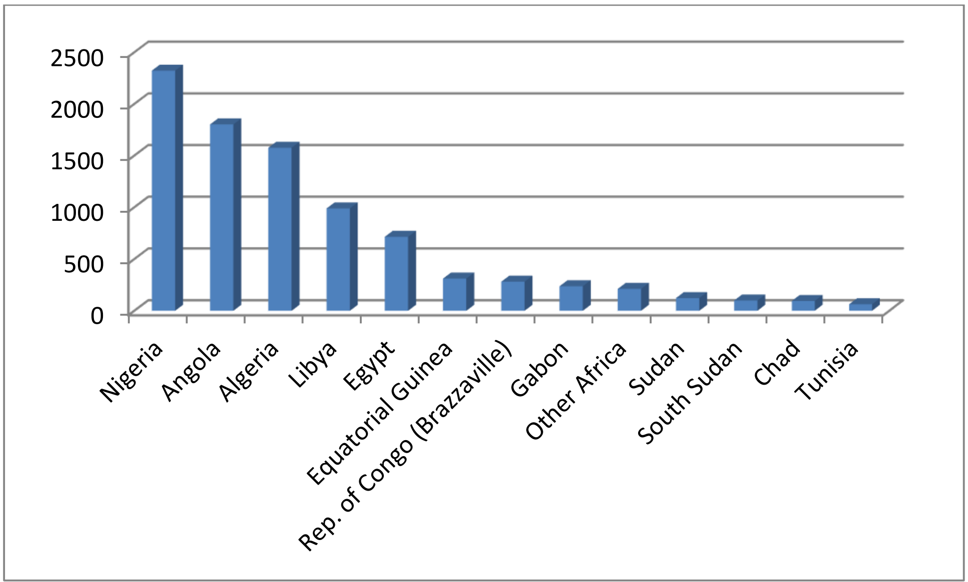
Figure 1.8: Production levels and share of the world total, 2000-2013



Source: Compiled from data by BP (2014)
Note: LHS: production in thousand barrels a day, RHS: % share in global production

From Figure 1.8, Africa's total production as a share of the total world oil production was 10% for 2000-2001, 11% for 2002-2003, stable at 12% for 2004-2010 before falling to 10% in 2011, rising to 11% in 2012 and falling back to 10% in 2013. Nigeria's production showed a decrease between 2005 and 2008, coinciding with the global financial crises. Production picked up again in 2010, after which it tapered off slightly. Algeria's production showed an upward trend following 2001 and a downward trend after 2008. Angola experienced a significant upward production trend from 2003, also falling in 2008 and showing a relatively stable trend since. The impact of Libya's 2011 civil war is clearly visible from the drastic drop in Libya's production for the corresponding year. Apart from Sudan, with falling production from 2010, the other countries (Equatorial Guinea, Rep. of Congo (Brazzaville), Gabon, Chad and Tunisia) all have relatively stable production levels. Note that Chad's production only started in 2003. The majority of Africa's oil production is currently (2013) based in Nigeria, Angola, Algeria and Libya, as shown in Figure 1.9.

Figure 1.9: Africa's largest oil producers in thousand barrels a day, 2013



Source: Compiled from data by BP (2014)

This thesis uses Nigeria, Angola, Algeria and Chad to develop a structure to evaluate petroleum fiscal systems in Africa. In light of the political turmoil, uncertainty and a lack of data, Libya's fiscal system will not be considered. Furthermore, due to a lack of data, the empirical analyses in Chapters 5 and 6 will only focus on Nigeria, Algeria and Chad.

1.4 Problem statement

Host governments are tasked with being the custodians of their countries' natural resources and are therefore responsible for the design, evaluation and implementation of petroleum fiscal systems. Within this context, the fiscal system should be designed to secure a fair share of economic rent for the host country, while still being conducive towards attracting upstream investment. From the government policy perspective, the government-take statistic is most often used to evaluate and compare petroleum fiscal systems. However, it is often calculated on unrealistic assumptions. More importantly, the macroeconomic scope of government take is too narrow and does not account for the oil sector's economy-wide impacts. Accordingly, the research question of this thesis pertains to the government policy perspective. Although there have been studies that estimated the economic impacts from the oil sector, none of these studies have attempted to incorporate these results into the evaluation of petroleum fiscal systems. The majority of these studies focus on the investor perspective rather than the government policy perspective. However, in terms of attracting investment, the investor perspective influences the government policy perspective and vice versa. Therefore, this additional and important dimension is not currently part of the process of evaluating petroleum fiscal systems.

1.5 Motivation

Oil-producing countries face a trade-off between attaining a fair share of economic rent and providing sufficient incentive for upstream exploration and development by IOCs. African countries are in need of oil sector FDI to exploit their natural resources. The petroleum fiscal system is one aspect that host governments can directly control, as opposed to the level and type of oil reserves that the country holds. The standard approach used to evaluate petroleum fiscal systems is flawed by focusing on limited statistics such as the government take[6]. Most importantly, this approach ignores the possible wider spectrum of macroeconomic (economy-wide) impacts associated with the oil sector and its investments to expand production. There are two key motivations for this thesis.

Firstly, although data on individual fiscal systems are publicly available, there is no recent comparative analysis of petroleum fiscal systems between countries. For this reason, this thesis identified the need to conduct such a comparative analysis. Furthermore, in terms of attracting investment, the investor perspective influences the government policy perspective and vice versa. For this reason, the Fraser Institute's (2014) annual survey of the perceived barriers to investment in upstream E&P is also considered as part of the comparative analysis.

Secondly, there is currently no measurement instrument that measures impacts wider than the government take. For this reason, this thesis identified the need to develop a specific tool called

[6] See section 2.4.4 for more detail on the shortcomings of 'government take'.

the STRUCTURAL TAKE INDICATOR (STI), based on the structure of a country's economy, which will expand the current limited focus on government take alone. The STI provides further clarity on the issues that are at stake. It is not only the government take (taxation) that is important, but also the extent of the oil sector's economy-wide impacts. Countries that receive significant economic benefits from their oil sector's activities could consider charging a lower government take, assuming this will promote further investment and with it further economic benefits in terms of the oil sector's economy-wide impacts. This thesis represents a new contribution to the field of knowledge on petroleum fiscal systems by providing a recent comparative analysis of petroleum fiscal systems as well developing a specific tool to measure the impacts that are wider than the government take.

1.6 Research objectives

The research objectives comprise the general objective as well as the specific sub-objectives that are necessary to achieve the general, overall, objective of this thesis.

1.6.1 General objective

The aim of this research is to conduct a comparative analysis of petroleum fiscal systems between countries and to develop a Structural Take Indicator (STI) to measure the wider spectrum of economy-wide impacts created by oil sector investment in Africa; the use of which will enhance the evaluation of petroleum fiscal systems. This expands the current narrow measure of government take alone. Governments can incorporate the STI in the appraisal of their petroleum fiscal system and develop a more balanced system. Specifically, the STI will better address the trade-off that oil-producing countries (or nascent producers) face in terms of attaining a fair share of economic rent and providing sufficient incentive for investment in upstream exploration and development. There is currently no measure incorporating the oil sector's economy-wide impacts in the evaluation of petroleum fiscal systems. Therefore, this thesis represents a new contribution to the field of petroleum fiscal systems.

1.6.2 Specific objectives

- To review the literature on petroleum taxation.
- To do a comparative analysis of global petroleum fiscal systems.
- To do a comparative analysis of petroleum fiscal systems for Africa's three largest oil producers (Nigeria, Angola and Algeria) as well as one nascent producer (Chad).

- To develop and apply a STRUCTURAL TAKE model for the evaluation of petroleum fiscal systems, incorporating the oil sector's economy-wide impacts, in African countries.
- To draw policy conclusions and recommendations.

1.7 Research method

This thesis consists of both a literature review and empirical analysis. The literature review covers the petroleum taxation literature and theory. The oil sector overview provided in this chapter together with the detailed literature in Chapters 2, 3 and 4 serves as important background information to put the oil sector within context and further contextualise the issues surrounding upstream petroleum taxation. Chapter 2 reviews the foundations of petroleum taxation and the theory of economic rent and rent capture, which provide the theoretical underpinnings for the rest of this thesis. Chapter 3 provides a comparative analysis of global petroleum fiscal systems, while Chapter 4 provides a comparative analysis of petroleum fiscal systems for Africa's three largest oil producers (Nigeria, Angola and Algeria) as well as one nascent producer (Chad).

The aim of this thesis is to enhance the evaluation of petroleum fiscal systems by considering the economy-wide impacts of the oil sector and the implications they hold for petroleum tax policy. The critical underlying theme is the trade-off faced by host governments in terms of attaining a fair share of economic rent and providing sufficient incentive for investment in upstream exploration and development, with a particular focus on oil-producing countries in Africa.

In terms of the empirical analysis, there are two components to answering the petroleum tax policy question highlighted above. Firstly, the broader economy-wide linkages (impacts) associated with the oil sector have to be measured. This impact can most directly be measured by the oil sector's backward linkages, which embody the oil sector's purchases from other sectors to enable production of oil sector output. **It is possible to measure forward linkages, but this falls outside the scope of this thesis. The focus of this thesis is the oil sector's economy-wide (upstream) impacts, i.e. backward linkages.** Measuring these economic impacts, which depend on the oil sector's structural linkages and that vary with the structure of individual economies, is the focus of Chapter 5.

Social accounting matrices (SAMs) are used as the underlying database to analyse oil sector inter-sector linkages. The SAM data are used as input for calculating Leontief sector multipliers (multiplier decomposition) and extended by structural path analysis (SPA), which provides additional detail by tracing the various paths (sectors) through which the oil sector's multiplier impacts spread throughout the economy. There is currently no SAM available for Angola[7]. Given this data limitation, the analysis is extended to include a nascent producer, Chad. The empirical analysis is therefore limited to Nigeria, Algeria and Chad. Nigeria's oil sector linkages are analysed using a 2006 SAM, developed by the International Food Policy Research Institute (IFPRI) (Nwafor & Alpuerto, 2010). Algeria's oil sector linkages are analysed using a 2002 SAM, developed by Bouazouni (2008). Chad's oil sector linkages are analysed using a 2000 SAM, developed by Garber (2014a).

Secondly, the results from Chapter 5 are used to develop the Structural Take Indicator (STI) in Chapter 6. The oil sector can influence the host country's economy in terms of three categories: the impact on other sectors (activities) through backward linkages, the use of factors of production (capital and labour), and the impact on households. Considering the relative importance of these three components, the components are assigned weights that are used to combine these impact components into a single indicator, i.e. the STI. The STI serves as an additional measure to government take when evaluating petroleum fiscal systems. The development of the STI is a unique contribution to the literature on petroleum fiscal systems. Therefore, the STI serves to enhance the evaluation of petroleum fiscal systems by filling the current gap in the field of petroleum fiscal systems.

It is crucial to highlight the following issues. Data limitations are a particular problem when doing empirical analysis in Africa. For example, there is currently no SAM available for Angola. The most recent SAMs for Nigeria and Algeria are to a certain extent dated, with base years of 2006 and 2002, respectively. The latest SAM available for Chad (2000 base year) is a snap-shot of the pre-oil economy and does not capture the current structure of Chad's oil-producing economy. However, the 2000 SAM is currently the best available for this analysis. The focus of this thesis is on the evaluation of petroleum fiscal systems, which entails the

[7] The absence of an Angola SAM was confirmed in a personal communication with Muzima (2014) from the African Development Bank (AfDB). Angola's National Institute of Statistics is still planning to build such a matrix from the consolidated 2010 National Accounts Data.

relationship between the collection of revenue (government take) and the promotion of oil sector investment. This thesis is done within the context of the data limitations outlined above. Despite these limitations, the research still provides significant results on the structure of petroleum fiscal systems in these countries.

Through the development of the STI, the oil sector's economy-wide impacts can be incorporated into the evaluation of petroleum fiscal systems. However, this thesis does not consider the expenditure side of fiscal policy, which deals with the policies governments use to manage the revenues they receive from the oil sector. Revenue management and allocation are separate issues that fall under the revenue management side of the literature and falls outside the scope of this thesis. The revenue management literature is concerned with the spending and use of resource revenues with the aim of avoiding the so-called 'resource curse'.

1.8 Structure

This thesis is presented in seven chapters, which are structured as follows: Chapter 2 provides a literature and theoretical overview on petroleum taxation and provides the bases upon which the rest of the study can be conducted and the results thereof interpreted. Chapter 3 provides a comparative analysis of global petroleum fiscal systems by considering five countries using concessionary systems and five countries using contractual systems. The countries were selected to present a combination of developed, emerging and developing economies. The review includes the results from the Fraser Institute (2014) global petroleum survey on the perceived barriers to investment in upstream E&P around the world. Chapter 4 provides a comparative analysis of the petroleum fiscal systems used in Africa's three largest oil producers (Nigeria, Angola and Algeria) as well as the nascent producer Chad. Chapter 5 provides an overview of the SAM, multiplier and SPA methodology and presents the multiplier decomposition and SPA results for Nigeria, Algeria and Chad. Chapter 6 uses the results from Chapter 5 to develop the STI and discusses the implications of this new indicator. The summary and final recommendations are contained in Chapter 7.

Chapter 2: Petroleum taxation: Literature and theoretical overview

"The art of taxation consists in so plucking the goose as to obtain the largest amount of feathers with the least possible amount of hissing". JB Colbert (1619-1683), Louis XIV's controller-general of finance.

2.1 Introduction

Host governments compete to attract the necessary investment to develop their oil resources (Tordo, 2007:1). Petroleum fiscal systems are one of the main factors investors consider when making an investment decision (African Development Bank, 2009:80). The fiscal system must secure a fair share of economic rent for the host country, while still being conducive towards attracting upstream investment. From the government policy perspective, government take is one of the main considerations. However, it is often calculated on unrealistic assumptions, but more importantly, the macroeconomic scope of government take is too narrow and does not account for the oil sector's economy-wide impacts. This thesis aims to enhance the evaluation of petroleum fiscal systems by considering the broader economic impacts associated with oil sector investment and the implications it holds for petroleum tax policy.

Before the oil sector's economy-wide impacts can be considered, the foundations of petroleum taxation must be examined more closely. To this end, the rest of this chapter divides the topic of petroleum taxation into its core components. Firstly, mineral taxation serves specific functions, while the oil sector's characteristics make petroleum taxation unique. Furthermore, the scarcity of non-renewable resources such as oil creates economic rent when the resource is extracted. The 'fair' division of this economic rent between the host government and the producer (IOC) is a primary objective of petroleum taxation. Therefore, the types of economic rent as well as the issue of measuring economic rent are reviewed. Governments can use various taxation and non-taxation instruments to collect their share of economic rent. The different 'combinations' of taxation and non-taxation instruments used by host countries are controlled or organised by a country's petroleum fiscal system. This chapter reviews the foundations of petroleum taxation and the theory of economic rent and rent capture, which provide the theoretical underpinnings for the rest of this thesis.

2.2 The functions of taxation

Petroleum taxation is an important policy instrument for host governments and has a wide-ranging impact on the economies of oil-producing countries. Governments rely on tax revenues to fund their activities. However, petroleum taxation has a broader function than simply providing the government with revenue (Nakhle, 2008:7). Sarma and Naresh (2001:3) identify three broad objectives of mineral taxation. The first objective is based on the government's responsibility to achieve economic and social development. Governments should ensure the socially optimal and equitable extraction of resources, while also ensuring that the sector contributes to public revenues to promote economic development. Secondly, as the resource owner, the government should secure a fair share of the mineral rent. The third objective is to minimise any environmental costs associated with mineral production.

A petroleum fiscal system is incorporated in the tax structure of a country and falls within the ambit of a good tax system. The effectiveness of a tax can be benchmarked against a number of criteria, which are well established in general taxation literature[8]. The main criteria are: efficiency, neutrality, equity, stability, flexibility, clarity and simplicity.

2.3 Petroleum taxation: Theoretical background

The exploitation of oil resources involves high investment costs with the potential for very large rewards or losses (Daniel, Keen, & McPherson, 2010). Host governments need to attract investment (capital) to transform oil resources into productive capacity (Goldsworthy & Zakharova, 2010:6). To achieve this goal, the host government should ensure that investors receive a return on investment that is in line with the associated risk. The distribution of rewards between the host governments that control access to oil resources and the investors who discover and exploit these resources is determined by petroleum taxation (Daniel, Keen, & McPherson, 2010).

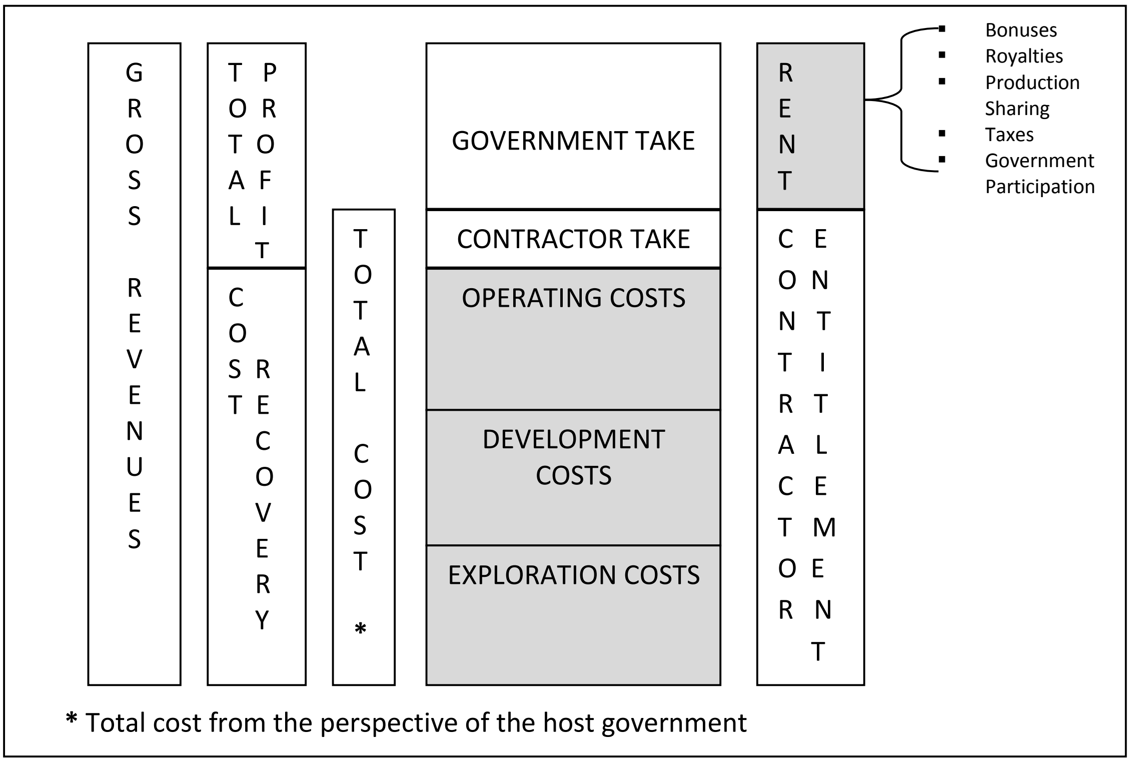
The basic premise of petroleum taxation is to retrieve for the host government, as owner of the resource, a fair share of the economic rent[9] generated by the extraction of oil resources (Baunsgaard, 2001:3; Nakhle, 2008:5). Johnston (1994:6) defines economic rent in the oil sector as the difference between the value of production and extraction costs. Extraction costs

[8] See for example: Boskin & Robinson (1985), Goldsworthy & Zakharova (2010), Nakhle (2008), Nakhle (2009), Stauffer & Gault (1985), Stiglitz (2000) and Tordo (2007).

[9] Economic rent is discussed in detail in section 2.3.2

include exploration, development, and operating costs as well as an appropriate share of the profit for the oil sector. Economic rent is regarded as surplus or excess profits that host governments want to capture by using various tax instruments. The government's profit is the difference between the gross revenue and the government's costs. The government regards the contractor's (investor) share of profits as a cost. The contractor may ultimately recover the exploration, development and operating costs out of production. For this reason, the government also regards these expenditures as a cost. After the government has accounted for these costs, the remaining revenue is the resource rent that accrues to the government. The allocation of oil revenue, cost and the division of profits is illustrated in Figure 2.1.

Figure 2.1: Revenue allocation for oil production



Source: Johnston (1994:7)

The allocation of revenue shown in Figure 2.1 can be interpreted by starting with gross revenues on the left hand side and moving rightward where gross revenue is finally split into the rent that accrues to the government and the contractor (company) entitlement. The contractor (company) entitlement comprises the contractor's 'take' or share of the profit plus the recovery of operating, development and exploration costs.

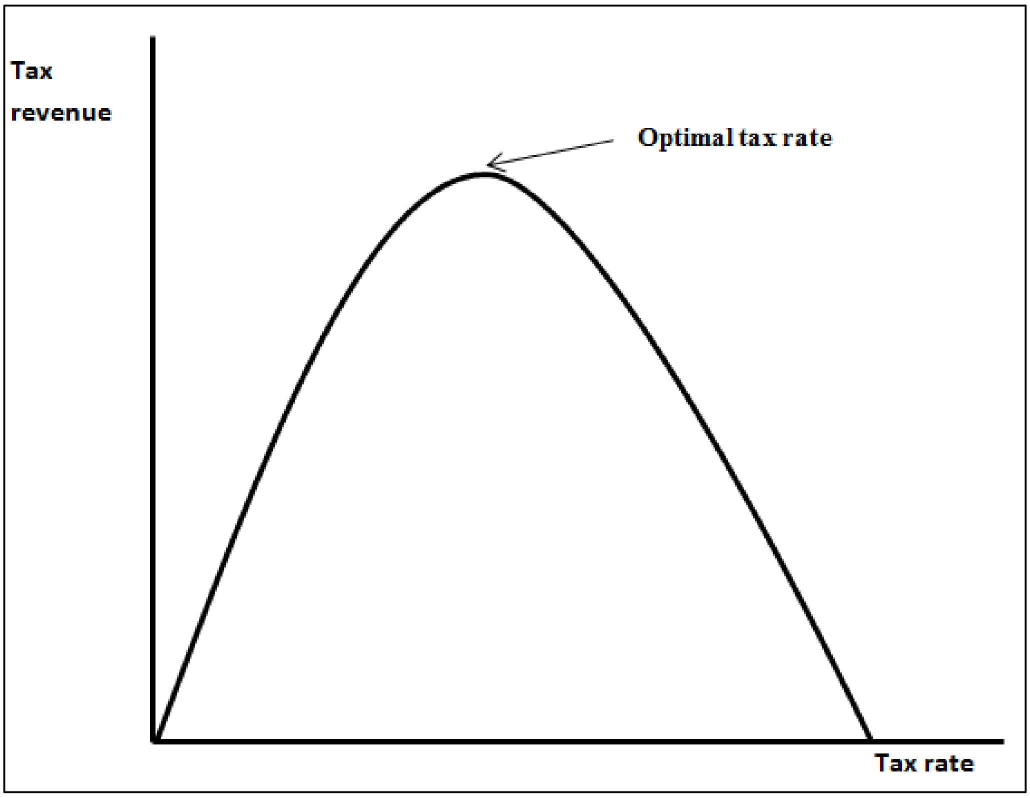
Petroleum taxation should not discourage investors but rather encourage investment and the optimal recovery of oil resources (Nakhle, 2008:5-6). Extremely high levels of taxation may maximise short-term revenue, but have long-term negative impacts on future investment (Baunsgaard, 2001:3-4). Petroleum taxation is a key component when host governments and potential investors negotiate new projects; host governments can give up potential revenue by providing more lenient terms and in so doing attract more investors. Investors argue in favour of more lenient fiscal terms to compensate them for excessive costs or risk within a specific host country. Furthermore, it can be argued that the loss of revenue is not real; attracting investment and collecting revenue under lenient terms would be better than not collecting any revenue under a system of tougher fiscal terms. The situation is obscured by uncertainty and asymmetric information on the profitability of a project; it is difficult to determine whether investment would still take place without the lenient terms sought by investors.

In addition to sharing rewards, petroleum fiscal systems can be used to distribute risk between the investor and host government (Goldsworthy & Zakharova, 2010:6). For example, governments can ensure a stable and low-risk revenue stream by using a fiscal system based on oil revenues rather than profits. In this case, the government will still earn revenue even if the investor is not earning profits. Such an arrangement shifts risk from the government onto the investor, but this will require the government to accept a lower level of taxation[10]. For this reason, some governments may rather prefer a more progressive system that will link the government's revenue to the project's profitability. Such a system would increase the government's potential revenue as well as the government's share of risk. A progressive system links the government take to project profitability, which is a function of the oil price. For this reason, the government will automatically reap the benefits of higher oil prices. Based on its risk preferences, the host government faces a trade-off between a scenario of low risk with lower (more stable) returns or a case of high risk and higher (more volatile) returns. Government risk preferences are influenced by the country's fiscal health, access to capital markets, the range of its oil field portfolio, and the relative size of a project compared to the overall economy (Daniel, *et al.*, 2010).

[10] Differing time preferences and risk profiles may allow for a mutually beneficial 'exchange' from changing the time and risk allocation between the two parties (Goldsworthy & Zakharova, 2010:6).

The objective of attaining a fair share for the government often competes rather than complements the objective of encouraging investment (Nakhle, 2008:6). For this reason, a critical policy issue is the design of petroleum taxation that gives the host government a fair share of the benefits in both times of high and low oil prices without compromising the stability of investment and with it the sustainability of the country's oil sector (Goldsworthy & Zakharova, 2010:3; Land, 2009). Nakhle (2008:6-7) illustrates the trade-off between tax rates and tax revenues, as applied to the oil sector, using the concept of a Laffer curve. The curve identifies an optimal point of taxation (tax rate). When tax rates are below this rate, tax revenue can be increased by increasing the tax rate. Increasing the tax rate above the optimal level will reduce tax revenue. However, the Laffer cuve concept is not free from critique, Mirowski (1982) provides a detailed discussion of the objections against it[11]. The Laffer curve is illustrated in Figure 2.2.

Figure 2.2: The Laffer curve



Source: Stiglitz (2000:699)

The Laffer curve concept was applied in the USA during the first Reagan administration when lower tax rates for high income brackets increased tax revenues. The same was found in the

[11] See Hsing (1996) and Heijman & Van Ophem (2005) for a discussion of policy applications.

United Kingdom (UK) during Margaret Thatcher's first administration. When the USA and UK applied this policy to the larger group of people who fall in the 'standard' bracket, tax revenues fell considerably. However, the Laffer curve's applicability to petroleum taxation can still be seen in the UK's North Sea tax policy. In 2002, the corporate tax rate of 30% was supplemented with a 10% supplementary charge, and in 2005, this charge was doubled to 20%. These actions were based upon increased oil prices and the even higher prices expected in the medium term. These policy actions decreased North Sea oil production levels and accordingly government revenues were significantly lowered. These experiences show that a balanced tax regime can produce a positive outcome as opposed to a zero-sum outcome.

2.3.1 Special tax relevant characteristics of the oil sector

Extractive industries, in particular the oil sector, have tax-relevant characteristics that differentiate them from other industries, which makes tax policy both important and challenging (Boadway & Keen, 2010; Land, 2009). These characteristics can explain the economic interests and behaviour of both host governments and the investing oil companies (Land, 2009). Boadway and Keen (2010) argue that these characteristics are not solely unique to resources; it is rather the sheer scale of these characteristics that distinguishes resources from other industries.

2.3.1.1 High sunk costs and time consistency

Oil projects involve large upfront investment for exploration and development prior to the generation of any cashflows. Once incurred, these expenditures rarely have an alternative use and become sunk costs (Boadway & Keen, 2010; IMF, 2012:10; Tordo, 2007:4). An oil project's evolving risk profile shifts negotiating power from the investor to the host government and creates a problem of time consistency. In the lease/negotiation stage of an oil project, the proposed tax system will have a significant impact on the investors' decision to invest (Boadway & Keen, 2010). However, once the investors have incurred sunk costs on the project, governments can increase the tax burden on investors (Boadway & Keen, 2010; IMF, 2012:10). In light of the sunk costs, investors will still favour production above abandonment as long as they cover their variable costs (Boadway & Keen, 2010). Therefore, the tax base (investors) is relatively elastic to the tax burden during the lease/negotiation stage and relatively inelastic during the post-lease/negotiation stages. For this reason, host governments have an incentive to offer attractive fiscal terms in the lease/negotiation stage and to then change to less favourable terms in the post-lease/negotiation stages. The resource literature refers to this shifting bargaining power as the 'obsolescing bargain' (Boadway & Keen, 2010; Land, 2009). Obsolescing bargaining can lead to inefficiency when forward-looking investors anticipate the government's incentive to change fiscal terms once they have incurred sunk costs and make them reluctant to invest, referred to as the 'hold-up' problem (Boadway & Keen, 2010). The problem does not arise from ill will from either the host government or the investor, but rather reflects the principle of efficient tax design, based on setting the tax rate using the inverse relation to the elasticity of the tax base. The problem is that the host government is unable to commit to a specific regime at the start of the project; a promise alone will lack credibility since investors know that the government's incentive will change once they invest and incur sunk costs. The government's incentive to change fiscal terms will be even greater when projects prove to be more profitable, for example when the oil price increases.

2.3.1.2 The potential for economic rent

Governments use taxation to capture the economic rent[12] associated with the production of oil (Nakhle, 2008:8). Economic rents are not confined to the oil sector, but it is the large scale and potential persistence of economic rents that distinguish the sector (Boadway & Keen, 2010). In terms of efficiency, rents provide an attractive tax base that can be taxed up to almost 100 per cent without changing behaviour, conforming to the ideal of a non-distorting tax (Boadway & Keen, 2010; IMF, 2012). Rent taxation also holds benefits in terms of equity, if the rents would have accrued to foreigners (Boadway & Keen, 2010; IMF, 2012).

2.3.1.3 Uncertainty

Both host governments and investors are subject to significant uncertainty surrounding the economic outcomes of oil projects, especially during the exploration phase (Boadway & Keen, 2010; Land, 2009). These uncertainties are further perpetuated by the long time-frames associated with developing oil projects (Land, 2009). In addition to uncertainty, outcomes are also very variable. Geological risk and oil price volatility are two of the main factors that contribute to uncertainty. In terms of geological risk, it is uncertain whether exploration will be successful. Even if reserves are found, there is still no certainty as to the quality of such reserves, which will determine the economic value of production. Resource rent is dependent on the quality of reserves and a portion of the rent will be appropriated by the investing company as far as the fiscal system allows it.

[12] The concept of economic rent is discussed in section 2.3.2

Geological risk is greater for host countries with only a few potentially viable basins. Imperfect demand and supply responses to price signals as well as geopolitical tensions can give rise to oil price fluctuations (Land, 2009). Oil price volatility translates into considerable uncertainty and variability in the total rents that governments will earn over the life-time of an oil project (Boadway & Keen, 2010). However, the geological risk of failure is less severe for multinationals that can offset unsuccessful exploration projects against the successful projects in their exploration portfolio.

2.3.1.4 International considerations

Developing oil resources requires technical and managerial skills that host countries often lack (Boadway & Keen, 2010). For this reason, it is mostly foreign-owned firms, even if in joint venture with domestic companies or NOCs, which conduct exploration and development activities. In such a situation, more than one jurisdiction[13] will want to tax an oil project. The relevant governments and investors should therefore consider the overall impact of all these taxes.

2.3.1.5 Asymmetric information

Investors responsible for E&P tend to have more knowledge of the technical and commercial components of an oil project, while the host government will have full knowledge of its own future fiscal stance (IMF, 2012). These information asymmetries complicate rent extraction (Boadway & Keen, 2010). Investors have an incentive to understate the potential resource base and overstate the difficulty of extraction. Host governments can mitigate this information asymmetry by conducting their own geological surveys and by using expert consultancy services.

2.3.1.6 Market power

The resource taxation literature often assumes that host governments and investors behave competitively by being price takers, where the 'world oil price' is determined in the international market (Boadway & Keen, 2010). However, producers who own or control a significant share of global deposits may have substantial market power (IMF, 2012:12). For example, countries acting collectively (such as OPEC members) or individually can exert an influence over the supply of oil and accordingly the oil price (Boadway & Keen, 2010). Large

[13] For a detailed discussion of international tax issues influencing the resources sector see Mullins (2010).

oil companies can also exert some market power. Market power can alter tax-setting behaviour in oil exporting as well as oil importing countries.

2.3.1.7 Exhaustibility

A unique characteristic of oil resources is the finiteness of potential production (Boadway & Keen, 2010). The impact on long-term economic performance and oil price developments is questionable as proven oil reserves have continued to increase despite of increased demand (IMF, 2012:12). However, a significant opportunity cost of current extraction is the foregone production in the future (IMF, 2012:12).

2.3.1.8 Project basis

Oil deposits cannot be switched between projects (Boadway & Keen, 2010). For this reason, oil projects can be taxed on a project-by-project basis, a tax design not commonly found in other sectors (Boadway & Keen, 2010). For example, oil projects can be differentiated in terms of onshore or offshore projects, a distinction allowing for separate tax treatments.

The sheer scale of the above-mentioned characteristics distinguishes resources from other industries and explains the economic interests and behaviour of both host governments and the investing oil companies. Particularly, host governments want to capture as much of the oil sector's economic benefits as possible, while IOCs want to maximise profits.

2.3.2 Economic rent

The use of a separate fiscal system for the oil sector is largely based upon the special role of economic rent in the production of oil. The scarcity of non-renewable resources, such as oil, creates economic rent when the resource is extracted[14]. As mentioned earlier in this chapter, economic rent in the oil sector is defined as the difference between the value of oil production and the costs of extraction (Johnston, 1994:6). The costs of extraction include factor costs as well as their opportunity costs (Nakhle, 2008:16-17). Accordingly, economic rent is the surplus return above the value of factor inputs used to produce the resource (see Figure 2.1). Inputs accounted for include capital, labour, entrepreneurial profit and risk-taking.

[14] See Hotelling (1931) for the influential contribution to understanding non-renewable natural resource markets and more specifically the pricing of these resources. Also see Hart & Spiro (2011) as well as Reynolds & Baek (2012) for an alternative view to Hotelling's (1931) theory.

This surplus (financial return) is not necessary to motivate economic behaviour and for this reason, in theory, can be taxed without altering production decisions (Baunsgaard, 2001:5-6). Investors would still earn an acceptable return on their investment even if all the economic (pure) rent is taxed. For this reason, resource allocation is unaffected and investment would still take place. The opportunity cost of supplying or producing oil is the so called ‘supply price of investment’, which is an investor’s required return to justify a decision to invest. The supply price of investment should be enough to cover the exploration, development and production costs. Furthermore, it should also cover the cost of capital and a risk premium. Considering a specific project and total return on investment, the potential for economic rent will increase with a lower supply price of investment. The relative proportions between the supply price of investment and economic rent will determine the government’s scope for taxation and the possibility of either discouraging or encouraging investment. The actions of the host government can reduce the supply price of investment by minimising investor uncertainty and in so doing increase the economic rent available for taxation without being a disincentive for investment.

For petroleum taxation, the identification of rent can be particularly important and has a practical meaning (Garnaut, 2010). The terms ‘resource rent’ and ‘economic rent’ are often used interchangeably (ICMM, 2009:20). However, there are other sources of economic rent and they exist in various markets. For example, the ownership of land, access to a licence to conduct a particular business when a limited number of licences are issued, and monopoly power of a market or a certain technology (Garnaut, 2010). Rents provide market participants with signals to adjust demand and supply and in this process rents disappear (ICMM, 2009:20).

However, under certain conditions, various types of rents will not disappear[15]. Resource rents fall in this category. Oil resources already ‘exist’ and are not manufactured. For this reason, the efficient level of output from extraction includes a producer surplus to the owner of the resource. Demand and supply does not eliminate this surplus. For example, two oil projects may deliver the same type of crude oil but with different costs of extraction because of differences in geography and geology. The lower cost oil project will deliver more resource rent than the more marginal oil project. When the joint output is needed to satisfy demand, both

[15] This is not limited to resource rents, for example rents created by public policy and institutions cannot be eliminated because there is no market mechanism to eliminate them (ICMM, 2009:20). For example, key infrastrucutre developments may lead nearby locations to become prime property (ICMM, 2009:20).

project owners will receive the same price per barrel, irrespective of the difference in their cost structures. Within this context, Land (1995) defines resource rent as “the excess of the total value (gross proceeds) arising from the exploitation of a deposit over the sum of all project costs including the rewards to each of the factors of production”. Furthermore, Land (1995) notes that “resource rent is most likely to be generated over the life of a project by the exploitation of easily accessed high quality mineral deposits with below average exploitation costs.”

In terms of taxation, mineral rent can be distinguished from the other sources of rent in two ways (Garnaut, 2010). Firstly, mineral or oil resources are immobile between countries. Secondly, most mineral resources are owned by the state that allocates exclusive rights to extract and produce these resources. Communities expect the private party (investor) to pay the full value of the resource it was given access to. Accordingly, the value of a resource lease made available to investors should present the expected present value of the economic rent (Garnaut & Clunies Ross, 1983). There are two reasons motivating host governments to extract economic rent as revenue. On efficiency grounds, taxing resource rent has a lower economic cost than other forms of taxation, and furthermore, it measures the value of public property that is transferred to private investors (Garnaut, 2010).

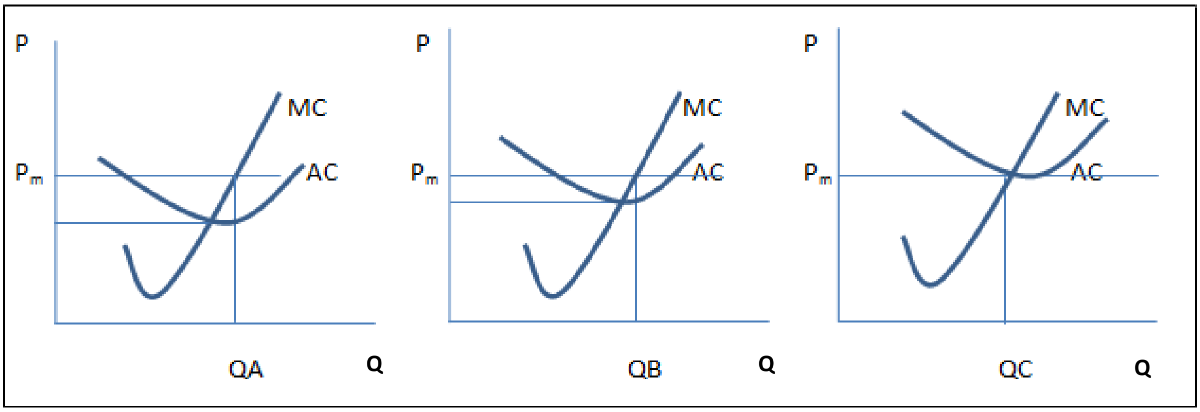
Although the literature has easily managed to theoretically identify and describe the issues surrounding resource rents, the identification, measurement and collection of resource rents have proven to be more difficult in practice (Land, 1995). This is illustrated when considering the different time-related components of an overall resource rent (ICMM, 2009:21).

2.3.2.1 Types of rent

There are three main types of rent: scarcity rent, differential or Ricardian rent and quasi-rent (Nakhle, 2008:17). Quasi-rents are short-term rents. From these three types of rent we can identify the pure rent, which comprises scarcity and differential rent. The natural scarcity of a resource limits the available production and creates scarcity rent. Scarcity rent accounts for the future profits that are forgone by extracting the resource today. According to Hotelling (1931), the behaviour of an exhaustible natural resource firm, with a given level of reserves, will differ from non-resource-based firms. Competitive firms will normally increase their output to a level where the price of their product (marginal revenue) equals the associated marginal cost. However, an exhaustible natural resource firm must not only consider its production costs, but also the opportunity cost of producing an additional unit of output today, which is forgone production in the future (reserves produced today cannot be produced in the future) (Nakhle, 2008:17). This opportunity cost is the scarcity rent or user cost and is equal to the present value of the loss of future profits incurred by producing one more unit of output today.

The second type of rent is called differential or Ricardian rent. Differential rent theory is often attributed to David Ricardo ('Ricardian theory of rent'); however, it was proposed before Ricardo in 1815, by Malthus, as part of a debate on the duties on corn (Roncaglia, 2007:184). However, Ricardo was able to apply this concept. The concept was applied to agricultural land that could be classified according to the land's productivity. Considering both fertile and marginal land, the lower per unit costs of fertile land create differential rent. For a specific piece of land, rent is calculated as the difference between its per unit cost of production and the per unit cost of production on the less fertile lands, multiplied by the quantity of output attainable from the land in question. Rent on marginal or less fertile land is zero (Roncaglia, 2007:184). Ricardian rent is illustrated in Figure 2.3.

Figure 2.3: Ricardian rent

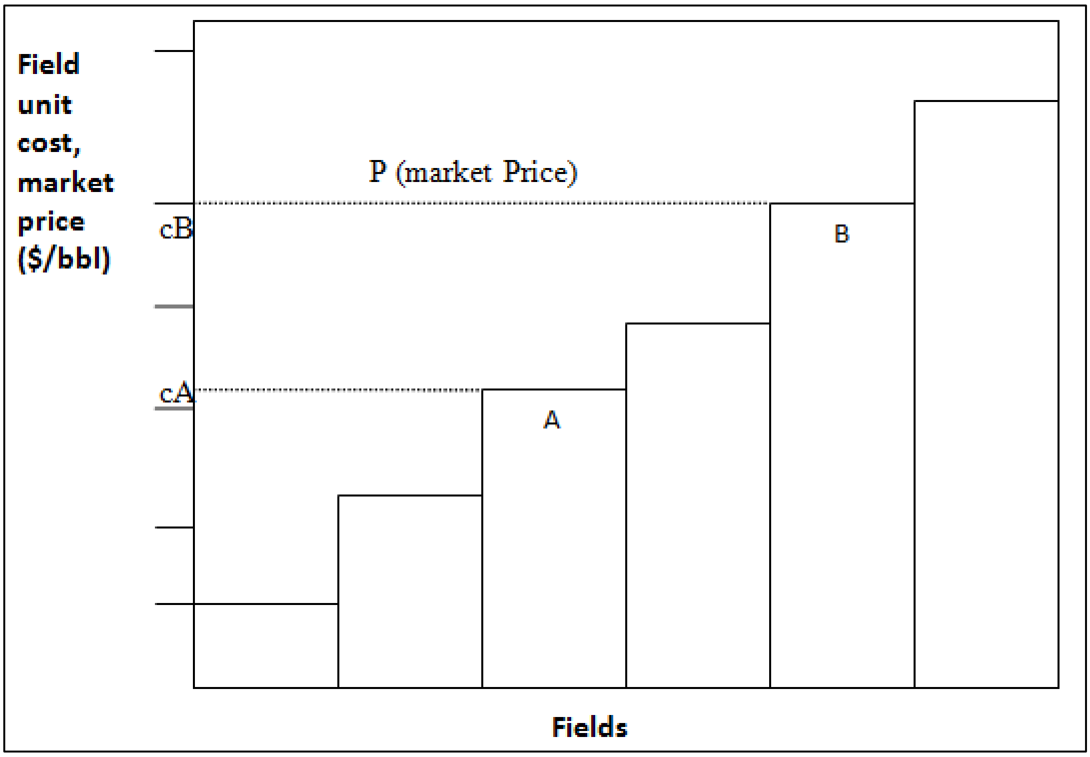


Source: Nakhle (2008:18)

Figure 2.3 illustrates the marginal cost (MC) and average cost (AC) for food production on three pieces of land named land A, B and C, respectively (Nakhle, 2008:17-18). Land A can produce food at the lowest cost and therefore enjoys the largest rent. Second to land A, land B produces food at a somewhat higher cost, but still earns rent. Land B's average cost is still lower than the market price (P_m). Land C is marginal land with a much higher average cost. Therefore, it does not earn any rent; its average cost is equal to the market price. The rents for land A and B are determined by means of comparison to land C, therefore also referred to as differential rent.

Ricardian rent normally arises due to differences in the quality and location of resources (Nakhle, 2008:18). This is similar to the returns for different oil fields. Oil fields or oil projects can be grouped according to their cost of production. Oil fields with an average cost below market prices will earn Ricardian rent and will therefore be more profitable. Average costs could be lower due to production efficiencies or favourable physical properties. Oil fields with an average cost equal to the market price are marginal fields and will not earn any rent. Oil field Ricardian rent is illustrated in Figure 2.4.

Figure 2.4: Oil field Ricardian rent



Source: Nakhle (2008:19)

In Figure 2.4, the vertical axis indicates the oil field unit costs and the wellhead prices, while the horizontal axis shows oil field production in terms of ascending cost, i.e. field A is a lower cost field than field B (Nakhle, 2008:18). The unit cost for field A is given by cA and a unit rent of P-cA, where P is the market price. For field B, the unit cost is equal to the price (P) and the field has no rent, i.e. the market price and unit cost for field B are the same.

The third type of rent is called quasi-rent. Quasi-rents are short-terms rents, which only exist in the short run before it is competed away as the market adjusts to new circumstances (Cordes, 1995). Quasi-rents accrue to firms from past investments or changes in market conditions (Nakhle, 2008:18). In the short run, when prices fall but still cover average variable cost, the firm earns quasi-rents and can continue to operate (ICMM, 2009:21). Quasi-rents from high price periods should be saved to recover the fixed costs of production from low price periods. For this reason, quasi-rents that exist above average variable costs should not be taxed.

Quasi-rents, over the long run, are payments that provide firms with an incentive to maintain an economically valuable allocation of resources (Garnaut, 2010). Firms expect a portion of their return on investment to cover the costs of exploration conducted in the past. This portion is the quasi-rent of exploration. A current mineral project will not be closed if the quasi-rent is taxed away. However, it will impact on decisions for new exploration. A portion of the expected future cashflow for a current mineral project includes a return on the original exploration and development cost. It is a quasi-rent on development expenditure. The government could tax the entire quasi-rent without affecting the production of current mineral projects; however, this would eliminate the incentive for new exploration projects.

For oil projects, the short-run rent (wellhead revenues less extraction costs) for an established (discovered and developed) project tends to be large as the extraction costs are normally relatively small (Nakhle, 2008:18). In addition to extraction costs, discovered but undeveloped oil resource projects must also account for development costs, which reduce the size of the rent (Nakhle, 2008:18-19). In addition to development and extraction costs, new exploration projects (still to discover oil resources) must also account for finding costs. Accordingly, economic rent will vary based on the costs and required return to sustain production from oil resources in the various stages of development. The value of economic rent will be influenced by the stage of development for the oil property under consideration.

When considering total economic or resource rent, it is important to identify the pure rent. Pure rent is what is left after considering short-run (quasi) rents (ICMM, 2009:21). Pure rent reflects a firm’s advantage in terms of lower per unit costs (Cordes, 1995). Therefore, pure rent comprises scarcity and differential rent (Nakhle, 2008:20).

2.3.2.2 Simplified theory for a complex reality

The determination of oil and gas production's taxable income has long been a controversial issue (Nakhle, 2008:19). Rent-based taxation should satisfy the neutrality criterion since taxing rent (surplus return) will not alter resource allocation (Cordes 1995). Rent-based taxes are only collected when a normal profit or acceptable rate of return is achieved and thereby encourages investment at the margin. Such taxation will not discourage potential investment.

Theoretically, it follows that economic rent is viewed as an important and appropriate source of government revenue, which, in theory, can be levied without affecting economic incentives (Nakhle, 2008:19-20). There are a number of arguments in favour of this theoretical line of reasoning. The reason most often claimed is that rent taxes do not affect the incentive for investment because it is a 'bonus'. Furthermore, by collecting the true value of the resource, the consumption of future generations will not be sacrificed at a cheap price. When capturing economic rent, the tax take will fall when economic rent decreases and rise when the rent increases. It follows that the tax base will respond appropriately to changes in costs and crude oil prices that affect the economic rent. Rent taxation is progressive, neutral, stable and fair to the community. A neutral tax on economic rent will promote risk sharing between the host government and the investor. As an exhaustible resource with no perfect substitute, oil can generate significant economic rent that host governments want to tax.

According to traditional resource rent theorists, collecting only the pure rent as tax will not cause any projects to close, not even in the long run (ICMM, 2009:21). This conclusion has been criticised, under the argument that firms will have insufficient incentives for exploration if they cannot keep a portion of the pure rent, preventing exploration to take place in the first place. Furthermore, without a share of the pure rent, there is no incentive to develop technologies for exploration in previously inaccessible areas. Under this line of thought, taxing the full pure rent would be detrimental to the long-run sustainability of a country's mineral sector. The policy conclusion is that the pure rent should be allocated in a 'fair share' between the host government and the investing companies. Such taxation would use a neutral fiscal regime with direct tax instruments[16] based on some definition of profit or income.

Although the literature thoroughly describes the theoretical concepts of resource rents, the practical identification, measurement and collection of these rents have proven to be more

[16] The various tax instruments available to tax the oil sector are discussed in section 2.3.3.

difficult (Land 1995). For this reason, the practical design of fiscal systems holds two complications (ICMM, 2009:21). Firstly, there is the problem of how to determine the pure rent of a project. The distinctive types of rent make it difficult to accurately measure the pure rent, which comprises scarcity and differential rent (Nakhle, 2008:20). The problem is that the distinction between these two types of rent can be fairly artificial. Most rents could be regarded as originating from either scarcity or differential effects alone and in practice host governments have difficulty in distinguishing between the two types of rent. It is appropriate to tax the pure rent but not the short-run quasi-rent. This exacerbates the problem of distinguishing and measuring the different types of rent and only taxing the pure rent. Furthermore, it is difficult for host governments to determine the acceptable rates of return for all IOCs, which the government needs in assessing the extent of the economic rent and the corresponding portion that has to be taxed. An associated problem is that an estimation of economic rent requires knowledge about the various costs of production factors, including their opportunity costs. Obtaining such information is often complex and difficult. The second problem is to incorporate the variation in pure rent across different projects and the further variation in the occurrence of rent over time (ICMM, 2009:21). Both these issues support an argument for taxation based on profitability.

In addition to the above complications, Nakhle (2008:20-21) highlights two additional concerns created by the calculation of economic rent. Firstly, economic rent is also present in other sectors. Ricardo focused on rents from agricultural land, but other natural resource sectors, such as forestry and fishing, also generate rents. However, these rents are not taxed. This raises the question, if oil sector rents are taxed, should not all sectors generating economic rent be taxed? The second issue concerns the incentive for continued exploration, which is necessary for the long-run sustainability of the oil sector. It is the possibility of significant pure rent that motivates exploration activity. Furthermore, it is also the driver behind the development of technologies that enable the exploitation and development of known but previously uneconomic oil resources. Without exploration and technological advancements in development and production methods, the resources have no value to the host country. Even if a host government taxes only the pure rent and exempts quasi-rents, reserves will decline along with a reduction in exploration activity until the country's current (known) reserves are depleted. A scenario of significant short-run Ricardian rent coupled with zero long-run rent may give raise to short-sighted taxation policy. Within this context, increased taxes may appear effective in the short run, while its negative effects on the sustainability of the country's oil sector and government revenues will only become apparent in the long run.

The issues discussed above show that the practical application of resource rent taxation is much more complicated than rent theory would predict and that other forms of taxation might be needed. The alternative taxation instruments are discussed below.

2.3.3 Taxation instruments to capture economic rent

Once a host government has decided upon the appropriate share of economic rent, it must decide upon the appropriate taxation instruments it will use to collect and capture this rent. Different combinations of instruments can be used and the specific design of the fiscal system will impact on the profitability and risk sharing of oil projects. The chosen instruments will affect the investor's appraisal of a project's viability. For example, two fiscal systems with the same allocation of rent between the host government and investor, but that use different instruments, will cause the investor to have different viability assessments for the two projects. To ensure the objectives of both the host government and the investor are met, the choice of instruments must consider the implications for risk sharing and the timing of revenue collections.

The general taxation literature distinguishes between direct (*in personam*) and indirect (*in rem*) taxation instruments (ICMM, 2009:36-37). In terms of mineral taxation, a distinction can be made between profit-based taxes and production-based taxes. Profit-based taxes are defined as taxes charged on a specific definition of a company's revenues less specified (qualifying) costs. Production taxes are defined as taxes charged on reserves or production inputs and services. There is an extent of overlap between profit-based taxes and direct taxes and also between production-based taxes and indirect taxes. A third category of instruments are the so-called non-taxation instruments. Companies are assumed to prefer profit-based taxes, while governments have a preference to include at least some production-based tax components in their fiscal regime. From the company perspective, depending on the host country's taxation and accounting conventions, profit-based taxes can be used to delay tax payments until up-front costs have been recovered, be it in part or in full. From the host government perspective, production-based taxes can provide early tax payments and furthermore, these taxes can be more easily earmarked for political purposes. However, these taxes are regressive and can increase the investor's risk by requiring tax payments in years when oil projects are incurring losses. Profit-based taxes require a high level of administrative capacity from the host country and are often lacking in the countries that want to attract investment. In contrast, most production-based taxes are easily administered and also cost efficient. The main taxation instruments are summarised in Table 2.1, and non-taxation instruments are summarised in Table 2.2.

Table 2.1: Taxation instruments

Taxation instruments			
Profit-based taxes (Direct taxes)	**Description**	**Production-based taxes (Indirect taxes)**	**Description**
Corporate income tax (CIT)	These taxes are based on profits at a company level rather than the oil field level and typically apply to the consolidated operations of the company.	**Royalties**	Royalties are payments for the right to exploit a host country's resources and are levied directly on the extraction of the resource itself.
Ring-fencing	Ring-fencing applies when the taxable entity is project/field based rather than company based. Ring-fencing normally forms a boundary around the licence area. Ring-fencing is used to protect present tax revenues from being postponed by cost deductions from other projects	**Import duties**	Import duties are levied on the imports needed to develop and produce the resource.
Brown tax (BT)	Levied on a fixed proportion of a project's net cashflow in each period. Taxes have to be paid when the net cashflow is positive. A negative net cashflow will give firms a rebate.	**Other taxes**	Export duties, VAT, payroll taxes, sales and excise taxes.
Resource rent tax (RRT)	The RRT is a modified version of the BT. Taxation is based on an estimate of economic rent. Instead of investors receiving tax credits for years with negative cashflows, the negative amounts are carried forward and deducted from positive cashflows in later periods. The RRT is only payable after the investor has earned a required rate of return. The RRT carries losses forward while a BT provides a rebate for losses.		

Source: adapted from Baunsgaard (2001:6-14), Boadway & Keen (2010), Goldsworthy & Zakharova (2010:7), ICMM (2009:36-37), IMF (2012:18-22) and Nakhle (2008:22-23)

Table 2.2: Non-taxation instruments

Non-taxation instruments	Description
Fixed fees and bonus payments	For example: • A signature bonus paid upon the allocation of exploration rights to a company. • A discovery bonus paid upon the discovery of oil. • A production bonus paid once oil production commences.
Production sharing	Ownership of the oil resource remains with the host government and the oil company is contracted to extract and develop the resource in return for a share of the output that is produced.
State equity	The host government holds equity in an oil project to secure a higher share of the rewards, by securing additional revenue beyond tax revenue.

Source: Adapted from Baunsgaard (2001:11-14) and IMF (2012:21)

2.3.3.1 Assessing the main taxation instruments

The main taxation instruments can be summarised in terms of royalties, the Brown tax (BT), the resource rent tax (RRT) and corporate income tax (CIT), which could include ring-fencing. Each of these instruments has advantages and disadvantages, and will be applicable in certain circumstances (see Table 2.1).

Royalties have the advantages of being easy to implement and administer, providing the government with revenue from the start of production as well as providing a more stable and predictable tax base (Boadway & Keen, 2010, Sunley, Baunsgaard, & Simard, 2002). However, royalties increase the marginal cost of extraction and can discourage investment if imposed at too high a level (Sunley, Baunsgaard, & Simard, 2002). Because royalties are focused on the extraction stage and do not provide offsets for exploration and development costs, it can discourage investment decisions by falling heavily on quasi-rents (Boadway & Keen, 2010).

Royalties shift more commercial risk onto the investor who has little protection against higher costs or lower oil prices (Nakhle, 2008:23-24). A high tax rate on production can potentially create more distortions than a similar tax based on profits. For this reason, the literature regards royalties as a regressive tax that can make profitable projects unattractive when considering the tax burden. However, there are mechanisms available to mitigate these distortions, for example the sliding scale[17] royalty. The sliding scale royalty charges different tax rates based on either

[17] Sliding scales are a mechanism that increases effective taxes/royalties and is based upon profitability or a proxy of profitability, for example increased production levels (Johnston, 2003:362).

the level of production or the oil price. The royalty rate will be lower for low production levels or low oil prices and higher for higher production levels or higher oil prices. This allows the royalty to still provide early government revenue, while incorporating a progressive character. However, a sliding scale system has the burden of administrative complexity.

Arguments for profit-based taxation assume the fiscal system to be neutral and use direct taxation instruments that are based on profit or income (ICMM, 2009). Indirect, production-based, taxation instruments have shown a negative incentive, supporting proposals for moving away from these regressive instruments and emphasise a greater reliance on direct, profit or income-based instruments. However, this assumption may face difficulty in countries that rely on these revenues as a major source of government revenue, whereby political pressure may shift the governments' preference towards instruments that deliver revenue sooner. The BT and RRT are instruments that attempt to approximate rent taxation.

The BT, also referred to as an 'R-based cashflow tax'[18], is charged on the producer's cashflow, which is all current receipts less all current expenses (Boadway & Keen, 2010, IMF, 2012:20). Under such a tax, negative cashflows provide companies with negative tax liabilities, which are immediately refunded or carried forward. The BT targets economic rent and satisfies the criteria of neutrality and risk sharing. However, despite the BT's theoretical advantages, in practice it is an unpopular instrument because it shifts a very high level of risk onto the host government (Nakhle, 2008:24).

The RRT, a modified form of the BT, also targets economic rent and is a regarded as a neutral tax (Nakhle, 2008:25). The RRT allows firms to earn an agreed upon rate of return on investment before a tax liability is incurred and once the required rate of return was achieved, the marginal tax rate is very high (Cordes 1995). The RRT shares risk between the government and investor, for example if the oil prices fall or costs increase the tax burden falls accordingly (Nakhle, 2008:25). The literature often argues in favour of the RRT as an appropriate tax instrument that collects economic rent without affecting investment decisions. For this reason, the RRT could be applied with higher tax rates to capture a bigger share of economic rent, creating fewer distortions at the margin relative to alternative instruments. The RRT is levied

[18] In the terminology of Meade (1978), the R-based cash flow tax is based on real, rather than financial, flows (Bond & Devereux, 2002).

on a project basis as opposed to an aggregate company level. Theoretically, the threshold rate should vary across projects; however, in practice, a uniform threshold rate is often applied. The RRT also has its weaknesses. It could give rise to over-investment, which affects the rate of resource depletion. Considering the difficulties in identifying economic rent and that the RRT targets economic rent, it is difficult to raise large amounts of tax revenue without affecting the neutrality characteristic. The determination of a threshold rate at which to levy the RRT creates further difficulties. Setting the rate too high could mean the RRT will never be applied while setting it too low will deter investment (Sunley, Baunsgaard, & Simard, 2002:6).

CIT systems are commonly used to tax the resource sector based on the accounting definition of annualised profit, where taxable income is determined after accounting for operating costs and permitted allowances (Cordes 1995). CIT holds the advantages of being familiar and easy to administer, being based on ability to pay, and its neutrality in terms of decision-making. CIT can be used as a base for a variable income tax, which varies the tax rate based on the ratio of profits to gross revenues (IMF, 2012:19). However, this could create distortions when high tax rates are charged in periods of high accounting profit during the early stages of the project, before the needed returns have been earned.

A proportional income tax has the benefit of not affecting the choice between projects with different economic lifetimes and time-line profiles (Nakhle, 2008:25-26). Dasgputa and Stiglitz (1971) argue that differential taxes (for example special petroleum taxes) will affect allocative efficiency and should only be used if economic rent exists. Should differential taxes be infeasible, higher tax rates can be applied to the energy sector to indirectly tax rent (Nakhle, 2008:26). Garnaut and Clunies Ross (1975) recommend the use of the higher rates of proportional income tax (HRIT), an adjusted version of CIT. The HRIT is more targeted at economic rent than profit and requires the payment of normal CIT at a higher rate than would be applicable to non-resource income (Nakhle, 2008:26).

A major limitation of CIT is that it does not allow any threshold return on equity capital; it is a tax on the total return equity (Nakhle, 2008:26). For this reason, many authors conclude that CIT is not targeted on economic rent and that it is not progressive, potentially distorting investment decisions. Furthermore, large tax reliefs could create a 'gold-plating'[19] effect whereby investing in capital equipment could provide tax relief that exceeds the original investment. However, the main debate surrounding CIT is often focused on the immediate deductibility of costs. CIT does allow deductions for capital costs using depreciation over time; this can apply over the life of a project. In contrast to BT and RRT, investors normally do not recover their costs immediately and it results in early revenue payments to the host government.

The extent of 'ring-fencing' can play an important role within CIT; it places a limit on the consolidation of income and allowable deductions across a company's different activities or projects (Sunley, Baunsgaard, & Simard, 2002:5). Without ring-fencing, oil companies will be able to deduct exploration and development costs from new projects against the taxable income of established projects and so postpone their tax payments to government. However, allowing deductions against current income could lead to more exploration and development activities, which, over time, increase the tax base and government revenue. The choice will depend on the government's preference for early (modest) revenues or later (bigger) revenues as well as the government's bargaining power.

2.3.3.2 The choice between instruments

Tax instruments that create distortions cannot be excluded as a policy option based on this reason alone (Nakhle, 2008:26). The most suitable tax instrument will minimise distortions. Instruments targeted on economic rent should produce fewer distortions. Each of the taxation instruments discussed above holds their own benefits and limitations. For this reason, many oil-producing countries adopt a combination of two or more of these instruments to capture economic rent, while minimising distortions to investment decisions. Fiscal terms can be replicated by different instruments and intrinsically there is no reason to prefer a tax/royalty regime to a production sharing regime or vice versa (Baunsgaard, 2001:14). The host government's choice will reflect administrative preferences or a particular structure that is most suited to domestic conditions. Accordingly, there is leeway to design a fiscal system that provides the best fit for project-specific circumstances, while also accounting for the appropriate level of risk and reward sharing between the host government and the investor.

[19] Gold plating is when the IOC resorts to making unreasonably large expenditures because of insufficient cost cutting incentives (Johnston, 2003:344).

Achieving efficiency in risk sharing between the host government and the IOC may constrain the value of 'progressivity'[20] of fiscal systems for particular developing countries (IMF, 2012). In this case, defining progressivity as the extent of revenue increases in response to increases in the oil price or to reductions in production costs. This progressivity will influence risk sharing between the government and IOC. To achieve efficiency, more risk must be borne by the party most able to bear it, which, in the case of developing countries, is often the IOC. This is given that the IOC has the ability to diversify its portfolio across the world. Accordingly, this developing country scenario will require fiscal systems that are not significantly responsive to oil prices, ensuring that the IOC receives the majority of upside gains, while the government is protected against the downside risk.

The different 'combinations' of taxation and non-taxation instruments used by host countries are controlled or organised by a country's petroleum fiscal system. The various types of petroleum fiscal systems are discussed below.

2.4 Petroleum fiscal systems

Even though the oil sector has a strong international character, local influences from within and outside of the oil sector can still have a significant influence on how a country's fiscal system is shaped and will affect the country's overall attractiveness for oil sector investment (Nakhle, 2010). The design of a country's petroleum fiscal system plays a significant role in shaping perceptions of an oil basin's competitiveness. A fiscal system should produce a mutually beneficial outcome for both the host government and investors. However, it is a fine balance to achieve. Overly generous terms will harm government returns and overly tough terms will reduce investment in exploration as investors will redirect their exploration activities to regions with more attractive fiscal regimes. The pattern of petroleum fiscal systems is influenced by petroleum geology, oil field-specific characteristics and investment returns, the age and maturity of an oil province and the general and expected pattern of world crude oil prices (Nakhle, 2008:31, Nakhle, 2010).

Sunley, Baunsgaard and Simard (2002:16-18) trace the development of petroleum fiscal systems over time and across countries using Norway, Kazakhstan, Indonesia and Angola as case studies. Differences in bargaining power are one of the main reasons for the wide variation

[20] Progressivity is often used imprecisely in discussions of resource taxation; it could also be defined in terms of how the present value (PV) of taxes varies with the lifetime PV of a project (IMF, 2012).

in fiscal patterns across countries. Countries with very attractive geology as well as political and macroeconomic stability tend to have stricter fiscal terms. Four features form part of the dynamic evolution of these fiscal systems. Firstly, it seems that oil prices have an influence on fiscal terms, which become more lenient in times of low oil prices and vice versa. Lower oil prices reduce profitability and investment and there appears to be evidence that host governments react to these conditions by providing more lenient fiscal terms. However, it still has to be confirmed whether this behaviour can be generalised to most oil producing countries for periods of sustained price changes. Secondly, tax policies of the investor or IOC's host country influence the tax policies of the host country. Thirdly, over time, the system of bonus payments has become streamlined and less important for collecting petroleum revenue. Fourthly, it is inferred from the case studies that tax regimes become more progressive as the petroleum fiscal system matures (Sunley, Baunsgaard, & Simard, 2002:18).

Host governments and investors both want to maximise their share of the value or benefits derived from oil production. The objectives for fiscal systems will differ depending on the viewpoint used, i.e. a government or investor viewpoint, which is summarised in Table 2.3.

Table 2.3: Objectives of fiscal policy

Government	Investor
• Supports macroeconomic stability by providing predictable and stable tax revenue flows. • Captures a greater share of the revenue during periods of high profits. • Maximises the present value of revenue receipts by providing for appropriations during the early years of production. • Is neutral and encourages economic efficiency.	• Has a minimum number of front-end-loaded[21] non-profit-based taxes. • Permits to repatriate profits to shareholders in their home countries. • Is transparent, predictable, stable, and based on recognised sector standards.

Source: Tordo, Johnston, & Johnston (2010:11)

[21] This refers to the timing of payments made to the host government; a front-loaded system levies up-front payments during the initial phases of an oil project. Investors (IOCs) tend to prefer systems that are not highly 'front-loaded' because this means they can postpone payments to the government to a later stage in the project lifecycle.

Mommer (2001) classifies gross income-based systems as proprietorial and profit-based systems as liberal. Under a proprietorial system, IOCs have limited scope to minimise liabilities, as long as the market determines prices, and accordingly volume is the only variable they can manipulate. The liberal system's levies only apply when there are profits or in some cases only for excess profits. For this reason, IOCs are in a stronger position under a liberal system than with a proprietorial system where host governments have a greater influence over upstream activities. However, according to Nakhle (2008:32), the reality underlying these different systems lies more in ideology and political fashion, for example the choice of state ownership versus privatisation.

2.4.1 The structure of petroleum fiscal systems

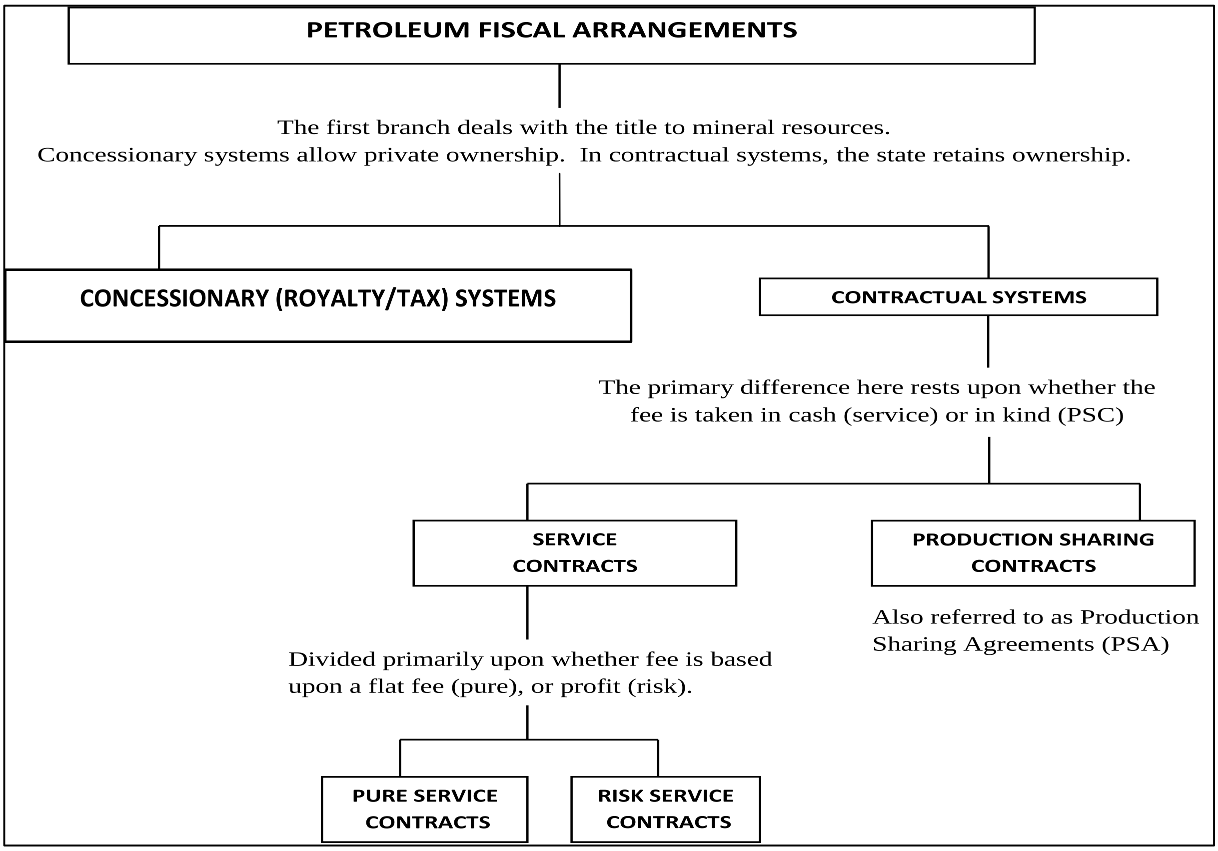
A petroleum fiscal system is the legal tax structure for a country, including royalty payments (Johnston, 1994:302). This term encompasses all contractual and fiscal elements that define the relationship between a host government and foreign oil company. Petroleum fiscal systems are the main mechanism that determines how oil wealth is shared between the host government and investors (Nakhle, 2010). For the purposes of this thesis, petroleum fiscal systems encompass taxation, contractual frameworks, state participation and bonus payments. Nakhle (2010) identifies three options that host governments can choose from when deciding on how to administer their oil sector. The three options are:

1. A 'go it alone strategy' where the government runs the oil sector and no private investors are allowed. Under such an arrangement, where no private companies are involved, there is no need for a petroleum fiscal system.
2. An arrangement of no direct government involvement, only private ownership. This arrangement normally takes the form of a concessionary system.
3. A 'hybrid' system of partnership or co-operation between IOCs and NOCs. This option allows for a greater variety of arrangements, varying between concessions, production sharing agreements and service contracts.

Host governments are in competition with other countries to attract investment and technologies to develop their oil resources (Tordo, 2007:1). IOCs' initial decisions to invest and the return on investment are highly influenced by the petroleum fiscal system of the host country. Many countries negotiate specific terms with specific producers (Johnston, 1994:5). For this reason, there are more petroleum fiscal systems than the number of countries producing oil.

The legal framework for oil exploration, development and production is normally contained in a country's constitution, while hydrocarbon law sets out the particular principles of law (Tordo, 2007:7). Petroleum fiscal systems define the rights and obligations of the host government and the IOCs. The essence of these systems is the division of profits and the recovery of costs (Johnston, 1994:5-6). A large portion of exploration ventures are unsuccessful. For this reason, it is difficult to determine the best means for efficiently capturing the rent from oil projects. A petroleum fiscal system should provide sufficient potential rewards for exploration investments by incorporating the high risk associated with exploration activities (Johnston, 2003:2-3). Host governments want petroleum fiscal systems that assign exploration and development rights to the companies that place the highest value on those rights. This outcome can be achieved by a system of competitive bidding for the allocation of these rights. However, an efficient bid market requires the availability of information. Without sufficient competition, efficiency must be incorporated into the petroleum fiscal system by design. There are two main types of petroleum fiscal systems, namely royalty/tax (concessionary) systems and contractual-based systems (see Figure 2.5).

Figure 2.5: Petroleum fiscal system taxonomy



Source: Johnston (1994:25)

In terms of a financial viewpoint, there are more similarities between these systems than there are differences. However, from a legal viewpoint, the differences that do exist have important implications. The main distinction between the two systems is the question of ownership (Johnston, 2003:11). A royalty/tax (concessionary) system assigns the title of the crude oil that is produced to the oil company, which has to pay royalties and taxes on production. Title to the oil production passes to the IOC at the wellhead. Contractual systems assign ownership of the oil to the host government (Johnston, 2003:11). A contractual system will either be a production sharing contract/agreement (PSC/PSA) or a service contract (Mazeel, 2010:8-9). The difference between these two arrangements is how the IOC (contractor) is compensated, which could be in cash or in kind (oil). A PSC gives the IOC a share of production (compensation in oil) and a service agreement gives the IOC a share of the profits (compensation in cash). A PSC allocates a portion of the oil that is produced to cover development and production costs (cost oil) and the residual oil (profit oil) is split between the host country and the producing company (Inkpen & Moffett, 2011:89). Service contracts pay IOCs a fee to conduct E&P activities (Mazeel, 2010:9). The difference between a pure service and a risk service contract is whether the fee is based on profits or not (Johnston, 1994:24). Under a risk service contract, contractors run the risk of not receiving a fee for exploration work that does not result in an oil discovery, implying that no profit translates into a zero fee (Johnston, 1994:87). Under service contracts, IOCs essentially act as contractors who receive a fee for services rendered (Inkpen & Moffett, 2011:245). For this reason, service agreements are not considered in further detail and fall outside the scope of this thesis.

All E&P agreements, regardless of being concessionary or contractual systems, include certain additional components that impact on the financial returns of both investors and the host government (Inkpen & Moffett, 2011:228). These components include signature bonuses; market obligations' investment uplifts and stabilisation clauses. IOCs commonly make up-front payments, known as signature bonuses, to the host government as part of the fiscal agreement. These bonuses are intended to motivate investors to speed up the exploration, development and production processes in order to recoup their capital expenditure on bonuses. Domestic market obligations form part of PSCs and require IOCs to sell a portion of its profit oil back to the host government at a discounted price (Inkpen & Moffett, 2011:231). In terms of petroleum fiscal systems, the term uplift is used in a variety of ways. It generally refers to an IOC's ability to recover an added percentage of investment as a deductible expense as soon as operations begin. For concessionary systems, stabilisation clauses attempt to freeze the laws of the host country and prevent the government from unilaterally changing an agreement.

The division of profit between the host government and the investor is measured by the contractor and government 'take', respectively (Johnston, 1994:9). These measures are expressed as percentages. The investor or contractor's share is measured by the contractor take and the host government's share by the government take. The contractor take is a useful measure to compare one fiscal system with another. The contractor take is focused on the division of profits and is directly correlated to the project economic metrics, such as the reserve value and the field size threshold. The variations in terminology surrounding the division of profits are illustrated in Table 2.4.

Table 2.4: The division of profits

"The Split"	
Government	**Company/Contractor**
• Government equity split. • Government after-tax equity split. • *Almost obsolete terminology.*	• Contractor equity split. • Contractor after-tax equity split. • *Almost obsolete terminology.*
• Government take (excludes government participation). • State take (includes government participation). • *Petroconsultants (Geneva) use this terminology.*	• Contractor take. • Contractor take. • *Petroconsultants (Geneva) use this terminology.*
• Government marginal take. • Net government take on the marginal barrel. • *This terminology is used mostly in the U.K.*	• Contractor marginal take. • Net contractor take on the marginal barrel. • *This terminology is used mostly in the U.K.*
• Tax take (= Petroconsultants' government take). • Government take (= Petroconsultants' state take). • *This is the terminology used at the University of Aberdeen.*	• Contractor take. • Contractor take. • *This is the terminology used at the University of Aberdeen.*
• Discounted government take The picture changes dramatically from present value point of view (in favour of government); nevertheless, the take statistics are very valuable and useful.	• Discounted contractor take The picture changes dramatically from present value point of view (in favour of government); nevertheless, the take statistics are very valuable and useful.

• Government profit share
  • Net cash margin
  • Fiscal take
  • Fiscal net
  • Bottom-line financial split or bottom line income split
	• Contractor profit share

Source: Adapted from Johnston (2003:99).

The issues surrounding the division of profits, specifically the concept of 'take' or 'government take' are discussed further in sections 2.4.4 and 2.4.5. However, before these issues are discussed in more detail, the following section first provides an overview of the historical development of petroleum fiscal systems.

2.4.2 The historical development of petroleum fiscal systems

Even though the basic concessionary and contractual systems have been in place for a long time, the specific terms of each system have gone through a number of changes in the last few decades (Le Leuch, 2013). These changes are related to changes in the political environment as well as to changes in the international oil market. Historically, concessionary systems were the primary fiscal arrangement used in the oil sector (Likosky, 2009). Modern-day concessions as well as the other contractual forms were developed in reaction to the overly lenient terms of the traditional concessions. Today's systems are premised on transnational public-private partnerships, where the nature of the primary partnership varies according to the contract type, i.e. modern concessions or PSCs.

From the start and early development of the oil sector (19th century), host governments were reliant on the skills and knowledge of IOCs to explore and develop their oil resources (Graig, King & Spalding LLP, & Weems, 2005). Many host governments concluded that the concessionary system gave IOCs too much control over their sovereign resources. In reaction to this belief, many host countries resorted to nationalisation or threats of nationalisation. After nationalisation, host countries controlled the E&P facilities they took from IOCs; however, they still lacked the intellectual and technical capital to effectively use what they took from the IOCs. The solution was to again grant concessions. However, these concessions had more favourable bonus and royalty structures as well as relinquishment and knowledge transfer requirements to help host governments achieve self-sufficiency.

From the early 1970s, as OPEC started to gain prominence, the oil market shifted from being a buyer's market to being a seller's market[22] (Johnston, 2008). During this period, OPEC nations sought greater control over their oil resources. Governments sought greater control for the following reasons, the need to control a vital sector, to enhance national security, increase the government's share of oil wealth and to gain experience. Considering the nationalistic

[22] The recent oil price downturn, shown in Figure 1.5, could indicate an opposite shift in the oil market from being a seller's market to being a buyer's market.

disposition of the 1970s, oil-producing countries viewed the existing concessions as remnants of colonial times. Following the 1973 oil embargo, oil prices were high and host countries experienced an increase in their per-barrel revenue, while IOCs' revenues increased even more. A new form of contract with different terms was needed to establish the required level of control over oil resources.

For some countries, the concessionary system was neither politically nor legally acceptable (Graig, King & Spalding LLP, & Weems, 2005). Indonesia was one of those countries and in 1967 Indonesia introduced the first model production sharing contract (PSC). The PSC gave host countries greater control over the operations of IOCs in their countries. Many countries throughout the world soon followed the PSC example set by Indonesia in some form or another. Fiscal agreements have continuously evolved since the embargo and are now more sophisticated (Johnston, 2008). The fiscal terms of the late 1990s and early 2000s have their origin in the multitude of systems that developed during the 1980s and 1990s. By 2015 the environment is not only characterised by an increased availability of exploration acreage, but also more companies competing for access to acreage. The evolution of fiscal systems changed the type of activities that fiscal contracts govern (Likosky, 2009). The new emphasis is on developing local capacity, while human rights and environmental commitments are also important.

According to Al-Attar and Alomair (2005), the most important factors affecting the choice of fiscal system include reserves, E&P costs and the recovery factor[23]. The concessionary (R/T) systems are more prevalent in countries with relatively low reserves and high costs, while PSCs are preferred in countries with large reserves and medium-level costs. However, a number of countries use more than one type of system because of different reserves with a variety of E&P costs that could either be low, medium and/or high. The recovery factor will also affect upstream costs. To improve recovery from basins with a low recovery factor requires the use of enhanced recovery methods that increase costs. The decline of basins in mature oil regions has led to the opening of basins for upstream investment. Exploration for new reserves and the enhanced recovery methods needed to maintain or expand production from mature oilfields require substantial capital investments, technology transfers as well as the transfer of skills.

[23] The recovery factor refers to the percentage of oil or gas in place that is expected to be produced (Johnston, 2003:357)

For these reasons, host countries have opened their upstream sectors by using the appropriate fiscal systems. The new upstream agreements include five central components. They are reduced marginal E&P costs, sharing of geological and capital investment risk between the host country and IOCs, using optimal technology to increase production capacities, and increasing investment to meet future oil demand. The new type of agreements manages the relationship between IOCs and host countries that are represented by either the country's oil ministry or NOC. These agreements attempt to share the risks and costs of E&P between the IOC and host country. In practice, the structure of a specific fiscal arrangement is the important issue rather than the type of agreement itself.

Furthermore, Al-Attar and Alomair (2005) identify four main differences between the traditional concessions and the new types of upstream fiscal systems. Firstly, the new agreements are for specific areas instead of the vast areas allowed for under the old concessions. Secondly, the new agreements are for a shorter time period. The global average for such agreements is 25 years, while the traditional concessions could range between 60 and 75 years. Thirdly, the new agreements legally preserve the host country's sovereignty over its oil resources as opposed to the traditional concessions that left the host country with limited sovereignty and a limited government take based on production. Finally, the new agreements specify specific work obligations for the E&P phases, while traditionally, IOCs had more extensive control over the timeframe and methods used for E&P activities.

Even though modern-day concessions are more government friendly, many oil-producing countries still have a strong disregard for this type of arrangement (Graig, King & Spalding LLP, & Weems, 2005). In contrast, PSCs give host governments operational control over E&P activities, something they lacked under the original concessions. IOCs no longer have the exclusive control over reserves that they had under the original concessions. However, under the PSC, IOCs still get a share of production and 'own' their share of the produced reserves. The 'booking' of reserves for financial reporting purposes is an important consideration for IOCs and makes the PSC an attractive arrangement. Concessionary systems would allow IOCs to 'book' all the reserves under the ground for which they hold exploration and development rights. The main differences between concessionary and contractual fiscal systems are summarised in Table 2.5.

Table 2.5: Difference between concessionary and contractual systems

	Concessionary system	Contractual systems
Ownership of nation's mineral resources	Held by sovereign state	Held by sovereign state
Title transfer point	At the wellhead	At the export point
Company entitlement	Gross production less royalty	Cost oil + profit oil
Entitlement percentage	Typically 90%	Typically 50-60%
Ownership of facilities	Held by company	Held by the state
Management and control	Typically less government control	More direct government control and participation
Government participation (carried working interest)	Less likely	More Likely
Ring fencing	Less likely	More likely

Source: Tordo (2007:10) adapted from Johnston (1994)

Baunsgaard (2001:26) surveyed petroleum fiscal systems for a number of developing countries and found that the majority of countries sampled use royalties to ensure an up-front revenue stream. Most of the countries used *ad valorem* royalties where the rates varied between 2 and 30%, while the most common range would vary between 5 and 10%. Two-thirds of the countries surveyed used PSCs as the main fiscal system. The PSCs use a formula-based system, which links the rate of profit-oil sharing to production levels; the host governments typically get a 50 to 60% share of profit oil. Profit oil is a term used in PSCs for the share of oil that is left after accounting for royalty and cost oil, which is allocated to the host government and IOC, respectively (Johnston, 2003:356). Cost oil is a term used in PSCs for the oil (or revenue) that is used to pay the IOC/contractor for exploration, development and operating costs (Johnston, 2003:335). Regionally, in terms of the sample, half of African countries use PSCs, while a large portion of the other half, using a profit-based tax system, applies RRTs in addition to CIT. Most of the Asian countries surveyed use PSCs. For the Western Hemisphere, PSCs are rare outside the Caribbean and few countries use RRTs. For the Middle East, PSCs are the most common contract form.

Many countries developing their petroleum fiscal system choose to use PSCs (Johnston, 1994:131). A concessionary system could achieve the same results depending on the overall level of taxation. However, philosophical and political considerations often give the advantage to PSCs. Examples of nascent oil producers include Uganda, Tanzania and Kenya. All three these countries use a combination of taxes (including royalties in Kenya and Tanzania) and include PSCs, this is in line with the findings from the literature discussed above. However, the more recent (2014/15) oil price downturn could impact on the extent of resource nationalism and the specific mix of policies used by host governments. For example, in April 2015, Uganda announced that it will relax taxes on its oil and gas industries by only charging taxes once production starts.

Nakhle (2010) provides a summary of the important issues surrounding the choice of concessionary and PSC systems. Concessionary systems may be perceived more attractive for investors than PSCs. However, both systems can be used to achieve similar outcomes depending on how the systems are structured. The host government's objectives and the structure of the fiscal system aimed at achieving these objectives are the factors that really matter. Concessionary systems can also be very tough and allocate a substantial share of the benefits to the government. The differences between concessionary and PSC systems are linked to legal and political issues rather than economic fundamentals. Comparing systems solely in terms of tax rates is misleading. There are three important considerations when comparing systems based on tax rates or government take. Firstly, the objectives of the host government, for example, tax rates could be low in order to attract investment and offset negative factors such as political risk, poor geology and high costs. Secondly, country-specific as well as regional factors must be kept in perspective, for example the level of government take in relation to the conditions of geological risk and high costs in mature basins. Finally, there must be a balance between securing a fair share for the host government and providing sufficient incentives for continued investment.

2.4.3 System design: Characteristics of an effective petroleum fiscal system

The fiscal terms of a concessionary system can be replicated by a contractual (PSC) system and vice versa, and therefore there is no fundamental reason to prefer the one system to the other (Sunley, Baunsgaard, & Simard, 2002:9). The two systems are compared in Table 2.6.

Table 2.6: Comparing concessionary and contractual (PSC) systems

Concessionary (royalty/tax) systems	Production sharing
Royalty	There may be an explicit royalty, or there may be a limit on cost oil[24] that functions as an implicit royalty.
Corporate income tax	Corporate income tax, which may be paid out of the government's share of production.
Resource rent tax	The determination of the amount of profit oil[25] can mimic a resource rent tax.

Source: Adapted from Sunley, Baunsgaard, & Simard (2002:9)

There is no 'one-size fits all' fiscal system that is suitable for all countries or projects because countries differ in terms of upstream costs, the size and quality of reserves and the perceptions of commercial and political risk held by potential investors (Sunley, Baunsgaard, & Simard, 2002:18). However, there are certain desirable features to pursue when designing a petroleum fiscal system. A country's petroleum fiscal system can attract investment by using a framework that is clear and not subject to retroactive changes (Tordo, 2007:1). An efficient system will promote the development of a country's upstream sector by inducing efficient exploration and development by IOCs, while ensuring a fair share for the host government.

Johnston (2003:149-150) provides a number of criteria for an effective petroleum fiscal system. Such a system should provide a stable business environment, deter undue speculation, minimise sovereign risk, provide a balance between risk and reward to provide potential for a fair return to both the host government and investors, minimise complexity and administrative burdens, incorporate flexibility for changing economic conditions and finally promote competition and market efficiency. Land (1995) identifies a number of criteria to appraise fiscal systems for governments that want to maximise their revenue over the long term. These criteria include economic efficiency, the minimisation of both investor risk and government revenue risk and finally the ease of implementing the system.

[24] Cost oil: A term used in PSCs for the oil (or revenue) that is used to pay the IOC/contractor for exploration, development and operating costs (Johnston, 2003:335).

[25] Profit oil: A term used in PSCs for the share of oil that is left after accounting for royalty and cost oil that is allocated to the host government and IOC respectively (Johnston, 2003:356).

Demirmen (2010) identifies four characteristics of a so-called ‘win-win’ petroleum fiscal system. Such a system will promote exploration activities, encourages the development of both small and large oil reserves, provide incentives for areas that are difficult to explore and difficult to develop, and finally provide an equitable distribution of economic benefits between the host government and IOC. Goldsworthy and Zakharova (2010:6-7) highlight a number of fiscal objectives attributed to a desirable fiscal system. These objectives include neutrality, rent capture, stability and timing of revenue, progressivity and adaptability, administrative simplicity and enforceability, and finally international competitiveness. The IMF (2012) suggests a combination of a modest *ad valorem* royalty, CIT and an RRT as an appealing option for lower income countries. The royalty will generate revenue upon production, CIT will tax the normal return to equity and the RRT will capture the distinct revenue potential of the sector.

In addition to the above-mentioned instruments, host governments may prefer to be more directly involved in upstream projects by taking state equity in a project (Baunsgaard, 2001:13). The main motivation would be to share in the possible up-side of projects but there could be non-economic reasons such as attaining skills and knowledge transfers, to increase the sense of ownership or to simply gain more direct control of project development.

2.4.4 Evaluating fiscal systems

Petroleum fiscal systems are evaluated and compared by using economic and fiscal measures. These metrics stem from two branches, depending on the viewpoint that is used, namely the government viewpoint (the focus of this thesis) and the investor (IOC) viewpoint. In terms of these two viewpoints, Kaiser and Pulsipher (2004) distinguish between economic and system (fiscal) measures.

Economic measures are used by investors (IOCs) to evaluate a potential project’s overall return (net worth) in accordance with the associated risks. The main methods are centred on a time value of money approach[26], for example net present value (NPV), internal rate of return (IRR) and a profitability ratio (PR) (Tordo, 2007:17-18). The NPV is an indication of a project’s net worth, while the IRR and PR are used to compare or rank alternative projects. These values are best used in conjunction with other measures or parameters rather than stand-alone criteria.

[26] For example, see Dougherty (1985), Mian (2002) and Seba (1987).

The timing of payments (royalties or taxes) to the government, i.e. during exploration or production, is also a consideration for investors.

Fiscal measures are used by host governments to evaluate whether they obtain a 'fair share' from oil resources. Within this context, the division of profit between an investor and host government (summarised in Table 2.4) is referred to as 'take', i.e. the government and contractor take. The 'take' statistic is the most commonly used statistic to evaluate the fiscal terms of oil contracts. It includes most of the revenue accruing to the government; it does not, however, include employment benefits or skills transfer (Johnston, 2007). The 'take' statistic is often used by consultants and academics to evaluate the impact of proposed tax policy changes (Agalliu, 2011). However, take is a fiscal measure and not an economic indicator (Kaiser & Pulsipher, 2004). For this reason, the take statistic is mostly the concern of host governments, while it is only of secondary value to investors, since it does not provide information on the potential economic performance of an oil project. In contrast to the generally well-established economic measures, much confusion surrounds the interpretation and application of the take statistic.

According to Johnston (2007), the government take statistic (although commonly used) has a number of shortcomings. It is often calculated on unrealistic assumptions, fails to adequately account for risk, ignores timing of payments (undiscounted) and leaves out other key elements, specifically the economy-wide impacts of the oil sector. The assumptions used to calculate government take could include the following variables: oil prices, costs, escalation rates, production rates and cumulative production. However, variations in the assumptions surrounding these variables can influence the expected profitability of an oil project. Furthermore, government take does not adequately capture risk and can vary dramatically with project profitability. The measurement of 'take' represents the division of profits over the 'full cycle', meaning the full project lifetime. Therefore, this includes years with high, low or even zero profit. However, a range of possible take measures can be calculated at the start of a project, using different assumptions for sensitivity analysis. The variations in the variables that are included or excluded in calculating government take make international comparisons between countries difficult and problematic. Other measures[27] that can be used in conjunction with, and as a supplement to, the government take statistic include: the effective royalty rate

[27] See Johnston (2007) for a more detailed discussion of these measures.

(ERR), access to gross revenues (AGR) and the savings index (SI)[28]. The ERR considers the timing of payments to the government, the AGR is the maximum share of revenue an IOC can obtain in relation to its working interest for a specific accounting period and the SI measures the amount a company can retain per $1 of cost saving. The following section reviews the comparative fiscal literature where the government take statistic is central to most of these studies.

2.4.5 Comparative studies

The comparative analysis of fiscal systems consists of two components or perspectives: the investor perspective and the host government (government policy) perspective. It is important to note that the 'investor perspective' portion of the literature has received much attention, but the literature for the government perspective has not received as much attention. Although a number of studies have attempted to compare the relative attractiveness of petroleum fiscal systems in terms of government take, it seems the overarching viewpoint is still from an investor perspective. Furthermore, none of these studies consider the oil sector's economy-wide impacts as is done in this thesis.

Dongkun and Na (2010) consider the impact of petroleum fiscal systems when IOCs evaluate the investment environment of a potential host country's oil sector. The authors highlight that government take is a flawed instrument when evaluating the attractiveness of fiscal systems across countries. To this end, the analysis is expanded to distinguish between government take (GTE) and host nation take (GT). The main difference between these two variables is that host nation take (GT) includes the NOC's income, while government take (GTE) does not include the NOC's income. GT can be calculated using the undiscounted cashflow method (GT), the discounted cashflow method (GT_i) and an intuitive method. This statistic combines the impact of bonus payments, royalties, the profit oil split, taxation, state equity participation and other factors into one indicator. It follows that the larger the GT, the smaller the share available for an IOC (contractor take) will be and the less attractive a project will be for a potential investor.

Furthermore, Dongkun and Na (2010) extend the GT measure by using a front-loading index that can be combined with the GT statistic to form a composite score (CS) indicator. The front-loading index considers the timing of payments to the host government and is developed from

[28] The Savings Index measures the extent to which an IOC will benefit from a specific reduction in costs, it is defined as the part of one additional dollar in profit which arises from saving one dollar in cost (Tordo, 2007).

an investor viewpoint. By delaying up-front payments, IOCs can recover their costs early and quickly, which translates into higher project returns for IOCs. Under profit-based taxes, there is no front-end loading as taxation only accrues once a project starts making profits; this is similar for discounted and non-discounted GT. However, carried (free) state equity interest, bonus payments and other taxes are often levied in the early stages of the project lifecycle. These payments occur before the project makes profits (which will later be taxed) and this is regarded as front-loading. During the production phase, more taxes and production sharing come into play. Taxes and production sharing will be determined by income and output. In this phase, the host nation's income could start to grow faster than the project profit, which would also constitute front-loading from an IOC perspective. For these reasons, GT is often not solely based on project profits and this leads to a difference in discounted and undiscounted GT. An IOC's front-loading index (FLI) is defined as the difference between the non-discounted GT and the discounted GT_i as ratio to GT:

$$FLI = \frac{GT - GT_i}{GT} \times 100\% \tag{2.1}$$

A smaller FLI will mean an IOC faces less risk during the earlier stages of the project lifecycle and the more attractive the project will be for the investing IOC. The CS indicator is calculated using a linear weighting method to account for both the GT and FLI variables:

$$CS = (W_1 \times GT) + (W_2 \times FLI) \tag{2.2}$$

The respective weights, W_1 and W_2, are based on the relevant IOC analyst's view of the respective contribution of GT and FLI towards the attractiveness of a specific project, based on the analyst's experience. The smaller the CS value, the greater the attractiveness of the fiscal terms for the specific project is.

Isehunwa and Ifeoma (2011) evaluated the impact on government take using a sliding scale royalty as opposed to a fixed royalty for both joint venture agreement or arrangement (JVA) (a concession with government participation) and PSC systems in Nigeria. They concluded that the government take from a sliding scale royalty compared favourably with that from a fixed royalty. Zahidi (2010) compared petroleum fiscal systems across Pakistan, Thailand, Turkey, Cameroon and the Democratic Republic of the Congo using government/contractor take statistics and ranked these jurisdictions in terms of their attractiveness to investors, based on the contractor take statistic.

In their comparative economic evaluation of JVA and PSC systems in Nigeria, Mmakwe and Ajienka (2009) determined that the JVA arrangement is more favourable to the host government, while IOCs would prefer the PSC. In evaluating the impact of fiscal systems on government take, Van Meurs (2008) concluded that the type of petroleum fiscal system is not as important as the detailed design and structure of the system.

Blake and Roberts (2006) compared the petroleum fiscal systems – spanning both ‘pure’ and hybrid types – across five regions under conditions of oil price uncertainty. The regions in question were Alberta (Canada), Papua New Guinea, the Sao Tome and Principe/Nigerian Joint Development Zone (SNJDZ), Tanzania, and Trinidad and Tobago. Using contingent claims analysis to value the governments’ tax claims under uncertainty using Monte Carlo simulation, Blake and Roberts ranked the fiscal systems according to the after-tax value due to IOCs and the extent of distortions created by the systems. The Alberta and Papua New Guinea systems were ranked highest in terms of their after-tax returns and also created the least distortions. The Tanzanian system was ranked lowest in terms of after-tax returns and its high distortionary effects.

Iledare (2004) used a hypothetical oil field, a discounted cashflow model and government take to measure the impact of two different fiscal arrangements – a PSC and a JVA – on exploration, production and government take in Nigeria. The study concluded that if the government aims to maximise wealth for society, direct government participation might not be the best option. However, a move from a JVA to a PSC would also not necessarily lead to wealth maximisation.

Rapp, Litvak, Kokolis and Wang (1999) compared the standard government take measure with a ‘discounted government take’. The discounted government take incorporates both the timing of payments to governments and the timing of revenues and costs. Differences between ‘undiscounted’ and ‘discounted’ government take may lead to different results for relative rankings for fiscal regime attractiveness. However, the difference between these two take statistics can be used as a measure of the front-end loading of government take. The authors conclude that the discounted government take is preferable to the standard take measure.

Rutledge and Wright (1998) analysed the distribution of rewards between the government and IOCs in the United Kingdom Continental Shelf (UKCS) and compared the system to that of Norway. They found that IOCs enjoyed higher profitability than those operating in other oil provinces around the world and in the light of this, recommended that the UKCS fiscal system be reformed. Abdo (2010) also analysed the UK regime, including the relaxation of tax terms over time, which has failed to increase the government take.

Finally, the World Bank (1995) ranked global fiscal systems using various economic yardsticks, including the rate of return, net present value, government take and geological risk. The Bank found that regions disconnected from other regions and countries in the same region had similar fiscal terms. Furthermore, the average fiscal system was found to be regressive and front-end loaded, with government take higher in the first six years of production and lower during the remaining period.

IHS CERA (2010) recommends the following measures of attractiveness to be more appropriate than government take: the rate of return allowed to accrue to an investor on development, the profit-to-investment (PI) ratio and the exploration cover ratio (the value of successful exploration as a ratio of exploration cost). However, the above measures are also based on an investor perspective.

Agalliu (2011) suggests the incorporation of profitability measures, revenue risk and fiscal system stability when assessing petroleum fiscal systems. Furthermore, the author also emphasises due consideration of issues such as the resource potential and the relative prospectivity. The author's analysis uses four variables to construct an index to rank fiscal terms of competitor countries (that compete for upstream investment) to that of the USA. The variables include the following: government take, profit-to-investment ratio (PI), IRR and progressivity/regressivity[29]. The index could be interpreted from both a government and an investor perspective, whereby the most favourable system from a government perspective is the least favourable from an investor perspective. Accordingly, the results may be useful in terms of comparing fiscal systems or 'competitiveness' across countries or regions. However, although the study presents an extension, by expanding the standard comparison of government take, it does not address the question that is posed by this thesis; namely to measure and incorporate the oil sector's economy-wide impacts into a fiscal statistic that can enhance the evaluation of a country's petroleum fiscal system.

[29] Progressivity/regressivity refers to the relationship between government take and project profitability.

It is important to note (see Chapter 1) that the issue of the oil sector economy-wide impacts is separate from the question of economic impact and development connected with the allocation and expenditure of the tax revenue received by the host government. The thesis question relates to the trade-off between achieving a 'fair share' for the host government and contractor (IOC), while still being conducive to upstream investment. This is an issue of revenue collection and investment attraction as opposed to the question of revenue allocation and management. None of the above studies consider the economy-wide impacts (benefits) of the upstream oil sector for host economies. Specifically, the majority of studies focus on the investor perspective, which further highlights the need to focus on the government viewpoint, especially in terms of economy-wide impacts.

2.5 Conclusion

Petroleum fiscal systems must secure a fair share of economic rent for the host country, while still being conducive towards attracting upstream investment. From the government policy perspective, government take is one of the main considerations. However, it is often calculated on unrealistic assumptions, but more importantly, the macroeconomic scope of government take is too narrow and does not account for the oil sector's economy-wide impacts. In order to set the scene for the evaluation of the oil sector's economy-wide impacts, this chapter reviewed the foundations of petroleum taxation.

Firstly, mineral taxation serves specific functions that comprise three broad objectives. The first objective is based on the government's responsibility to achieve economic and social development. Governments should ensure the socially optimal and equitable extraction of resources, while also ensuring that the sector contributes to public revenues to promote economic development. Secondly, as the resource owner, the government should secure a fair share of the mineral rent. The third objective is to minimise any environmental costs associated with mineral production.

Secondly, the oil sector has distinguishing tax-relevant characteristics that make petroleum taxation unique from other industries. These characteristics include high sunk costs, finite production potential, the potential for economic rent, uncertainty surrounding the outcome of exploration, while information asymmetries complicate rent extraction. Furthermore, the international nature of the sector implies that more than one jurisdiction will want to tax an oil project and finally because deposits cannot be switched between projects, oil projects can be taxed on a project by project basis.

Thirdly, the scarcity of non-renewable resources, such as oil, creates economic rent when the resource is extracted. The 'fair' division of this economic rent between the host government and the producer (IOC) is a primary objective of petroleum taxation. The three main types of rent are scarcity rent, differential or Ricardian rent and quasi-rent. Although the literature thoroughly describes the theoretical concepts of resource rents, the practical identification, measurement and collection of these rents have proven to be more difficult. This creates two practical complications. Firstly, the distinctive types of rent make it difficult to accurately measure the pure rent that comprises scarcity and differential rent. Secondly, it is difficult to incorporate the variation in pure rent across different projects and the further variation in the occurrence of rent over time. These complications support an argument for taxation based on profitability.

Furthermore, the literature identifies two additional concerns created by the calculation of economic rent. Firstly, economic rent is also present in other sectors. However, these rents are not taxed. This raises the question, if oil sector rents are taxed, should not all sectors generating economic rent be taxed? The second issue concerns the incentive for continued exploration, which is necessary for the long-run sustainability of the oil sector. It is the possibility of significant pure rent that motivates exploration activity. Furthermore, it is also the driver behind the development of technologies that enables the exploitation and development of known but previously uneconomic oil resources. Without exploration and technological advancements in development and production methods, the resources have no value to the host country. Even if a host government taxes only the pure rent and exempts quasi-rents, reserves will decline along with a reduction in exploration activity until the country's current (known) reserves are depleted. A scenario of significant short-run Ricardian rent coupled with zero long-run rent may give rise to short-sighted taxation policy. Within this context, increased taxes may appear effective in the short run, while its negative effects on the sustainability of the country's oil sector and government revenues will only become apparent in the long run.

Fourthly, once a host government has decided upon the appropriate share of economic rent, it must decide upon the appropriate taxation instruments it will use to collect and capture this rent. A distinction can be made between profit-based taxes and production-based taxes. Profit-based taxes are defined as taxes charged on a specific definition of a company's revenues less specified (qualifying) costs. Production taxes are defined as taxes charged on reserves or production inputs and services. There is an extent of overlap between profit-based taxes and direct taxes and also between production-based taxes and indirect taxes. A third category of instruments are the so-called non-taxation instruments. Companies are assumed to prefer profit-based taxes, while governments have a preference to include at least some production-based tax components in their fiscal regime.

Fifthly, the different 'combinations' of taxation and non-taxation instruments used by host countries are controlled or organised by a country's petroleum fiscal system. This term encompasses all contractual and fiscal elements that define the relationship between a host government and foreign oil company. The two main types of petroleum fiscal systems are royalty/tax (concessionary) systems and contractual (PSC)-based systems. There is no 'one size fits all' fiscal system that is suitable for all countries or projects because countries differ in terms of upstream costs, the size and quality of reserves and the perceptions of commercial and political risk held by potential investors.

Even though the basic concessionary or contractual systems have been in place for a long time, the specific terms of each system have gone through a number of changes in the last few decades. These changes are related to changing political conditions as well as to changes in the international oil market. Historically, concessionary systems were the primary fiscal arrangement used in the oil sector. Modern-day concessions as well as the other contractual forms were developed in reaction to the overly lenient terms of the traditional concessions.

Although investor perceptions may regard concessionary systems to be more attractive than PSCs, both systems can be used to achieve similar outcomes depending on how the systems are structured. The differences between concessionary and PSC systems are linked to legal and political dynamics rather than economic fundamentals. Comparing systems solely in terms of tax rates is misleading. Issues to be considered include the host government's objectives, the country- and region-specific influences as well as the trade-off between a fair share for the host government and continued investment attraction.

According to the literature, there are certain desirable features to pursue when designing a petroleum fiscal system. A country's petroleum fiscal system can attract investment by using a framework that is clear and not subject to retroactive changes. An effective system should provide a stable business environment, deter undue speculation, minimise sovereign risk, provide a balance between risk and reward to provide potential for a fair return to both the host government and investors, minimise complexity and administrative burdens, incorporate flexibility for changing economic conditions, and finally promote competition and market efficiency. Furthermore, the literature identifies a number of other criteria to appraise fiscal systems; these include economic efficiency, the minimisation of both investor risk and government revenue risk, and finally the ease of implementing the system. A petroleum fiscal system that benefits both the host country and IOC will promote exploration activities, encourage the development of both small and large oil reserves, provide incentives for areas that are difficult to explore and difficult to develop, and finally provide an equitable distribution of economic benefits between the host government and IOC. The literature also highlights the objectives of neutrality, rent capture, stability and timing of revenue, progressivity and adaptability, administrative simplicity and enforceability, and finally international competitiveness. Suggestions within the literature include the use of a combination of a modest *ad valorem* royalty, CIT and an RRT as an appealing option for lower income countries. In addition to the above-mentioned instruments, host governments may prefer to be more directly involved in upstream projects by taking state equity in a project.

Economic measures and fiscal variables are used to evaluate and compare petroleum fiscal systems. These metrics stem from two branches, depending on the viewpoint that is used, namely the government viewpoint (the focus of this thesis) and the investor (IOC) viewpoint. Economic measures are used by investors (IOCs) to evaluate a potential project's overall return in accordance with the associated risks. Fiscal measures are used by host governments to evaluate whether they obtain a 'fair share' from oil resources. Within this context, the division of profit between an investor and host government is referred to as 'take', i.e. the government and contractor take. The government take statistic is plagued by a number of shortcomings and importantly does not measure the oil sector's economy-wide impacts.

The comparative analysis of fiscal systems consists of two components or perspectives, the investor perspective and the host government (government policy) perspective. It is important to note that the 'investor perspective' portion of the literature has received much attention, but the literature for the government perspective has not received similar attention. Although a number of studies have attempted to compare the relative attractiveness of petroleum fiscal systems in terms of government take, it seems the overarching viewpoint is still from an investor perspective. Furthermore, none of these studies consider the oil sector's economy-wide impacts as is done in this thesis.

The following chapter will provide a comparative analysis of global petroleum fiscal systems outside Africa.

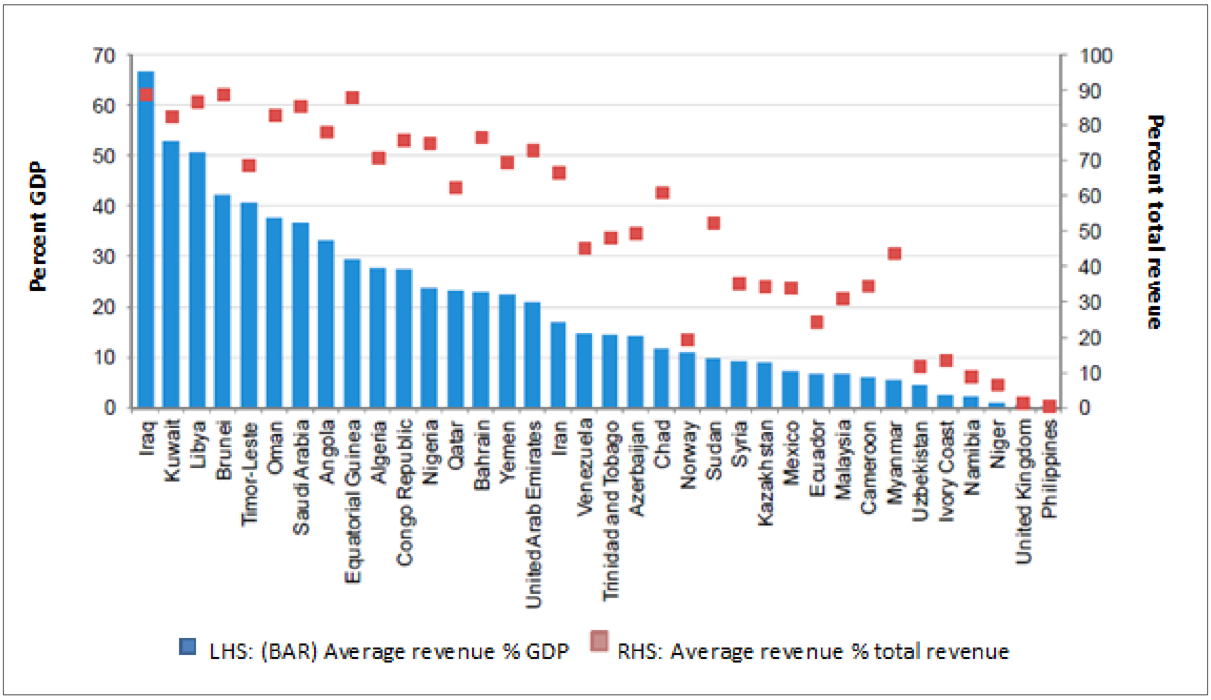
Chapter 3: Comparative analysis of selected global petroleum fiscal systems

"The Earth is round but, for most purposes, it's sensible to treat it as flat." – Theodore Levitt.

3.1 Introduction

Oil resources can provide host countries with substantial tax revenues. Such revenues can make up a large share of total tax revenue (Boadway & Keen, 2010). Oil sector taxation is an easy and efficient source of tax revenue that can potentially strengthen a country's fiscal position. The relative importance of tax revenue from the oil sector implies that tax design is essentially a case of negotiation between the government and investor rather than the design of a uniform system applied in a top-down approach. Considering the equity and efficiency criteria, oil sector rents are a particularly attractive tax base (IMF, 2012:10).

Figure 3.1: Oil sector tax revenue in selected oil producing countries (Average 2001-2010)



Source: IMF staff estimates referenced in IMF (2012)

Figure 3.1[30] illustrates the importance of oil sector revenue, expressed as a percentage of GDP (left-hand side axis) and as a percentage of the government's total revenue (right-hand side

[30] The figure illustrates the latest available estimates. Although it does not include all the countries discussed in this chapter, the figure provides a good indication of the importance of oil sector tax revenues.

axis). From the blue bar chart, it can be seen that oil sector revenue is very important when expressed as a percentage of GDP, particularly for countries such as Iraq, Kuwait Libya and others that have less diversified economies. Considering the percentage share of oil revenue in total revenue (red blocks), oil revenue is a major contributor to government revenue in the majority of oil-producing countries.

Host governments can use various 'combinations' of taxation and non-taxation instruments that are collectively controlled or organised by a country's petroleum fiscal system. As discussed in Chapter 2, fiscal systems fall into two categories of concessionary and contractual systems with contractual systems sub-dived into PSCs and service contracts. This chapter is focused on concessionary and contractual (PSC) systems[31]. The two families of fiscal systems differ in terms of the level of government control, resource ownership and compensation arrangements (Tordo, Johnston, & Johnston, 2010:9). However, both systems can be used to achieve the same outcomes depending on how these systems are structured. In practice, the structure of a specific fiscal arrangement is the important issue rather than the type of agreement itself.

Considering the importance of oil sector rents, which are collected through a particular petroleum fiscal system, this chapter provides a comparative analysis of global petroleum fiscal systems. Considering that host governments face a trade-off between obtaining a fair share of oil revenues and providing sufficient incentive for investors, section 3.2 reviews the measurement of perceived barriers to upstream investment and resource governance. The comparative analysis considers ten different national petroleum fiscal systems. Section 3.3.1 reviews five countries following a concessionary system, which include Russia, Brazil, Norway, United Kingdom (UK) and Australia. Section 3.3.2 reviews five countries following contractual (PSC) systems, which include China, Iraq, Oman, Indonesia and Azerbaijan. Finally, section 3.3.3 provides a comparative summary of these ten petroleum fiscal systems. There is currently no similar recent comparative analysis of petroleum fiscal systems between countries. For this reason, the comparative analysis of this chapter is a unique contribution to the field of knowledge on petroleum fiscal systems.

[31] Under service contracts, IOCs essentially act as contractors who receive a fee for services rendered (Inkpen & Moffett, 2011:245). For this reason, service agreements are not considered in further detail.

3.2 Barriers to investment and resource governance

A number of factors influence investors' decision to invest. A country's petroleum fiscal system is one of the factors that investors consider. Although the government policy perspective is the focus of this thesis, the investor perspective influences the government policy perspective in terms of attracting investment. For this reason, the Fraser Institute's (2014) annual survey of the perceived barriers to investment in upstream E&P is considered as part of the comparative analysis. The survey is targeted at upstream executives and managers. The 2014 results are based on information obtained from 710 respondents and cover 156 jurisdictions (157 in 2013). For 2014, 48% of the respondents reported to be either a manager or of a more senior level position. The names of potential respondents were identified using publicly available membership lists of trade associations or other sources, whilst certain industry associations and non-profit think tanks provided contact information.

The aim of the survey is to identify the regions, countries, states or provinces and offshore regions for which the barriers to investment in oil and gas exploration is greatest, using the survey results to quantify the perceived barriers to investment. The result can be a useful guide for policy reforms in cases where investors regard a jurisdiction as relatively unattractive, such reforms could focus on improving on specific areas which could make the jurisdiction more attractive for investment. The results are also a useful for IOCs to support their own assessments and to help identify regulatory environments that are attractive for investment.

There are two potential areas of critique or caution against the global petroleum survey and similar studies. Firstly the results are based on a survey, as such the normal assumptions and problems associated with survey research come into play. Secondly, the results are based on perceptions which are influenced by a wide array of factors which cannot all be considered when interpreting the results. The main focus is on the actual perceptions of respondent regarding variables relevant to a jurisdiction's attractiveness for investment. Whilst noting these potential areas of critique, the results are still a useful indicator of investors' perception regarding investment in the various upstream jurisdictions.

Some of the common factors respondents regard as barriers include: onerous fiscal regimes, political instability, land claim disputes as well as costly, time-consuming uncertainty surrounding regulations. Competitive tax and regulatory regimes are regarded as positive factors that can attract investment.

Jurisdictions are scored in terms of 16 factors that affect investors' decisions to invest. For each of these factors, respondents could select one of the following responses:

1. Encourages investment.
2. Is not a deterrent to investment.
3. Is a mild deterrent to investment.
4. Is a strong deterrent to investment.
5. Would not invest due to this criterion.

Jurisdictions are scored based on these responses. The scores consider the proportion of negative responses, where a greater proportion of negative responses indicate a greater perception of investment barriers and accordingly a lower ranking in terms of investment attractiveness. Up until 2012, the survey included an all-inclusive composite index, which was derived from the 16 factor questions to measure investors' perceptions on the conditions that affect investment decisions. From 2013, this was renamed the Policy Perception Index (PPI). The 2012 index does not consider the known reserves of jurisdictions and a new section was incorporated from 2013 to also consider the index within the context of countries' proven reserves. In terms of the PPI, the higher the score the less attractive the jurisdiction is. The scores are arranged into five quintiles such that:

1. Score <19 (being most attractive);
2. 20 to 39.99;
3. 40 to 59.99;
4. 60 to 79.99;
5. 80 to 100 (being least attractive).

It must be noted that the PPI scores are based purely on responses to the survey questions, the perspectives of the respondents, and do not account for a jurisdictions' proven reserves. The jurisdictions with scores in the first quintile are all located in Canada, the United States, and Europe. The top ten rated jurisdictions are: Oklahoma, Mississippi, Saskatchewan, Arkansas, Manitoba, Alabama, Kansas, Texas, North Dakota, Wyoming and the Netherlands (offshore). For 2014, 23 countries fell into the fifth quintile as opposed to only 12 during 2013. The ten least attractive jurisdictions for 2014 were Venezuela, Bolivia, Ecuador, Iran, Russia (Eastern Siberia), Russia (Offshore Arctic), Iraq, Uzbekistan, Democratic Republic of the Congo and

Turkmenistan. To add a regional dimension, Figure 3.2 illustrates the regional median PPI scores (Fraser Institute, 2014).

Figure 3.2: Regional median PPI scores

Source: Compiled from data by the Fraser Institute (2014)

From Figure 3.2, the lowest (best) regional score is achieved by the United States, followed by Oceania, Canada, Europe, the Middle East and North Africa, Latin American and the Caribbean, Africa and finally Asia.

As an extension, jurisdictions are also compared within the context of their proven reserves. For this purpose, jurisdictions are divided into three tiers, according to their share of the sample group's oil and gas reserves. The tiers are classified as follows:

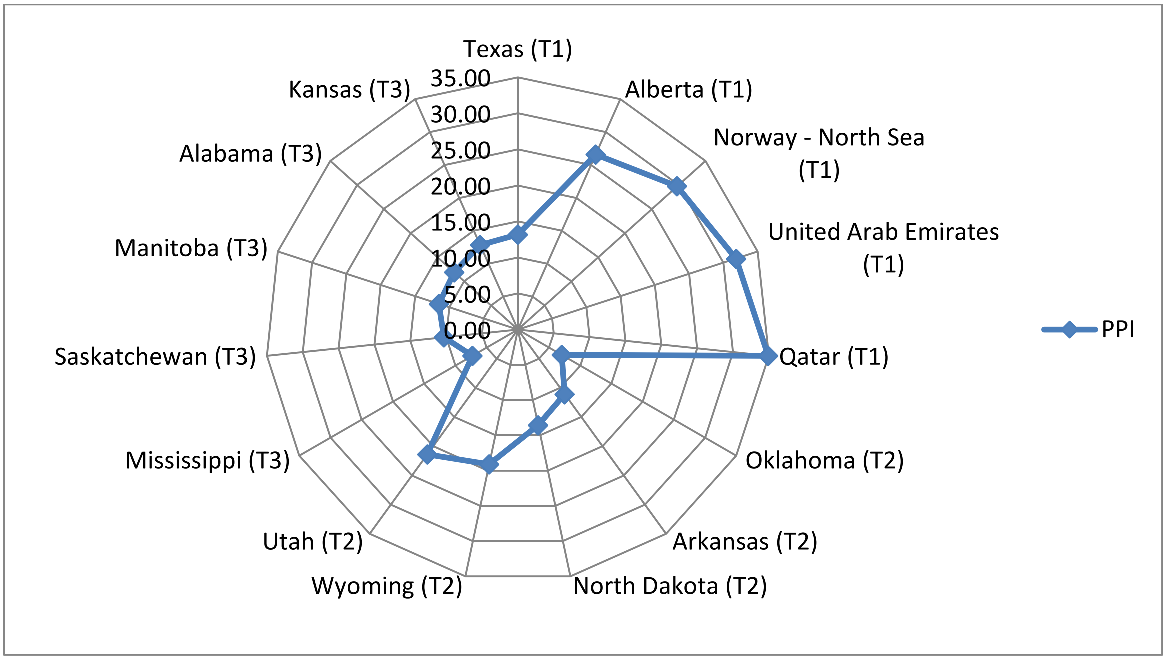
1. Tier one jurisdictions: hold at least 1%.
2. Tier two jurisdictions: hold at least 0.1 but less than 1%.
3. Tier three jurisdictions: hold less than 0.1%.

Sixteen (of the 156) jurisdictions do not have any proven reserves. For this reason, these jurisdictions where excluded[32] from the reserve-based ranking. Accordingly, the reserve-based ranking only considers 140 jurisdictions.

Tier one consists of 27 jurisdictions and accounts for 91% of global reserves held by the 140 jurisdictions. However, eleven of these jurisdictions fall into the least attractive quintile of the PPI. These eleven jurisdictions comprise the four Russian regions, Egypt, Libya, Indonesia, Turkmenistan, Iraq, Iran and Venezuela. In terms of the tier one jurisdictions that rank highly (Quintile 1 & 2) in the PPI, the top five jurisdictions are Texas, Alberta, Norway (North Sea), United Arab Emirates and Qatar. Forty-four jurisdictions fall into the tier two reserve classification. From this group, the top five attractive jurisdictions (PPI) include: Oklahoma, Arkansas, North Dakota and Wyoming. Seven jurisdictions fall into the least attractive quintile of the PPI; they are Argentina (Chubut), Syria, Uganda, South Sudan, Uzbekistan, Ecuador and Bolivia. Tier three consists of 69 jurisdictions, and each of these jurisdictions accounts for no more than 0.1% of the sample group's reserves. Least attractive jurisdictions in this group include: Guatemala, Argentina (Santa Cruz), Tanzania, Kyrgyzstan, Democratic Republic of the Congo (Kinshasa). The favourably ranked jurisdictions include Mississippi, Saskatchewan, Manitoba, Alabama and Kansas. To graphically illustrate the PPI scores in relation to reserves, the five jurisdictions with the highest PPI scores were selected from the reserve tiers 1 to 3 and are illustrated in Figure 3.3.

[32] These 16 jurisdictions are: Brazil (Offshore PSCs), Cambodia, Cyprus, Faroe Islands, French Guiana, Green land, Guyana, Kenya, Lebanon, Mali, Malta, New South Wales, Quebec, Seychelles, Tasmania, and Uruguay.

Figure 3.3: Highest five PPI scores for reserve tier groupings

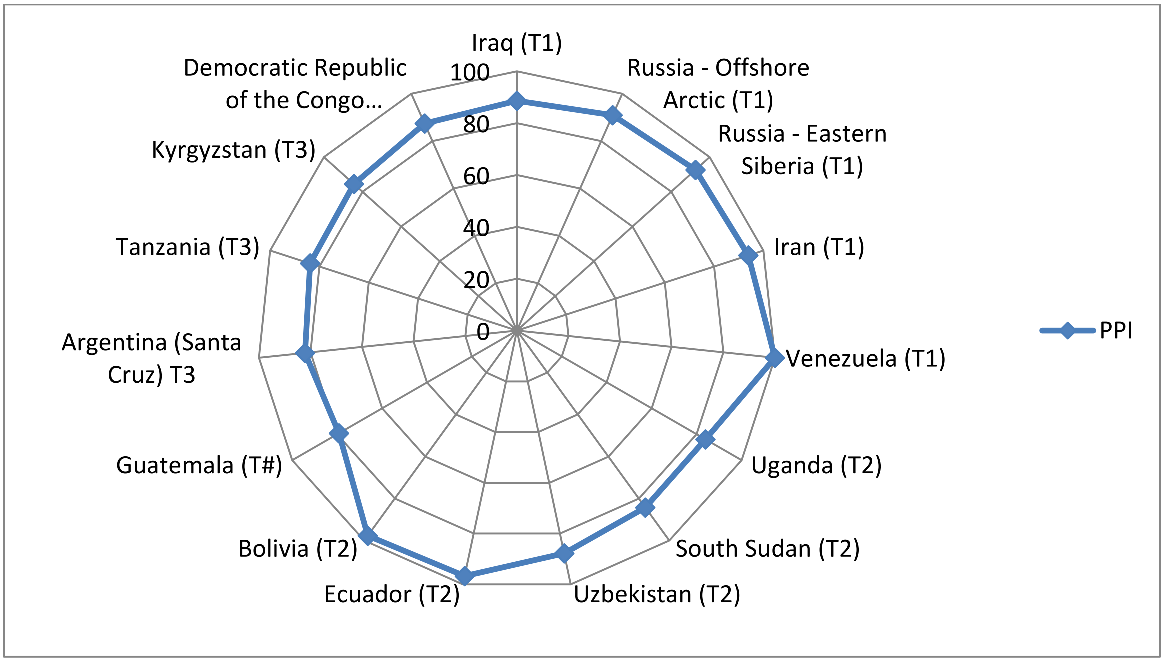


Source: Compiled from data by the Fraser Institute (2014)

Note: T1: tier 1; T2: tier 2; T3: tier 3

Similarly, the five jurisdictions with the lowest PPI scores were selected from tier 1 to 3 and are illustrated in Figure 3.4 below.

Figure 3.4: Lowest five PPI scores for reserve tier groupings



Source: Compiled from data by the Fraser Institute (2014)

Note: T1: tier 1; T2: tier 2; T3: tier 3

From Figure 3.3, Oklahoma (T2) has the best (lowest) PPI score, followed by Mississippi (T3), Saskatchewan (T3), Arkansas (T3) and Manitoba (T3). From Figure 3.4, Guatemala (T3) has the best (lowest) PPI score, followed by Argentina (Santa Cruz) (T3), Tanzania (T3), Uganda (T2) and South Sudan (T2). Upon closer inspection of the highest and lowest PPI scores across the three reserve tiers, the best (lowest) PPI scores fall in the reserve tiers 2 and 3, while the weakest (highest) PPI scores fall in the reserve tier 1. Accordingly, it seems that the larger a jurisdiction's reserves, the more stringent the jurisdiction becomes. The PPI scores will be discussed for this chapter's 10 selected countries in sections 3.3.1 and 3.3.2.

The effective management of oil rents by host governments influences the benefit host countries derive from the oil sector in terms of taxation. It can be argued that better governance should be more valuable to a country than poor governance. Although resource governance is not the focus of this thesis, it is useful to consider resource governance in light of the particular petroleum fiscal system that is used.

The Revenue Watch (2013) Resource Governance Index (RGI) is a measure of oil and gas governance quality in the oil, gas and mining sectors for 58 countries. The sampled countries produce 90% of the world's petroleum. The RGI is a hybrid measure, compiled by combining three questionnaire-based components, specifically assessing the extractive sector, and a fourth component, describing a country's broader governance environment. The fourth component, referred to as the enabling environment, is compiled using data from more than 30 external sources by the Economist Intelligence Unit, International Budget Partnership, Transparency International and Worldwide Governance Indicators. The three survey components include the institutional and legal setting, reporting practices and finally safeguard and quality controls. The maximum (best) score a country can get for each of these components is 100. The same applies for the fourth (external) component, the enabling environment. The four components are combined into a composite score, the RGI. The RGI is calculated using the weighted average of the four components. The RGI assigns the following weights:

1. 20% for institutional and legal setting.
2. 40% for reporting practices.
3. 20% for safeguards and quality controls.
4. 20% for enabling environment.

The RGI index gives countries a numerical score and countries can fall into four performance ranges: satisfactory (scores of 71-100), partial (51-70), weak (41-50) and failing (0-40). The RGI is only released every two years; the 2013 RGI is currently the latest available with the 2015 index only being released later in 2015. The 2013 RGI scores will be discussed for this chapter's 10 selected countries in sections 3.3.1 and 3.3.2.

These two indices aim to provide investors guidance on where to invest and also reflect the perceptions on where they are willing to take risks. It also highlights the quality of governance in these regions. It, however, remains broad indications and does not provide definitive recommendations. The next section is a comparative analysis of global petroleum fiscal systems, considering ten different national petroleum fiscal systems. It is important to note that the following sections provide a broad overview of these fiscal systems; it is not an exhaustive treatment of all the various possible fiscal elements, as such an analysis falls outside the scope of this thesis.

3.3 Comparative analysis: Concessionary versus contractual systems

This section reviews the petroleum fiscal systems used in developed and developing countries across the various regions of the world. The aim is not to draw a comparison of government take between countries, but rather to give a reflection of the current systems and taxation instruments that are prevalent in oil-producing countries. This is done in terms of five countries that use concessionary systems and five countries that use contractual systems. The countries were selected on the basis of the following criteria:

1. A combination of developed, emerging and developing economies.
2. A continental mix.
3. The availability of data and information.
4. Non-African countries because African countries will be discussed in Chapter 4.

The five countries selected with concessionary systems are Russia, Brazil, Norway, the United Kingdom and Australia. The five countries selected with contractual systems are China, Iraq, Oman, Indonesia and Azerbaijan. Table 3.1 illustrates the level of oil production, proved oil reserves and the reserves-to-production (R/P) ratio for these ten countries. Russia, China and Iraq are the largest producers from the 10 countries and Australia is the smallest producer. In terms of reserves, Iraq, Russia and China also have the largest reserves, while the United Kingdom (UK) has the least in this sample of countries.

Table 3.1: Oil production and proved oil reserves, 2013

Country	Production: Thousand barrels daily[33]	Share of world total	Reserves: Thousand million barrels	Share of world total	R/P Ratio[34]	System
Russia	**10788**	12.9%	**93.0**	5.5%	23.6	Concessionary
China	**4180**	5.0%	**18.1**	1.1%	11.9	Contractual
Iraq	**3141**	3.7%	**150.0**	8.9%	>100	Contractual
Brazil	**2114**	2.7%	**15.6**	0.9%	20.2	Concessionary
Norway	**1837**	2.0%	**8.7**	0.5%	12.9	Concessionary
Oman	**942**	1.1%	**5.5**	0.3%	16.0	Contractual
Indonesia	**882**	1.0%	**3.7**	0.2%	11.6	Contractual
Azerbaijan	**877**	1.1%	**7.0**	0.4%	21.9	Contractual
United Kingdom	**866**	1.0%	**3.0**	0.2%	9.6	Concessionary
Australia	**416**	0.4%	**4.0**	0.2%	26.1	Concessionary

Source: Compiled from data by BP (2014)

The R/P ratio shown in Table 3.1 highlights the importance of continued exploration investment. The reserves-to-production ratio is an indication of the length of time (years) that remaining reserves would last if production were to continue at the rate at the end of the year of measurement, in this case 2013. Except for Iraq who has in excess of 100 years of reserves, the R/P ratios are all less than 30.

3.3.1 Concessionary systems: selected countries

The term concession or concessionary system, as discussed in Chapter 2 (see Figure 2.5), often holds a negative connotation associated with the traditional concessions and these systems are today more commonly referred to as an R/T (royalty/tax) system, which comprises royalties and taxes. Production-based instruments, such as royalties, are preferred by some governments as they seem to have administrative simplicity because there is no need to audit costs nor are transfer pricing practices a concern (Goldsworthy & Zakharova, 2010:8). Furthermore, since royalties are based on production levels, they provide earlier and more stable revenues than

[33] Includes crude oil, shale oil, oil sands and NGLs (the liquid content of natural gas where this is recovered separately). Excludes liquid fuels from other sources such as biomass and coal derivatives.
[34] Reserves-to-production (R/P) ratio – If the reserves remaining at the end of any year are divided by the production in that year, the result is the length of time that those remaining reserves would last if production were to continue at that rate.

profit-based taxes. However, progressive (profit-based) taxes could provide a greater revenue stream although it might be more volatile. The apparent simplicity of production-based taxes can be misleading as companies or host governments could want to renegotiate when production costs or oil prices change. This could lead to longer-term complications for tax administration.

According to Blinn, Duval and Le Leuch (1986), a concession is an agreement between a host government and IOC, which grants the IOC exclusive rights to explore, develop, produce, transport and market petroleum resources at the IOC's own risk and cost within a specified area and timeframe. A concession gives an IOC the right or title to produce oil at the wellhead, upon which the IOC is required to pay the relevant royalties and taxes (Nakhle, 2010). As discussed in Chapter 2 (2.4.2), concessionary (R/T) systems are more prevalent in countries with relatively low reserves and high costs, while PSCs are preferred in countries with large reserves and medium-level costs. However, a number of countries use more than one type of system because of different reserves with a variety of E&P costs, which could either be low, medium and/or high. The following sections review five countries using a concessionary system. From these five countries Russia and Brazil also have a PSC system.

3.3.1.1 Russia

Russia's oil and gas sector is one of the largest in the world (Palantir, 2015). Western Siberia, specifically Priobskoye, Prirazlomnoye, Mamontovskoye, Malobalykskoye, and the Surgut group of fields provide the majority of Russia's oil production. In the near term, it is expected that the majority of production will be attributed to the Sakhalin group of fields in the Far East. The untapped reserves from Eastern Siberia, the Caspian Sea, and Sahkalin are expected to become more important for the longer term.

Russia uses a concessionary fiscal system consisting of CIT, a mineral extraction tax (MET) and export duties (Palantir, 2015). The MET is a special tax that replaces royalties. For the purposes of this analysis, the MET is regarded as a royalty. There is also a PSC regime; however, it is only used in exceptional cases under special conditions specified by the Russian government. For this reason, this review only considers the concessionary system. The system has seen many changes since its inception, specifically to the MET and export duty. The petroleum fiscal system is based on the Tax Code of the Russian Federation, PART ONE of July 1998 (and variously amended) and PART TWO of August 2000. Before 2000, CIT was charged at a rate of 35%, from 2000 to 2009 it was 24% and since 2009 to the present the rate is set at 20%. The export duty and MET have seen significant changes over the course of 2011. The MET is calculated on production levels using a specified formula. For oil, it is US$14 per tonne adjusted by coefficients. Export duty rates vary between 35 and 60%. In terms of state participation, Russia's government is involved with gas exports. Only Gazprom (NOC) and its 100% subsidiaries are permitted to export gas.

According Goldsworthy and Zakharova (2010:23), the Russian fiscal system has been successful in providing the government with a significant share of oil revenue; however, the high tax burden has constrained investment. Considering the maturing oil fields and remote location of some reserves, it is expected that production costs will increase leading to declining production under the current revenue-based system, which is onerous on high cost fields. In 2011, the oil sector contributed to 28% of government revenue (Revenue Watch, 2013).

In terms of the Fraser Institute's (2014) global petroleum survey, Russia's jurisdiction is broken down into regions. The 'other' Russian jurisdiction is ranked 135th (PPI of 82.11). The offshore Sakhalin jurisdiction is ranked 142nd, with a PPI of 84.33. The offshore Arctic region is ranked 151st (PPI of 90.90), while the Eastern Siberia region is ranked 152nd (PPI of 92.66). All these jurisdictions fall into the 5th (least attractive) PPI quintile. In terms of the Revenue Watch (2013) RGI, Russia is ranked 22nd (from 58 countries) with a composite score of 56 (partial). In terms of the individual components, Russia received a score of 57 for institutional and legal setting, 60 for reporting practices, 62 for safeguard and quality controls and 39 for enabling environment.

3.3.1.2 Brazil

From 2011, Brazil has used two types of arrangements, a concession contract and a PSC (Ernst & Young, 2014). The PSC is used to allocate pre-salt and other strategic areas by assigning the contract to the bid that offers the greatest volume of oil to the government, who is represented by Brazil's NOC. The concession system awards the bid to the entity that offers the largest signature bonus to the government. The level of local content that will be purchased has also become a consideration in the bid offer. Brazil's oil revenue as percentage of GDP (2010) is estimated at approximately 1.4% (Gobetti, 2010).

The concessionary system consists of a royalty, CIT, a special participation tax and a large number of smaller duties and taxes (Palantir, 2015). The numerous indirect taxes complicate the Brazilian regime and increase the cost of doing business. There is normally no direct government participation but the NOC, Petrobras, is a large and active ordinary participant. Signature bonuses are an important part of awarding licences. The wide array of indirect taxes creates confusion and uncertainty as the actual levels of taxation can vary significantly across projects. Indirect taxes can add more than 50% to the cost of imported capital goods. CIT is 34% and is made up of a basic rate of 15%, plus 10% surtax (additional tax) plus a 9% CSLL (Contribuição Social sobre o Lucro Líquido), which can be translated as 'Social Contribution on Net Profits'. The tax is levied at a company level on all activities after allowing for the qualifying deductions. The royalty rate is levied at 10%, but may be reduced down to 5% for considerations of geological risk, production expectations and other relevant factors. However, most fields pay the full 10% royalty. The concessionary system is the main focus of this section; therefore, Brazil's PSC is only briefly reviewed here.

With the discovery of the offshore Tupi Field in 2007, a new petroleum province named the 'pre-salt' was opened up for exploration (Palantir, 2015). The province is located under a thick layer of salt within the Espirito Santo, Campos and Santos basins; accordingly, it is called the 'pre-salt' province. The PSC levies a royalty (15% of gross production), CIT of 34% and a fixed signature bonus of US$ 7.5 billion. Production sharing is based on production rate and price, while the minimum state participation is 30%. Cost recovery is limited to 50% for the first two years after which it is 30%.

In terms of the Fraser Institute's (2014) global petroleum survey, Brazil's jurisdiction is broken down into regions. Brazil's offshore (concessionary) jurisdiction is ranked in 76th position (PPI of 55.19), while the onshore (concessionary) jurisdiction is ranked 80th (PPI of 59.53). The offshore presalt area (PSC) is ranked in 101st place with a PPI of 68.39. The offshore and onshore concessionary jurisdictions fall into the 3rd PPI quintile, while the offshore presalt area (PSC) falls into the 4th quintile. In terms of the Revenue Watch (2013) RGI, Brazil is ranked fifth (from 58 countries) with a composite score of 80 (satisfactory). In terms of the individual components, Brazil received a score of 81 for institutional and legal setting, 78 for reporting practices, 96 for safeguard and quality controls and 66 for enabling environment.

3.3.1.3 Norway

Many comparisons have been made between the Norwegian and UK fiscal systems (Nakhle, 2008:40). However, despite sharing the North Sea, there is a divergence in the respective governments' policies. For example, in the 1980s, the UK reduced government participation, while Norway continuously increased government participation and control up to 1986.

Norway's petroleum legislation was introduced in 1965, production started in the early 1970s and Norway has become one of the largest offshore oil producers in the world (Palantir, 2015). Norway has approximately 40 oil fields as well as 40 gas fields. Norway's main hydrocarbon areas are the North Sea, the Norwegian Sea and the Barents Sea. Norway's concessionary system consists of CIT and a special tax. Royalties were fully phased out in 2005, but a CO_2 tax is payable for flaring and production. Petroleum taxation is governed by the Norwegian Petroleum Tax Act (Ernst & Young, 2014). IOCs pay a marginal tax rate of 78% comprising 27% CIT and a 51% special tax (resource rent tax). There is no ring-fencing as the tax system is focused on the taxation of the entity rather than specific assets or licences. Losses incurred onshore may not be offset against offshore income or vice versa. However, 50% of onshore losses may be used to offset offshore income that is subject to the 27% CIT. The same applies to offsetting offshore losses against onshore income subjected to the 27% CIT. Through the state's direct financial interest, the government holds a large number licences on Norway's continental shelf (Palantir, 2015). Furthermore, the government has been a majority shareholder (67%) of Statoil since 2013. In 2011, the oil sector contributed to 30% of government revenue (Revenue Watch, 2013).

In terms of the Fraser Institute's (2014) global petroleum survey, Norway's North Sea jurisdiction is ranked 23rd (PPI of 29.70) and the other offshore (except North Sea) is ranked in 24th position (PPI of 30.07). Both of these jurisdictions fall into the 2nd PPI quintile. In terms of the Revenue Watch (2013) RGI, Norway is ranked 1st (from 58 countries) with a composite score of 98 (satisfactory). In terms of the individual components, Norway received a score of 100 for institutional and legal setting, 97 for reporting practices, 98 for safeguard and quality controls and 98 for enabling environment.

3.3.1.4 United Kingdom

The UK is a high-ranked non-OPEC oil and gas producer (Nakhle, 2008:37). The UK Continental Shelf is a mature oil province with high extraction costs that may be perceived as damaging to project economics and basin competitiveness.

Abdo (2010) analysed the progressive relaxation of the UK petroleum fiscal system in 1983, 1987-1988 and 1993. These relaxations were mostly unnecessary to stimulate development of marginal fields, which were assumed to be more costly to develop. The three relaxations consisted of different components, designs and objectives and accordingly had different effects on investment and government take. Abdo (2010) concludes that these interventions did not produce a win-win outcome for both the IOCs and the government. All three policies increased IOC cashflows, but failed to increase the government's share. Nakhle (2007) analysed the link between higher oil prices and increased petroleum taxation in the UK. In reaction to higher oil prices, the UK government introduced a 10% supplementary charge in 2002 and doubled it to 20% in 2005 in order to capture a greater share for the government. Based on the Laffer curve[35], higher taxes do not necessarily translate into higher government revenues. For this reason, the UK's 2007 Annual Budget showed a shortfall in oil revenue from the North Sea in comparison with the forecasted £4 billion. Nakhle (2007) argues that the timing of the increased taxation was wrong and that the government should have rather formulated policies to encourage more oil production from this declining province.

The UK's fiscal system is regarded as one of the most complex in Europe (Palantir, 2015). However, recent and planned changes are likely to reduce this system's historic complexity. Subsoil (oil) resources are the property of the Crown (Government), which issues licences, using bid rounds, and authorises development and decommissioning. Traditionally, the government participated in E&P developments, but this ended with privatisation in the 1980s. The UK uses a concessionary system incorporating a ring-fenced CIT and profit-based special taxes (Ernst & Young, 2014).

The ring-fenced CIT rate for oil and gas E&P profits is 30%. E&P activities are regarded as a separate 'ring-fenced' trade from other[36] trading activities, for example refining and marketing. Ring-fenced trading profits are calculated separately from non-ring-fenced trade profits.

[35] See Figure 2.2 in section 2.3.
[36] The UK's non-ring-fenced CIT is 21% and will be reduced to 20% from 1 April 2015.

Accordingly, non-ring-fenced losses may not be offset against ring-fenced profits. However, ring-fenced losses may be offset against non-ring-fenced profits (Ernst & Young, 2014). The profit-based special taxes consist of a supplementary charge (32%) and a petroleum revenue tax (50%) for fields that received development rights before 16 March 1993. The petroleum revenue tax is applied on a field-by-field basis instead of an entity-by-entity basis. Both the ring-fenced CIT and the supplementary charge are charged on approximately the same base (corporate profits), and when combined translates into a total corporate tax rate of 62% (Palantir, 2015). In 2011, the oil sector contributed to only 2% of government revenue (Revenue Watch, 2013).

In terms of the Fraser Institute's (2014) global petroleum survey, the UK's North Sea jurisdiction is ranked 31st, with a PPI of 33.18. The other offshore (except North Sea) jurisdiction is ranked 33rd with a PPI score of 34.75. Both of these jurisdictions fall into the 2nd PPI quintile. In terms of the Revenue Watch (2013) RGI, the UK is ranked 3rd (from 58 countries) with a composite score of 88 (satisfactory). In terms of the individual components, the UK received a score of 79 for institutional and legal setting, 91 for reporting practices, 83 for safeguard and quality controls and 93 for enabling environment.

3.3.1.5 Australia

Australia has two concessionary fiscal systems, a royalty/excise regime and a petroleum resource rent tax (PRRT) regime (Palantir, 2015). The royalty/excise regime comprises an excise duty, a royalty and CIT. The PRRT was extended to all onshore and offshore oil and gas production from 1 July 2012. However, the Joint Development Area in the Timor Sea is excluded from the PRRT. The excise duty is based on production and is levied as a percentage of gross production without any eligible deductions. The excise duty is calculated according to the classification of the oil that is produced. There are three classifications, namely old oil, intermediate oil and new oil. Discoveries before 17 September 1975 but that were developed before 23 October 1984 are classified as old oil. Discoveries made before 17 September 1975 but that were developed after 23 October 1984 are classified as intermediate oil. All discoveries after 17 September 1974 are classified as new oil. Royalties are generally applicable to onshore projects at a rate of between 10 to 12.5% (Ernst & Young, 2014). However, royalties paid are creditable for PRRT and deductible for CIT purposes. The CIT rate is 30% and the PRRT is 40%. PRRT is imposed on a project basis and for this reason deductible expenditure is normally limited to project-specific expenditures and cannot be deducted for other projects of the same company.

In terms of the Fraser Institute's (2014) global petroleum survey, Australia's upstream jurisdictions are subdivided. The PPI scores are 27.17 (ranked 18th) for South Australia, 36.85 (ranked 39th) for the Northern Territory, 38.41 (ranked 43rd) for the offshore, 39.88 (ranked 47th) for Tasmania, 40.96 (ranked 49th) for Victoria, 41.40 (ranked 50th) for Western Australia, 45.15 (ranked 55th) for Queensland and 60.38 (ranked 83rd) for New South Wales.

South Australia, Northern Territory, the offshore and Tasmania fall into the 2nd PPI quintile. Victoria, Western Australia and Queensland fall in to the 3rd PPI quintile, while New South Wales falls into the 4th PPI quintile. In terms of the Revenue Watch (2013) RGI, Australia is only ranked for minerals and not hydrocarbons. Australia is ranked 4th with a composite score of 85 (satisfactory).

3.3.2 Contractual systems (PSCs): selected countries

At first glance, PSCs (as discussed in Chapter 2: see Figure 2.5) may seem to be very different from concessionary (R/T) systems. However, the difference is rather a symbolic and philosophical one, filling a psychological niche that mainly serves a political function. From a financial and mechanical view, these systems are in essence not that different. The main mechanical difference lies in the cost recovery limit[37]. The essential characteristic of the PSC is that the state retains ownership of the resource and the contractor (IOC) receives a share of production. In some cases, CIT is a 'deemed' tax, whereby the government settles the IOC's tax liability from the government's share of production and the IOC does not physically settle any taxes (Ernst & Young, 2014). The IOC's share of the profit oil is considered net of taxes.

3.3.2.1 China

China uses PSCs but the various licence rounds and individual negotiations for some blocks have created significant divergence between PSCs (Palantir, 2015). This section is focused on the principle licence round terms. The main components of the fiscal system consist of the PSCs, special oil gain levies, resource tax and CIT (Ernst & Young, 2014). Foreign IOCs can

[37] This limits the allowable deductions for cost recovery; it is normally a percentage of gross revenues or gross production (Johnston, 2003:336).

participate in the exploration, development and production of hydrocarbons by entering into PSCs with the Chinese government or the designated Chinese national petroleum companies. The special oil gain levy is calculated using a formula based on the oil prices. Royalties range from 0 to 12.5%, but are not applicable to PSCs concluded after 1 November 2011. Subsequently, royalties have been replaced by a resource tax levied at 5%, based on the sales price. Signature bonuses consider the volume of the resource and the economic value of the field. Production sharing is based on production volumes. CIT is levied at 25% (Ernst & Young, 2014).

China's PSCs use annual gross production net of all revenue levies and revenue taxes to calculate the cost recovery and profit production (Ernst & Young, 2014). Onshore and offshore PSCs generally have cost recovery of 50 to 62.5% and 60% respectively. The profit oil split is either based on an R-factor[38] or a production-rate-based sliding scale (Palantir, 2015). In terms of state participation, China's government is involved through the NOCs, the China National Offshore Oil Corporation (CNOOC) and PetroChina (also known as the China National Petroleum Corporation). There is revenue windfall levy for oil prices above US$50 a barrel (formula based 20%-30%). State participation through the NOCs may be up to 51%.

In terms of the Fraser Institute's (2014) global petroleum survey, China's upstream jurisdiction is ranked 117th, with a composite score of 73.37 (4th quintile). In terms of the Revenue Watch (2013) RGI, China is ranked 36th (from 58 countries) with a composite score of 43 (weak). In terms of the individual components, China received a score of 43 for institutional and legal setting, 46 for reporting practices, 46 for safeguard and quality controls and 36 for enabling environment.

3.3.2.2 Iraq

Iraq uses concessionary, contractual (PSC) and service contract systems. As was noted earlier, service contract systems are not considered in this thesis. Concessions use an upstream specific CIT of 35% (Ernst & Young, 2014). The Kurdistan region of Iraq developed fiscal terms independently from the Iraqi central government after the 2003-2011 war (Palantir, 2015).

[38] R-factor systems are based on a pay-out formula; the tax rate is subject to an R-factor with several thresholds (Johnston, 2003:42). R (ratio) is a function of X devided by Y(X/X) where X is the accumulated receipts the contractor actually receives less tax. Y is the accumulated capital expenditure (Capex) and operating expenditures (Opex). The R-factor will be calculed for each accounting period and if a threshold is crossed, the new tax rate will be in effect in the following period.

However, there are on-going efforts from the national government to reassert its authority and control over Kurdistan oil revenues. The PSC is characterised by the use of an R-factor in the calculation of the profit share. For oil, the R-factor is in a range of 32 to 16% (contract dependant) and for gas the range is 40 to 20% (contract dependant). Cost recovery is 45% of revenue after royalty; the royalty rate is 10% and the CIT rate is 40%. State participation can vary from 20 to 25% through the oil ministry. Iraq's oil sector, on average for 2001-2010, contributed to approximately 68% of GDP and 63% of government revenue (see Figure 3.1).

In terms of the Fraser Institute's (2014) global petroleum survey, Iraq's upstream jurisdiction is ranked 150th, with a composite score of 88.59 (least attractive quintile). In terms of the Revenue Watch (2013) RGI, Iraq is ranked 29th (from 58 countries) with a composite score of 47 (weak). In terms of the individual components, Iraq received a score of 57 for institutional and legal setting, 52 for reporting practices, 63 for safeguard and quality controls and 9 for enabling environment.

3.3.2.3 Oman

Originally, Oman used concessions, but these have almost been entirely replaced by PSCs (Palantir, 2015). Licence rounds are held regularly and commercial terms are directly negotiated with the ministry. The Exploration and Production Sharing Agreement (EPSA), not the same as Libya's EPSA, is the standard PSC used in Oman. Both signature (<$500 000) and discovery ($1 000 000-$2 000 000) bonuses are payable and neither are cost-recoverable. Cost recovery is capped at 40% for oil and the cap for gas is 50%. There are numerous rates for profit sharing, the flat rates could be 15%, 20% or 30% to the contractor or it could be based on production tiers (the contractor receives 35% at low production levels and 15% at high production levels). The rate for CIT is (deemed) 55% and is payable by government on the contractors behalf. Oman's oil sector, on average for 2001-2010, contributed to approximately 38% of GDP and 59% of government revenue (see Figure 3.1).

In terms of the Fraser Institute's (2014) global petroleum survey, Oman's upstream jurisdiction is ranked 36th, with a composite score of 36.03 (2nd quintile). Oman was not part of the sample used for the 2013 RGI.

3.3.2.4 Indonesia

Indonesia was the first to introduce PSCs when they signed a contract with Asamera in 1961 (Palantir, 2015). There have been numerous changes to the fiscal system, with changes in CIT rates in 1976 and 1984 as well as the introduction of incentive packages in 1988, 1989, 1992, 1993 and 2001. For this reason, the point in time at which a specific PSC was signed must be considered when analysing Indonesian contracts.

Indonesia uses PSCs, which are entered into by contractors (IOCs) and BPMIGAS, the Indonesian executive body that regulates upstream activities (Ernst & Young, 2014). However, the Constitutional Court disbanded BPMIGAS in late 2012. It has been replaced by a similar body named SKKMIGAS, which falls under the authority of the Ministry of Energy and Mineral Resources. CIT depends on the generation of the contract and is currently 25%. There is also a branch profits tax (dividend tax) charged at 20%. Ring-fencing is used so that a contractor (IOC) cannot offset costs of one working interest against income from another area. For this reason, an entity will most likely only hold a working interest in one contract area. Bonus payments vary according to the specific PSC terms. The general terms of the PSC are that the contractor (IOC) bears all the exploration risks and costs up to production. Should production not materialise, the contractor (IOC) cannot recover costs. Should production materialise, the contractor is entitled to a share of production to cover the recoverable costs, investment credit for capital investment and an equity interest in the remaining production. The general terms of the PSC are that the contractor (IOC) bears all the exploration risks and costs up to production. Should production not materialise, the contractor (IOC) cannot recover costs. Should production materialise, the contractor is entitled to a share of production to cover the recoverable costs, an investment credit for capital investment and an equity interest in the remaining production. The equity share (equity oil) is normally based on oil production over and above the amounts received for First Tranche Petroleum, cost recovery and investment credit, after allowing for the contractor's domestic market (supply) obligation.

Instead of charging a royalty, Indonesia uses the so-called First Tranche Petroleum contract. Under this contract, 20% of production must be shared according to the respective equity share of the government and contractor stipulated in the agreement. The First Tranche Petroleum share is calculated before allowing for cost recovery; First Tranche Petroleum is regarded as taxable income (Ernst & Young, 2014). Under domestic market obligations, the IOC must supply a specified portion (maximum 25%) of its equity oil to the domestic market (Palantir, 2015). Costs incurred to earn, collect and maintain income and that are directly connected to the operation of an IOC's block, qualify for cost recovery and are tax deductible. State participation through the NOC can be variable. In 2011, the oil sector contributed to 18% of government revenue (Revenue Watch, 2013).

In terms of the Fraser Institute's (2014) global petroleum survey, Indonesia's upstream jurisdiction is ranked 145th, with a composite score of 85.89 (5th quintile). In terms of the Revenue Watch (2013) RGI, Indonesia is ranked 14th (from 58 countries) with a composite score of 66 (partial). In terms of the individual components, Indonesia received a score of 76 for institutional and legal setting, 66 for reporting practices, 75 for safeguard and quality controls and 46 for enabling environment.

3.3.2.5 Azerbaijan

Azerbaijan uses straightforward PSCs, but there is large variation between individual contracts (Palantir, 2015). There is no model PSC as contracts are individually negotiated and signed between contractors (IOCs) and the State Oil Company of the Azerbaijan Republic. Furthermore, the legal framework governing Azerbaijan's oil and gas upstream is based on the Code of the Azerbaijan Socialist Republic on Subsoil of 1976, which is confusing and incomplete. There have been actions taken to improve the legislation since then. The terms discussed here are based on the 'Shah Deniz' type of PSC, applicable to the Shah Deniz field. Signature and production bonuses can be substantial. Cost recovery is 50% of gross revenue and 100% of operational costs. The profit oil split is normally based on an R-factor tier system. The CIT rate is (deemed) 25% and state participation is typically 10% through the NOC.

In terms of the Fraser Institute's (2014) global petroleum survey, Azerbaijan's upstream jurisdiction is ranked 100th, with a composite score of 68.29 (4th quintile). In terms of the Revenue Watch (2013) RGI, Azerbaijan is ranked 28th (from 58 countries) with a composite score of 48 (weak). In terms of the individual components, Azerbaijan received a score of 57 for institutional and legal setting, 54 for reporting practices, 51 for safeguard and quality controls and 24 for enabling environment.

3.3.3 Summary of global trends

The previous two sections provided an overview of the petroleum fiscal systems and taxation instruments used in ten oil-producing countries. Tables 3.2 and 3.3 summarise the concessionary and contractual systems used by these countries. The following discussion of tax rates is focused solely on the stipulated rates and does not consider special provisions or exclusions. As discussed in Chapter 2, concessionary (R/T) systems are more prevalent in countries with relatively low reserves and high costs, while PSCs are preferred in countries with large reserves and medium-level costs. However, a number of countries use more than one type of system because of different reserves with a variety of E&P costs, which could either be low, medium and/or high. In practice, the structure of a specific fiscal arrangement is the important issue rather than the type of agreement itself. From the five concessionary system countries discussed in this chapter, Russia and Brazil also have a PSC system.

Under the concessionary systems (Table 3.2), only Russia, Brazil and Australia impose a royalty. In nominal terms, Australia has the highest rate (12.5%), followed by Brazil's 10%. Russia's royalty (MET) will vary according to the formula used. Russia's CIT of 20% is much lower than the other four countries using a concessionary system. However, the export duty (35-60%) could possibly compensate for the lower CIT rate. Brazil has the highest CIT rate (34%) and also has a number of indirect taxes. For example, the special participation tax can be up to 40%. Norway has the 2nd lowest CIT rate (27%) in this group, but also levies a special tax at a high rate (51%); the combination of these two taxes is relatively high and amounts to 78%. The UK and Australia have the same CIT rates (30%). In terms of other taxes, Australia's 40% petroleum resource rent tax is higher than the UK's 32% supplementary charge. In terms of the Fraser Institute's jurisdiction rankings, Norway, the UK, Australia (South Australia, Northern Territory, the offshore and Tasmania) have the most favourable jurisdictions in the group of five countries, falling in the 2nd PPI quintile. Jurisdictions in the 3rd PPI quintile include Brazil's offshore and Australia's Victoria, Western Australia and Queensland jurisdictions. New South Wales falls in the 4th PPI quintile. Russia falls in the 5th (least attractive) PPI quintile. Production sharing is a key component of contractual (PSC) systems (Table 3.3).

Table 3.2: A summary of five concessionary systems

Country	Royalty	CIT	Other	Fraser Institute: jurisdiction ranking/156
Russia	Royalties are replaced by MET, levied on production: For oil it is US$14 per tonne adjusted by coefficients.	20%	• Export duty: 35-60%. • MET (formula based) to replace royalties. • Signature & production bonuses.	<u>Four jurisdictions:</u> Other Russian: 135 Offshore Sakhalin: 142 Offshore Arctic: 151 Eastern Siberia: 152
Brazil	5-10%	34%	• Various indirect taxes. • Special Participation Tax: 0- 40% based on field size and maturity. • Signature bonuses.	<u>Three jurisdictions:</u> Offshore: 76 Onshore: 80 *Offshore pre-salt (PSC):* 101
Norway	-	27%	• Special tax: 51% (resource rent tax).	<u>Two jurisdiction:</u> Onshore Jurisdiction: 20 Offshore (North Sea) 28
United Kingdom	-	30%	• Supplementary Charge: 32%. • Petroleum revenue tax: 50% – only for development rights before 16 March 1993.	<u>Two jurisdiction:</u> North Sea: 23 Other offshore: 24
Australia	Onshore: 10-12.5%	30%	• Petroleum resource rent tax: 40%.	<u>Eight jurisdictions:</u> South Australia: 18 Northern Territory: 39 Offshore: 43 Tasmania: 47 Victoria: 49 Western Australia: 50 Queensland: 55 New South Wales: 83

Source: Adapted from Ernst & Young (2014), Fraser Institute (2014), and Palantir (2015)

Table 3.3: A summary of five contractual systems (PSCs)

Country	Production sharing	Cost recovery	Royalty	CIT	Other	Fraser Institute: jurisdiction ranking/156
China	Based on an R-factor or a production-rate-based sliding scale.	Onshore: 50-62.5%. Offshore: 60%.	Not applicable (Contracts dated before 1 November 2011: 0%-12.5%)	25%.	• Resources tax: 5% (on sales price). • Revenue windfall levy (formula based 20%-30% for oil prices above US$50 a barrel). • Submission and signature bonuses.	Jurisdiction: 117
Iraq	Based on an R-factor calculation.	45% of revenue after Royalty.	10%	40% (deemed)	• Variable and often large bonuses.	Jurisdiction: 150
Oman	Profit sharing based on flat rates or production tiers.	Capped at 40% (50% for gas).	Not applicable	55% (deemed)	• Signature bonuses: (<$500 000) • Discovery bonuses: ($1 000 ,000-$2 000 000)	Jurisdiction: 36
Indonesia	First Tranche Petroleum formula.	All costs are recoverable.	Not applicable. (First Tranche Petroleum of 10%).	25%-30% depending on the generation of the contract.	• Branch Profits Tax: 20% • Ring-fencing • Bonus payments vary over contracts (Signature, bonus and compensation) • Domestic market obligations.	Jurisdiction: 145
Azerbaijan[39]	Based on an R-factor calculation.	50% of gross revenue and 100% of operational costs.	Not applicable.	25% (deemed)	• Negotiated bonuses: Production and signature bonuses.	Jurisdiction: 100

Source: Adapted from Ernst & Young (2014), Fraser Institute (2014), Palantir (2015)

The method for calculating production sharing varies between countries and can be based on the volume of production, an R-factor, flat rates, production tiers or First Tranche Petroleum. China, Iraq and Azerbaijan use an R-factor in calculating the split between the contractor and government. Oman uses either a flat rate or production tiers. Indonesia uses a First Tranche Petroleum calculation. The allowance for cost recovery will influence the share obtained by an IOC. These allowances also vary widely between countries. For example, all costs are recoverable in Indonesia, but the other countries place a cap on the allowable cost recovery.

Currently, only Iraq levies a royalty (10%), while Indonesia levies a 10% First Tranche Petroleum. Oman has the highest CIT (55%) in the sampled group of contractual systems and

[39] There is no model PSC for Azerbaijan; this information is based on the ‘Shah Deniz’ type of PSC.

Iraq the second highest (40%). The other countries have a CIT of 25%. However, depending on the contract, the CIT in Indonesia can be up to 30%.

In terms of other levies, China charges a resource tax (5%) and a revenue windfall levy (formula based). China also levies submission and signature bonuses. Iraq may charge variable bonuses, which are often large. Oman charges both signature and discovery bonuses. Indonesia has a branch profits tax of 20% for branch operations, ring-fencing, bonus payments and domestic market obligations. Azerbaijan also charges production and signature bonuses.

In terms of the Fraser Institute's jurisdiction rankings, Oman (36) has the most favourable jurisdiction in the group of five countries, falling in the 2nd PPI quintile. China and Azerbaijan fall in the 4th PPI quintile. This is followed by Indonesia and Iraq in the 5th PPI quintile. In terms of state participation, Oman does not have state participation through an NOC, while Iraq uses the oil ministry. China, Indonesia and Azerbaijan all have some level of state participation through an NOC.

3.4 Conclusion

Oil sector taxation is an efficient source of tax revenue, which can potentially strengthen a country's fiscal position. The relative importance of tax revenue from the oil sector implies that tax design is essentially a case of negotiation between the government and investor rather than the design of a uniform system applied in a top-down approach. Considering the equity and efficiency criteria, oil sector rents are a particularly attractive tax base.

A number of factors influence investors' decision to invest or not. A country's petroleum fiscal system is one of the factors that investors consider. Although the government policy perspective is the focus of this thesis, the investor perspective influences the government policy perspective in terms of attracting investment. For this reason, the Fraser Institute's (2014) annual survey of the perceived barriers to investment in upstream E&P was considered as part of the comparative analysis. Common factors that respondents regard as barriers include: onerous fiscal regimes, political instability, land claim disputes as well as costly, time-consuming uncertainty surrounding regulations. Competitive tax and regulatory regimes are regarded as positive factors that can attract investment. The effective management of oil rents by host governments influences the benefit that host countries derive from the oil sector in terms of taxation. This issue was considered by incorporating the Revenue Watch (2013)

Resource Governance Index. It is a measure of oil and gas governance quality in the oil, gas and mining sectors for 58 countries

This chapter provided a comparative analysis of the current systems and taxation instruments that are prevalent in oil-producing countries. In terms of concessionary systems, the five countries selected were Russia, Brazil, Norway, the United Kingdom and Australia. The five countries selected with contractual systems (PSCs) were China, Iraq, Oman, Indonesia and Azerbaijan.

From the analysis, the following points can be highlighted. The concessionary systems mostly rely on CIT as a main instrument and royalties seem to be a secondary instrument based on production. Three of the five countries charge royalties, while Norway and the UK do not. However, there are various additional taxes that help to further increase the government's take. In percentage terms, these taxes vary from 0 to 60%. From the ten countries, it appears that the contractual (PSC) system is more prevalent in developing countries. With the exceptions of Russia and Oman, the concessionary system countries have a better PPI score than the contractual system countries. Overall, jurisdictions for developed countries such as Norway, the UK and Australia (South Australia, Northern Territory, the offshore and Tasmania) fall in the 2^{nd} PPI quintile. However, Australia's Victoria, Western Australia and Queensland fall in the 3^{rd} quintile, while New South Wales falls into the 4^{th} PPI quintile. With the exception of Oman (2^{nd} PPI quintile), jurisdictions from developing countries rank lower. For example, Brazil and China fall in the 3^{rd} quintile, while Azerbaijan falls in the 4^{th} quintile. Russia, Indonesia and Iraq fall into the 5^{th} quintile.

Norway, the UK and Australia (South Australia, Northern Territory, the offshore and Tasmania) have the most favourable jurisdictions in the group of five countries, falling in the 2^{nd} PPI quintile. Jurisdictions in the 3^{rd} PPI quintile include Brazil's offshore and Australia's Victoria, Western Australia and Queensland. China and Azerbaijan fall in the 4^{th} PPI quintile, while Russia, Indonesia and Iraq fall into the 5^{th} PPI quintile.

In general, the contractual system seems to be more complex, and less favoured by IOCs when considering the PPI. There are also many variations of PSCs within countries. The PSC systems mainly collect a share for the government through the production sharing process and secondly through CIT that ranges from 25 to 55%. In addition, the additional elements such as ring-fencing, bonuses and domestic market obligations place a further weight on IOCs.

This chapter has provided a comparative analysis of the approaches taken by countries using concessionary and contractual fiscal systems. It is important to note that both systems can be used to achieve the same outcomes depending on how these systems are structured. In practice, the structure of a specific fiscal arrangement is the important issue rather than the type of agreement itself. The next chapter continues this analysis by focusing on Africa's three largest oil producers (Nigeria, Angola and Algeria) as well as one emerging producer (Chad).

Chapter 4: Petroleum fiscal systems in selected African countries

"Africa is the story. The big story is Africa. The Chinese and Japanese are fighting over Africa. This is a market of a billion people, of natural resources." – Dr Ahmed Heikal, Chairman and Founder of Citadel Capital.

4.1 Introduction

The aim of this thesis is to advise on the effectiveness of petroleum fiscal systems in Africa, by considering Africa's three largest oil producers and one emerging producer (Chad). This chapter can be seen as a continuation of the discussion of petroleum fiscal systems presented in Chapters 2 and 3, but with a specific focus on the current petroleum fiscal systems of the African countries that are used for the empirical analysis.

Africa has nineteen countries that are regarded as significant oil producers (Ernst & Young, 2011). There are continuous new discoveries of oil in Africa, presenting unique opportunities for investors (African Development Bank, 2009:7). The current oil base and potential for further discoveries have made Africa a key 'target' in the global E&P landscape (African Development Bank, 2009:47). On a regional level, North and West Africa have a long history of oil production including countries such as Algeria, Libya and Egypt in the North and Nigeria and Angola in the West. The discovery of significant reserves in Uganda in 2006 has sparked renewed interest in the East African region, strengthened by subsequent discoveries in Kenya and offshore gas discoveries in Tanzania and Mozambique (Deloitte, 2013). There have also been discoveries in Liberia, Sierra Leone, Ghana and Namibia. Most of the latter ones are offshore and still in the exploration phase.

The majority of Africa's oil production is based in Nigeria, Angola, Algeria and Libya. This thesis uses Nigeria, Angola, Algeria and the emerging producer Chad to evaluate petroleum fiscal systems in Africa. Although Angola is considered in this chapter, it does not form part of the empirical analysis in Chapters 5 and 6, as the required data are not currently available. Furthermore, in light of the political turmoil, uncertainty and a lack of data, Libya's fiscal system will not be considered. The daily oil production and proved oil reserves in Africa (2013) are illustrated in Table 4.1.

Table 4.1: Oil production and reserves in Africa (2013)

Country	Production: Thousand barrels daily[40]	Share of world total	Reserves (proven): Thousand million barrels	Share of world total	R/P[41]
Nigeria	**2322**	2.70%	**37.1**	2.20%	43.8
Angola	**1801**	2.10%	**12.7**	0.80%	19.3
Algeria	**1575**	1.70%	**12.2**	0.70%	21.2
Libya	**988**	1.10%	**48.5**	2.90%	>100
Egypt	**714**	0.80%	**3.9**	0.20%	15
Equatorial Guinea	**311**	0.40%	**1.7**	0.10%	15
Rep. of Congo (Brazzaville)	**281**	0.40%	**1.6**	0.10%	15.6
Gabon	**237**	0.30%	**2**	0.10%	23.1
Other Africa	**211**	0.30%	**3.7**	0.20%	47.7
Sudan	**122**	0.10%	**1.5**	0.10%	33.7
South Sudan	**99**	0.10%	**3.5**	0.20%	96.9
Chad	**94**	0.10%	**1.5**	0.10%	43.5
Tunisia	**62**	0.10%	**0.4**	♦	18.7
Total Africa	**8818**	**10.10%**	**130.3**	**7.70%**	**40.5**

Source: Compiled from data by BP (2014)

Nigeria, Angola and Algeria currently have the largest production levels in Africa; while they are ranked 2nd, 3rd and 4th after Libya in terms of proven oil reserves. These top four countries are responsible for 76% of African oil production and 7.6% of world oil production, emphasising dominance in terms of production and reserves. The share of production and reserves held by other countries is still relatively small in comparison to these four countries. However, this may still change as more E&P comes on line from the emerging and current oil producers in the rest of Africa. Chad is one of these emerging oil producers, producing oil from 2004. To incorporate emerging producers, Chad is also considered in the analysis.

The rest of this chapter will provide an overview of the petroleum fiscal systems used in Africa, specifically in Nigeria, Angola, Algeria and Chad. It is important to note that the following sections provide a broad overview of these fiscal systems; it is not an exhaustive treatment of all the various possible fiscal elements as such an analysis falls outside the scope of this thesis.

[40] Includes crude oil, shale oil, oil sands and NGLs (the liquid content of natural gas where this is recovered separately). Excludes liquid fuels from other sources such as biomass and coal derivatives.
[41] Reserves-to-production (R/P) ratio – If the reserves remaining at the end of any year are divided by the production in that year, the result is the length of time that those remaining reserves would last if production were to continue at that rate.

4.2 Nigeria

The oil sector is a major contributor to Nigeria's economy. The first commercial oil discoveries were made in the Niger River Delta region in 1956 (Van Buren, 2011). Nigeria is a member of OPEC and accounts for approximately eight per cent of the organisation's oil production. The majority of FDI inflows to Nigeria are from IOCs (EIU, 2011). The main determinants attracting these investments are low production costs and the high quality of the country's oil reserves. Despite being an established oil producer, Nigeria is often plagued by supply disruptions from oil theft (bunkering) that have been as high as 500 000 barrels per day (bbl/d) (EIA, 2013a). Okonta (2013) identifies policy incoherence, vested interests and agitated citizens, demanding more social and economic benefits, as factors that create a chaotic environment that threatens Nigeria's energy security and ability to fulfil its commitments to the importing countries in Europe and North America. According to the Africa Economic Outlook (2014b), oil contributes to approximately 60% of government revenue and 96% of export earnings.

The current petroleum fiscal system will potentially be replaced by the proposed Petroleum Industry Bill. The Petroleum Industry Bill is still in the parliamentary process of being passed into law; the bill could have a significant impact on current IOCs operating in Nigeria as well as the potential new entrants (Palantir, 2015). The new system is complex and will offer generous terms for IOCs operating in small fields or a low price environment. However, terms will be very stringent for IOCs operating in large fields or a high price environment. IOCs have raised concerns that the changes proposed by the Petroleum Industry Bill could make projects commercially unviable, especially high cost deep-water projects (EIA, 2013a).

The main IOCs operating in Nigeria include Shell, ExxonMobil, Chevron, Total, and Eni. Instability and 'bunkering' in the Niger Delta have induced IOCs to generally farm-out their onshore projects and rather focus on the offshore. For this reason, current exploration is focused on the deep and ultra-deep offshore. Furthermore, instability, bunkering and the uncertainty created by the proposed Petroleum Industry Bill all contribute to lowering exploration activity, which translates into slow or no growth in reserves. Since the Petroleum Industry Bill has not yet been finalised, it will not be discussed in any more detail. The discussion below reviews the current petroleum fiscal system.

IOCs operating in Nigeria’s upstream sector are taxed under the Petroleum Profits Tax Act (Ernst & Young, 2014; Palantir, 2015). Under this act, Nigeria’s petroleum fiscal system is a mixture of both concessionary and contractual systems. The concessionary system comprises joint ventures as well as sole risk concessions that are offered to indigenous companies. The contractual system comprises normal production sharing terms as well as risk service contracts. Under a risk service contract, the IOC delivers a service in exchange for compensation. Such an arrangement falls outside the Petroleum Profits Tax Act and such operations are taxed under the Companies Income Tax Act at a far lower rate. For this reason, the risk service contract falls outside the scope of this thesis (as was mentioned in Chapter 2).

Under the concessionary regime, IOCs and the state oil company, the Nigerian National Petroleum Corporation, operate in a joint venture where the state oil company owns the asset, the IOC provides the funding and both parties share in the revenue and cost according to their respective shares in the joint venture (Nwaokoro, 2011). In terms of state participation through the NOC, the Nigerian National Petroleum Corporation participates in many projects. Under the PSC arrangement, IOCs fund operations, but share the revenues with the state oil company. Nigeria’s fiscal terms are summarised in Table 4.2.

Table 4.2: Nigeria's mixed model fiscal terms

Instrument	Concessionary (joint venture)	Contractual: PSC
Royalty	The rate depends on location and water depth. Inland basin: 10%, onshore: 20%, offshore: • up to 100 meters: 18.5%. • > 100 meters: 16.67%.	The rate depends on location and water depth: Inland basin: 10%, onshore: 20%, offshore: • Up to 200 meters: 16.67%. • 201 to 500 meters: 12%. • 501 to 800 meters: 8%. • 801 to 1 000 meters: 4%. • > 1 000 meters: 0%.
CIT	Replaced by Petroleum Profits Tax: • Standard: 65.75 (year 1-5) & 85% (year 6+). • Marginal fields: 55%. • Indigenous company: 60%.	Replaced by Petroleum Profits Tax: • Standard: 65.75 (year 1-5) & 85% (year 6+). • Inland basin/deepwater: 50%.
Production sharing	Not applicable.	Based on cumulative production in the range of 80% to 25% for the IOC.
Cost recovery	Not applicable.	80% of gross revenue available for cost recovery.
Other	• Resource Rent Tax based the area size of the licence. • Signature & production bonuses at discretion of the government. • Education tax as part of Petroleum Profits Tax. • Many indirect taxes, for example: import duty and port inspection fee.	• Resource Rent Tax based the area size of the licence. • Signature & production bonuses at discretion of the government. • Education tax as part of Petroleum Profits Tax. • Many indirect taxes, for example: import duty and port inspection fee.
Fraser Institute jurisdiction ranking/156	114	114

Source: Adapted from Ernst & Young (2014), Fraser Institute (2014) & Palantir (2015)

Nigeria's royalty rates are based on location and water depth as outlined in Table 4.2 above. Corporate Income Tax is replaced by the Petroleum Profits Tax, which varies between 65.75 and 85% for standard basins. The inland and deepwater basin rate for the PSC is 50%. The PSC's production sharing is based on cumulative production ranging from 80 to 25% for the IOC. The PSC's cost recovery is 80% of gross revenue. Various other taxes can be levied as outlined above.

In terms of the Fraser Institute's (2014) global petroleum survey, Nigeria's jurisdiction is ranked 114th with a composite score of 72.05. In terms of the Revenue Watch (2013) RGI, Nigeria is ranked 40th (tied with Angola) (from 58 countries) with a composite score of 42 (weak). In terms of the individual components, Nigeria received a score of 66 for institutional and legal setting, 38 for reporting practices, 53 for safeguard and quality controls and 18 for enabling environment.

4.3 Angola

Angola's oil sector is the main source of government income and the most important economic activity in Angola (George, 2011). Angola is the second largest oil exporter in sub-Saharan Africa, second to Nigeria. According to the Africa Economic Outlook (2014b), oil contributes to approximately 80% of government revenue and 95% of export earnings.

Oil was first discovered in 1955 in the Cuanza valley and Angola became a member of OPEC in 2007. The state oil company, Sonangol (Sociedade Nacional de Combustiveis de Angola), was created in 1978 to become the sole concessionaire and main shareholder in Angola's oil and gas exploration (EIA, 2013b). Onshore exploration is limited in comparison to the vast majority of E&P that is concentrated in Angola's offshore blocks. The offshore blocks fall into three categories: Band A (shallow water blocks 0-13), Band B (deep-water blocks 14-30), and Band C (ultra deep-water blocks 31-40)[42].

The sector is regulated by Sonangol, the Ministry of Petroleum and the Ministry of Finance (PWC, 2013). Sonangol manages the government's interest, the Ministry of Petroleum regulates operations under the various licences/leases and the Ministry of Finance administers oil sector taxation. Angola's petroleum fiscal system comprises three types of arrangements, namely concessionary (joint ventures), contractual (PSCs) and risk service contracts. However, risk service contracts fall outside the scope of this thesis (as was mentioned in Chapter 2). Angola's petroleum fiscal system was historically based on a concessionary system, which was supplemented by a PSC system from 1979 (Palantir, 2015). Concessionary systems are still used for some onshore blocks, while PSCs are used for offshore blocks; therefore, within this context, Angola uses a mixed system.

The concessionary system only applies to specific partnerships that were set up in the 1960s and 1970s (Ernst & Young, 2014). Specific taxes applicable to these partnerships include a petroleum production tax of 20% (may be reduced to 10%) and a petroleum transaction tax of 70%. Under this arrangement, the NOC (Sonangol) gives IOCs a concession to explore certain blocks (PWC, 2013).

[42] Potential oil fields are divided into blocks and given specific numbers. Various oil companies could hold exploration and/or production rights to specific blocks within the same oil field. The block numbers help in tracking/identifying the various portions of an oil field and the corresponding owner of a specific block.

The initial PSCs date back to 1979. A new PSC was introduced in 1992 for deeper offshore blocks, using an IRR-based profit split. Older and newer PSCs that are used for shallow offshore blocks are based on the 1979 PSC with a cumulative production-based split. However, there is a new version of the PSC from 2007 in which the cost recovery cap mechanism changes and expenditure as opposed to depreciation is recovered. The main difference between these PSCs is a change to the cost recovery cap mechanism used in the 2007 PSC (Palantir, 2015). Angola's PSCs are progressive and ensure the government receives a high government take. Angola's signature bonuses are among the highest (in excess of US$ 1 billion) in the world, specifically for offshore deep-water blocks. State participation through the NOC, Sonangol, can range between 0 and 20%. Angola's fiscal terms are summarised in Table 4.3.

Table 4.3: Angola's mixed model fiscal terms

Instrument	Concessionary (joint venture)	Contractual: PSC
Royalty	Not applicable.	Not applicable.
CIT	Petroleum income tax: 65.75%.	Petroleum income tax: 50%.
Production Sharing	Not applicable.	Either an IRR or a production-based sliding scale.
Cost Recovery	Not applicable.	1992 PSC: 50% of net revenue. 2007 PSC: 55% rising to 65% after 5 years if not recovered.
Petroleum production tax	20% (may be reduced to 10%). IOC may deduct as investment costs up to 50% of their oil output.	Not applicable.
Petroleum transaction tax	70%.	Not applicable.
Other	• Signature bonuses among the highest in the world. • Surface fees. • Training tax contribution. • Some indirect taxes.	• Signature bonuses among the highest in the world. • Surface fees. • Training tax contribution. • Some indirect taxes.
Fraser Institute Jurisdiction ranking/156	108	108

Source: Adapted from Ernst & Young (2014), Fraser Institute (2014) & Palantir (2015)

The PSC's corporate tax (50%) is relatively lower than for concessions (65.67%). However, the concessions are subject to a petroleum production tax as well as a petroleum transaction tax. Angola's mixed system can be complex when considering the variations between concessions and PSC, as well as the distinct variations between the various vintages of PSCs. State participation through the NOC (Sonangol) can be variable.

In terms of the Fraser Institute's (2014) global petroleum survey, Angola's jurisdiction is ranked 108th with a composite score of 69.92. In terms of the Revenue Watch (2013) RGI, Angola is also ranked 40th (but numerically assigned ranking 41), tied with Nigeria (from 58 countries) with a composite score of 42 (weak). In terms of the individual components, Angola received a score of 58 for institutional and legal setting, 43 for reporting practices, 52 for safeguard and quality controls and 15 for enabling environment.

Note: Although Angola is an important and mature oil producer, it does not form part of the empirical analysis in Chapters 5 and 6. There is a lack of data for Angola; more specifically, there is no social accounting matrix (SAM) currently available for Angola. SAMs form the basis of the analyses in Chapters 5 and 6. For this reason, Angola could only be reviewed in this chapter without following up with an empirical analysis. It is one of the constraints on this thesis and is a topic for future study as and when a SAM for Angola becomes available.

4.4 Algeria

Algeria is highly dependent on the oil sector and is a member of OPEC (NKC, 2012; OPEC, 2012). Algeria first extracted oil, on a small scale, in 1918, but significant production only started in 1957 (Frynas & Paulo, 2006). In terms of Africa, Algeria is currently the largest gas producer and the third largest oil producer (BP, 2014). There is a high degree of government involvement in Algeria's economy, dating back to the country's socialist development model (CIA, 2012). The government has a particularly harsh stance against foreign investors, which curtails FDI inflows to Algeria (NKC, 2012). However, there is an attempt within the energy ministry to improve policies towards foreign investors (NKC, 2012). In recent years, delays in new production and infrastructure projects have caused stagnation in oil production and a decline in gas production (EIA, 2013c). Strict fiscal terms have started to deter investors in bid rounds and necessitated the government to amend hydrocarbon law and introduce fiscal incentives to attract new exploration investment. Militant attacks such as the attack on the Amenas gas facility created further security concerns among investors. According to the Africa Economic Outlook (2014b), oil contributes to approximately 70% of government revenue and 98% of export earnings.

Algeria's petroleum fiscal system used to be a mixture of PSCs and a concessionary (R/T) system (Palantir, 2015). However, from 2005, only the concessionary system remained in place. The basic elements of the concessionary system include royalties, CIT and a petroleum revenue tax (PRT). State participation through the NOC, Sonatrach, is variable but fixed at a minimum of 51%. Algeria's fiscal terms are summarised in Table 4.4.

Table 4.4: Algeria's mixed model fiscal terms

Instrument	**Concessionary (R/T)**	**PSC: Pre-2001**	**PSC: Post-2001**
Royalty	Rates range between 5.5 & 23% (IOCs can propose higher rates as part of bidding process)	12% on gross revenue.	Royalty rates vary according to zone, minimum being 12.5%. Paid by Sonatrach on behalf of the contractor.
CIT	ICR (Impôt complémentaire sur les résultats)/income tax replaces corporate income tax: since 2005 it is taxed at 30%	38% of profit revenue, paid by Sonatrach on behalf of foreign partners.	30% of profit revenue, paid by Sonatrach on behalf of foreign partners.
Production sharing	Not applicable	The split is based on a production-based sliding scale and limited by a price coefficient factor.	The split is based on a production-based sliding scale and limited by price coefficient factor.
Cost recovery	Not applicable	100% of net revenue is available for cost recovery.	100% of net revenue is available for cost recovery.
Other	• Signature bonuses used in competitive bidding. but no production bonuses. • TRP tax levied before corporate tax (tax-deductible item for corporate tax) - Prior to 2013: PRT (for oil price above specific threshold). • Different area rentals for different zones. • Water Royalty. • Flaring tax.	• No signature bonuses or production bonuses. • Excess profit tax applies once price exceeds a reference price threshold.	• Signature bonuses from US$1 million to 50 million, no production bonuses. • Excess profit tax applies once price exceeds a reference price threshold.
Fraser Institute jurisdiction ranking/156	124.	124.	124.

Source: Adapted from Ernst & Young (2014), Fraser Institute (2014) & Palantir (2015)

The TRP tax (taxe sur le revenu pétrolier) is levied before corporate tax and the payment is a tax-deductible item for corporate tax. For completeness, both the concessionary and contractual (PSC) systems are summarised in Table 4.4. However, since 2005, only the concessionary system remained in place. Therefore, it is the main focus for the purposes of this chapter. The income tax of 30% is relatively low, although there are also royalties and other taxes to consider. In terms of the Fraser Institute's (2014) global petroleum survey, Algeria's jurisdiction is ranked 124th with a composite score of 75.74. In terms of the Revenue Watch (2013) RGI, Algeria is ranked 45th (from 58 countries) with a composite score of 38 (failing). In terms of the individual components, Algeria received a score of 57 for institutional and legal setting, 41 for reporting practices, 28 for safeguard and quality controls and 26 for enabling environment.

4.5 Chad

There have been attempts to find oil in Chad since the 1970s (Njiakin, 2013). Although construction of the oil fields did begin as early as 2000, the bulk of oil development activities did not begin until 2001 (Garber, 2014a). While the BP (2014) Statistical Review of World Energy's first account of oil reserves for Chad was in 2000 (the dawn of Chad's oil sector), the first account of production was not until 2003. Chad is an emerging producer and is ranked 11th in terms of oil production in Africa. In terms of reserves, Chad is the 10th largest reserve holder in Africa. Oil is an important part of Chad's economy, contributing 23.9% of GDP in 2013 (Africa Economic Outlook, 2014a). According to the Africa Economic Outlook (2014b), oil contributes approximately 60% of government revenue and 90% of export earnings. Chadian law provides for two types of petroleum fiscal systems, namely concessions contracts and PSCs (Njiakin, 2013). However, since 2010, all agreements between the host government and IOCs have followed an approved model PSC (Ernst & Young, 2014). For this reason, only the PSC is considered here. It is specifically since the issuance of Ordinance No. 001/PR/2010, dated 30 September 2010, that only the model PSC has been followed. The profit oil and gas split is based on an R-factor, state participation can be up to 25% and royalties range between 14.25 and 16.5% (5 to 10% for gas) (Palantir, 2015). Chad's fiscal terms are summarised in Table 4.5.

Table 4.5: Chad's contractual fiscal terms

Instrument	**Contractual: PSC**
Royalty	14.25 to 16.5%
CIT	Exempt: the share for the state via the profit oil mechanism is the equivalent of CIT.
Production sharing	R-factor split: cost oil cannot exceed 70% of production per year. The remaining production, i.e. profit oil ('tax oil'), is shared between the state and IOC. The state's share cannot be less than 40% and will vary with the R-factor.
Cost recovery	70% of revenue after deduction of the royalty.
Other	• A negotiable signature bonus. • A surface rent tax for the surface area provided for in the PSC. • VAT incentives: goods and services directly linked to petroleum operations are exempt from VAT.
Fraser Institute Jurisdiction ranking/156	99

Source: Adapted from Ernst & Young (2014), Fraser Institute (2014) & Palantir (2015)

Under the PSC, IOC's are exempt from CIT, which is replaced by the profit oil mechanism. The profit oil mechanism is based on production sharing between the IOC and the host government. After allowing IOCs to recover their costs through the cost oil portion, the remaining profit oil or 'tax oil' is shared between the IOC and host government. The state's share cannot be less than 40%. Other tax items include signature bonuses and surface rent tax. State participation can be up to 25% (either directly by the state or the NOC). In terms of the Fraser Institute's (2014) PPI, Chad's jurisdiction is ranked 99th with a score of 67.64. This is the most favourable ranking for the four African jurisdictions discussed in this chapter. Unfortunately, Chad was not included in the Revenue Watch (2013) RGI.

4.6 Country comparison

Nigeria, Angola, and Algeria all have some form of mixed systems whereby both concessionary and contractual systems are used. However, in some instances, one of the two systems form part of the 'older' regime as one system is preferred for all newer blocks. For example, Angola's concessionary system only applies to specific partnerships that were set up in the 1960s and 1970s. The more recent agreements are PSCs. In contrast, Algeria's mixed system gravitated towards the concessionary system, as from 2005 only the concessionary system remained in place. In contrast to the mature producers, Chad operates under a single system, namely production sharing. The petroleum fiscal systems for the four countries discussed above are compared in Table 4.6 below.

Table 4.6: Summary of fiscal terms

Instrument	Nigeria		Angola		Algeria			Chad
System	**Concessionary (joint venture)**	**Contractual: PSC**	**Concessionary (joint venture)**	**Contractual: PSC**	**Concessionary (R/T)**	**Contractual: PSC: Pre-2001**	**Contractual: PSC: Post-2001**	**Contractual: PSC**
Royalty	The rate depends on location and water depth. Inland basin: 10%, onshore: 20%, offshore: • up to 100 meters: 18.5%. • > 100 meters: 16.67%.	The rate depends on location and water depth: Inland basin: 10%, onshore: 20%, offshore: • Up to 200 meters: 16.67%. • 201 to 500 meters: 12%. • 501 to 800 meters: 8%. • 801 to 1,000 meters: 4%. • > 1 000 meters: 0%.	Not applicable.	Not applicable.	Rates range between 5.5 & 23% (IOCs can propose higher rates as part of bidding process)	12% on gross revenue.	Royalty rates vary according to zone, minimum being 12.5%. Paid by Sonatrach on behalf of the contractor.	14.25% to 16.5%
CIT	Replaced by petroleum profits tax: • Standard: 65.75 (year 1-5) & 85% (year 6+). • Marginal fields: 55%. • Indigenous company: 60%.	Replaced by petroleum profits tax: • Standard: 65.75 (year 1-5) & 85% (year 6+). • Inland basin/deepwater: 50%.	Petroleum income tax: 65.75%.	Petroleum income tax: 50%.	ICR (Impôt complémentaire sur les résultats)/income tax replaces corporate income tax: since 2005 it is taxed at 30%	38% of profit revenue, paid by Sonatrach on behalf of foreign partners.	30% of profit revenue, paid by Sonatrach on behalf of foreign partners.	Exempt: the share for the state via the profit oil mechanism is the equivalent of CIT.

Table 4.6: Continued

Instrument	Nigeria		Angola		Algeria			Chad
System	**Concessionary (joint venture)**	**Contractual: PSC**	**Concessionary (joint venture)**	**Contractual: PSC**	**Concessionary (R/T)**	**Contractual: PSC: Pre-2001**	**Contractual: PSC: Post-2001**	**Contractual: PSC**
Production sharing	Not applicable.	Based on cumulative production in the range of 80 to 25% for the IOC.	Not applicable.	Either an IRR or a production-based sliding scale.	Not applicable	The split is based on a production-based sliding scale and limited by a price coefficient factor.	The split is based on a production-based sliding scale and limited by price coefficient factor.	R-factor split: cost oil cannot exceed 70% of production per year. The remaining production, i.e. profit oil ('tax oil'), is shared between the state and IOC. The state's share cannot be less than 40% and will vary with the R-factor.
Cost recovery	Not applicable.	80% of gross revenue available for cost recovery.	Not applicable.	1992 PSC: 50% of net revenue. 2007 PSC: 55% rising to 65% after 5 years if not recovered.	Not applicable	100% of net revenue is available for cost recovery.	100% of net revenue is available for cost recovery.	70% of revenue after deduction of the royalty.

Table 4.6: Continued

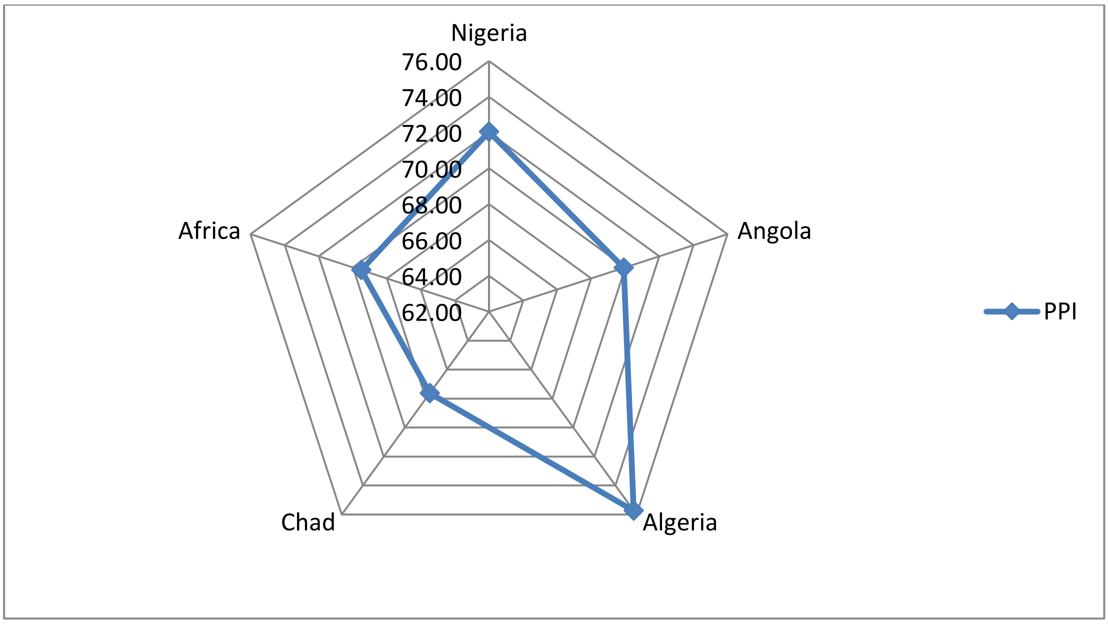
Instrument	Nigeria		Angola		Algeria			Chad
System	**Concessionary (joint venture)**	**Contractual: PSC**	**Concessionary (joint venture)**	**Contractual: PSC**	**Concessionary (R/T)**	**Contractual: PSC: Pre-2001**	**Contractual: PSC: Post-2001**	**Contractual: PSC**
Other	• Resource rent tax based the area size of the licence. • Signature & production bonuses at discretion of the government. • Education tax as part of petroleum profits tax. • Many indirect taxes, for example: import duty and port inspection fee.	• Resource rent tax based on the area size of the licence. • Signature & production bonuses at discretion of the government. • Education tax as part of petroleum profits tax. • Many indirect taxes, for example: import duty and port inspection fee.	• Signature bonuses among the highest in the world. • Surface fees. • Training tax contributio n. • Some indirect taxes.	• Signature bonuses among the highest in the world. • Surface fees. • Training tax contribution. • Some indirect taxes.	• Signature bonuses used in competitive bidding, but no production bonuses. • TRP tax levied before corporate tax (tax-deductible item for corporate tax) - Prior to 2013: PRT (for oil price above specific threshold). • Different area rentals for different zones. • Water royalty. • Flaring tax.	• No signature bonuses or production bonuses. • Excess profit tax applies once price exceeds a reference price threshol.	• Signature bonuses from US$1 million to 50 million, no production bonuses. • Excess profit tax applies once price exceeds a reference price threshold.	• A negotiable signature bonus. • A surface rent tax for the surface area provided for in the PSC. • VAT incentives: goods and services directly linked to petroleum operations are exempt from VAT.
Fraser Institute jurisdiction ranking/156	114.	114.	108.	108.	124.	124.	124.	99.

Source: Adapted from Ernst & Young (2014), Fraser Institute (2014) & Palantir (2015)

In terms of concessionary systems, the lower and upper bounds of Algeria's royalty rates (5.5-23%) exceed that of Nigeria (10-20%). In terms of CIT, Algeria has the lowest rate (30%), but there are a number of other taxes levied besides CIT. In terms of contractual (PSC) systems, Nigeria's CIT ranges between 50 and 85%, Angola is at 50%, while under Chad's PSC, companies are exempt from CIT, which is replaced by the profit oil mechanism as part of production sharing. In the case of Algeria's pre- and post-2001 PSC, the NOC (Sonotrach) pays the 38% of profit oil on behave of the IOC. Accordingly, this tax does not enter the company tax flow.

Nigeria's PSCs are based on production values and Angola uses either an IRR or a production-based sliding scale. Both of Algeria's pre- and post-2001 PSCs use a production-based sliding scale, while Chad's PSC used an R-factor split. Angola's concessionary system also charges a petroleum production tax of 20% and a petroleum transaction tax of 70%. In terms of cost recovery, Algeria's PSC allow for 100% of net revenue, Nigeria for 80% of gross revenue, Angola for either 50% (1992 PSC) or 55-65% (2007 PSC) of net revenue, while Chad allows for 70% of revenue after deduction of the royalty. All four countries charge bonus payments and various other taxes. Angola's signature bonuses are among the highest in the world. In terms of jurisdiction rankings, Chad has the best ranking (99), followed by Angola (108); Nigeria (114) and Algeria (124). These PPI scores are compared to the median PPI for Africa in Figure 4.1.

Figure 4.1: PPI score comparison for African countries



Source: Compiled from data by the Fraser Institute (2014)

From Figure 4.1, Chad's PPI score is lower than median for Africa, while the other three countries' PPI scores are higher.

4.7 Conclusion

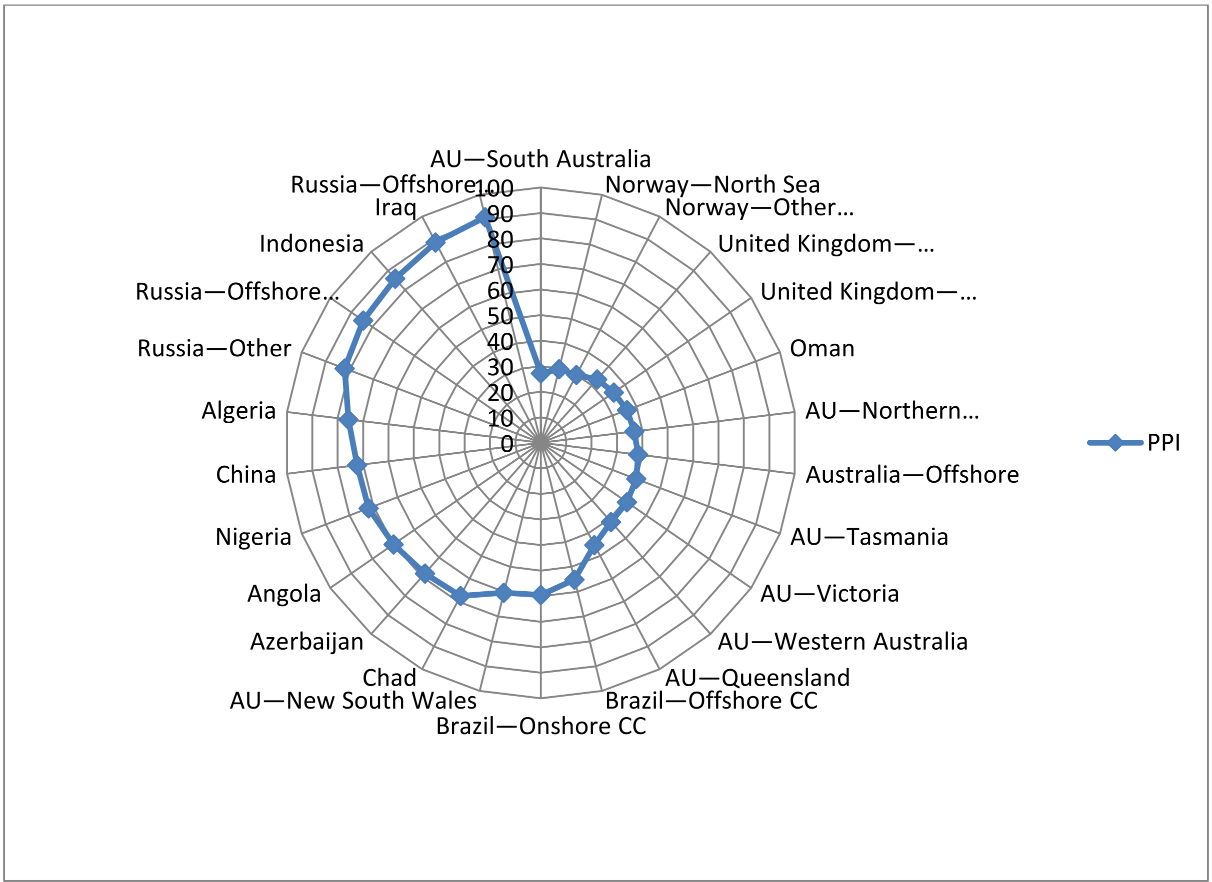
The majority of Africa's oil production is currently based in Nigeria, Angola, Algeria and Libya. Nigeria, Angola and Algeria currently have the largest production levels in Africa, while they are ranked 2nd, 3rd and 4th after Libya in terms of proven oil reserves. Chad is one of Africa's emerging oil producers, producing oil from 2004. To incorporate emerging producers, Chad was also considered in the analysis.

The oil sector is a major contributor to economic activity in all four of these countries. All three of the mature producers are members of OPEC. Nigeria and Algeria have problems of bunkering and security threats, respectively. Nigeria's proposed Petroleum Industry Bill has created considerable uncertainty among investors. Nigeria, Angola, and Algeria all have some form of mixed systems whereby both concessionary and contractual systems are used. In contrast to the mixed systems adopted by the mature producers, Chad uses only a PSC system. Within this context, it seems to be a more simplistic (investor friendly) system, especially when considering that Chad has the best PPI score of the four African countries evaluated here. The mature producers' mixed systems reflect a longer history and evolution of fiscal systems than the nascent oil sector in Chad.

From the analysis, the following points can be highlighted. All the countries except Angola make use of royalties. In terms of CIT, all the countries have some type of alternative mechanism in place that replaces traditional CIT. In the case of Chad, IOCs are exempt from CIT, which is replaced via the profit oil mechanism. For Nigeria, CIT is replaced by a petroleum profits tax that varies according to field maturity; furthermore, the rate is lower for indigenous companies. Angola levies a petroleum income tax of 65.75% under the concessionary system and 50% under the PSC. IOCs in Algeria are taxed at either 30 or 38% depending on the type and vintage of system. All four countries have a variety of additional taxes in place, for example bonus payments, surface fees and education taxes. In addition to concessionary and contractual arrangements, host countries further participate by means of an NOC, which can operate independently and/or in partnership with IOCs. Nigeria's NOC, the Nigerian National Petroleum Corporation (NNPC), participates in many projects. In Angola, Sonangol's participation can range between 0 and 20%. In Algeria, state participation through the NOC, Sonotrach, is variable but fixed at a minimum of 51%. In Chad, state participation can be up to 25% (either directly by the state or the NOC).

As was noted earlier, the investor viewpoint has direct bearing on the government policy perspective. The PPI is an indicator of investors' regard for specific upstream jurisdictions. Figure 4.2 summarises and compares all the jurisdictions from Chapters 3 and 4 in terms of their PPI score.

Figure 4:2 Overall PPI comparison



Source: Compiled from data by the Fraser Institute (2014)

Australia (South Australia, Northern Territory & Tasmania), Norway, UK and Oman fall into the 2nd quintile. Australia (Victoria, Western Australia & Queensland) and Brazil (concessionary) fall into the 3rd quintile. The four African jurisdictions fall into the 4th quintile together with Australia's New South Wales, Azerbaijan and China. Russia, Indonesia and Iraq fall into the 5th quintile.

From the wide variation in systems, it is important to emphasise that there is no one-size-fits-all system that can be applied to all countries. Individual circumstances differ between countries, particularly in terms of the oil sector's stage of development and the relative importance of the oil sector in comparison to the other sectors of a country's economy. These factors together with the specific government's approach to oil sector rents will all influence the specific make-up of the fiscal system. From the analysis in Chapter 3, these differences also relate to a country's state of development, i.e. developed, emerging or developing economy. Considering the wide variation in factors that can affect a country's oil sector and petroleum taxation, it is difficult to be prescriptive on petroleum fiscal systems.

This chapter has provided an overview of the petroleum taxation approaches taken by Africa's three largest oil producers as well as one emerging producer, Chad. The background (Chapter 1), theoretical literature (Chapter 2) as well as the comparative analyses in Chapters 3 and 4 have now set the stage for the empirical analysis (Chapters 5 and 6), which will answer the petroleum tax problem outlined at the start of this thesis. Although Angola is an important and mature oil producer, it does not form part of the empirical analyses in Chapters 5 and 6. There is a lack of data for Angola; more specifically, there is no social accounting matrix (SAM) currently available for Angola. SAMs form the basis of the analyses in Chapters 5 and 6. For this reason, Angola could only be reviewed in this chapter without following up with an empirical analysis. It is one of the constraints on this thesis and is a topic for future study as and when a SAM for Angola becomes available. The following chapter outlines the multiplier and SPA results used as input in the construction of the STI in Chapter 6.

Chapter 5: Structural path analysis (SPA) for Nigeria, Algeria and Chad

"Research is to see what everybody else has seen, and to think what nobody else has thought."
– Albert Szent-Gyorgyi.

5.1 Introduction

The government take statistic is often used to evaluate and compare petroleum fiscal systems. However, in addition to the revenue host governments receive from oil production, oil sector investment does have a wider impact on the rest of the economy. There is currently no measurement instrument that measures impacts wider than the government take. For this reason, this thesis identified the need to develop a specific tool, based on the structure of a country's economy, which will expand the current limited focus on government take alone. Therefore, the aim of this thesis is to develop such an instrument that accounts for oil sector investment's broader economic impacts and the implications they hold for petroleum tax policy. These impacts will flow through different sectors of the economy, depending on the particular inter-sector linkages of a country's oil sector. Knowledge of these linkages and the associated economy-wide impacts can be used to create a measurement instrument, a Structural Take Indicator, based on the structure of a country's economy. The Structural Take Indicator can be used in conjunction with the standard measure of government take as an additional and important instrument to incorporate in the evaluation of petroleum fiscal systems.

There are two components to answering the petroleum tax policy question highlighted above. Firstly, the broader economy-wide linkages (impacts) associated with the oil sector have to be measured. This impact can most directly be measured by the oil sector's backward linkages, which embody the oil sector's purchases from other sectors to enable production of oil sector output. Measuring these economic impacts, which depend on the oil sector's structural linkages and that vary with the structure of individual economies, is the focus of this chapter. **It is possible to measure forward linkages, but this falls outside the scope of this thesis. The focus of this thesis is the oil sector's economy-wide (upstream) impacts, i.e. backward linkages.** Secondly, the results from this chapter will be used to develop the Structural Take Indicator (STI) in Chapter 6. This indicator will serve as a single fiscal system indicator that incorporates all of the oil sector's economic (economy-wide) impacts.

This chapter is organised into two parts. Firstly, the methods used to measure economy-wide impacts, namely multiplier analysis and structural path analysis (SPA), are discussed. These methods use country-specific social accounting matrices (SAMs) as the underlying database. Secondly, an SPA is applied for Nigeria (using a 2006 SAM of Nigeria), Algeria (using a 2002 SAM of Algeria) and Chad (using a 2000 SAM of Chad). There is currently (by 2015) no SAM available for Angola[43], which limits the analysis to Nigeria, Algeria and Chad. Nigeria and Algeria are mature oil producers, while Chad is a nascent oil producer. Therefore, both new and established producers are considered in the analysis.

5.2 Social accounting matrices

5.2.1 Background

The first component of the petroleum tax policy question is to estimate the economy-wide impacts associated with the oil sector. Analysing the interactions between sectors can shed light on the relative importance of, and linkages between sectors in an economy. Input-output (IO) analysis, pioneered by Wassily Leontief in the late 1930s, forms the basis for economy-wide impact modelling (Leontief, 1986). The standard IO table is normally constructed from observed economic data for a specific region or country (Miller & Blair, 2009:2). The IO table traces the activity of a group of industries that both produce products (inputs for other sectors) and consume products (inputs from other sectors). IO tables are integrated with the system of national accounts of a country, reconciling the national accounts into the different sectors of the economy (Martins & Van Aardt, 2004; United Nations, 2009).

The basic IO transactions table, which represents a snapshot of the economy at a specific point in time (year), can be used to review the structure of an economy and to illustrate how industries are connected through forward and backward linkages. By using IO analysis, a multiplier model can be constructed. The purpose of a multiplier model is to trace the impact of a specific (exogenous) shock (change in final demand) for the output of a specific sector on the sector itself (direct impact) as well as for inter-connected industries (indirect impact). Table 5.1 illustrates the basic input-output transactions table.

[43] The absence of an Angola SAM was confirmed in a personal communication with Muzima (2014) from the African Development Bank (AfDB). Angola's National Institute of Statistics is still planning to build such a matrix from the consolidated 2010 National Accounts Data.

Table 5.1: The Input-Output transactions table

	Producers as consumers									Final Demand			
	Agriculture	Agriculture	Mining	Construction	Manufacturing	Trade	Transport	Services	Other	Personal Consumption Expenditure	Gross Private Domestic Investment	Government Purchases of goofs & services	Net Exports of good & services
Producers	Mining												
	Construction												
	Manufacturing												
	Trade												
	Transportation												
	Services												
Value added	Employees	Employee compensation								Gross Domestic Product			
	Business owners & capital	Profit-type income and capital consumption allowance											
	Government	Indirect business taxes											

Source: Miller & Blair (2009:3)

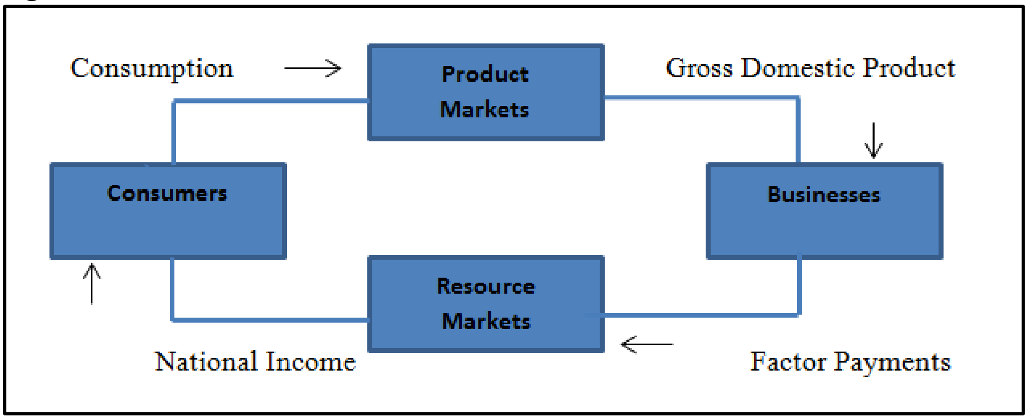
In the above IO table, the shaded area represents the inter-sector transactions (Miller & Blair, 2009:2-3). The rows describe the distribution or 'sale' of producers' output to other sectors in the economy and similarly columns indicate purchases of inputs required to produce outputs. The Final Demand columns capture each sector's sales of products to the final markets, such as personal consumption expenditure and government purchases. For example, agricultural output could be sold as input to the manufacturing sector or to individuals as the final consumer. The other production inputs such as labour, depreciation of capital, indirect taxes and imports are captured in the Value Added rows.

A SAM can be seen as an extended version of the basic IO table. The United Nations (2009) define a social accounting matrix (SAM) as: "a presentation of the SNA[44] in matrix terms that permits the incorporation of extra details of special interest". According to Bellù (2012:1), a SAM "is a summary table, which refers to a given period, representing the production process, income distribution and redistribution which occurs between sectors, factors of production, actors in an economic system and the 'rest of the world', meaning, all actors outside the economic system being studied." A SAM provides a consistent framework to analyse transactions between sectors and institutions, in which every income has a corresponding expenditure (Sadoulet & de Janvry, 1995).

[44] SNA: System of National Accounts.

A SAM represents the structure of a specific economy by capturing inter-sector linkages and highlighting the circular flow of income and expenditure (Bellù, 2012:2). Considering the SAM framework, the circular flow concept can be expanded in terms of the product and resource markets, the characteristics of the labour force, government policies for taxation and welfare transfers, as well as the other allocations of income (Miller & Blair, 2009:500). Figure 5.1 illustrates the expanded circular flow captured in a SAM.

Figure 5.1: The circular flow in a SAM



Source: Miller & Blair (2009:500)

Figure 5.1 depicts the circular flow income and expenditure between consumers and business in the factor (resource) market and product market. Transactions in the product market involve the consumption of goods and services, while the factor market includes transactions for the value-added factors of production such as the compensation of employees, profits, taxes and the consumption of fixed capital. SAMs can help to elaborate on the details of the product and resource markets, specifically the characteristics of the labour force, government policies and the allocation of income.

The six main accounts contained in a SAM are: activities, commodities, factors, institutions[45], the capital account and the 'rest of the world' account (Sadoulet & de Janvry, 1995:274). Columns list payments (expenditures) and rows list receipts. The activity/production accounts can be thought of as the sectors of the economy that buy (column view) inputs such as raw materials and intermediate commodities as well as hire production factors to produce goods and services (commodities). The value of production in excess of raw materials and

[45] Institutions is the standard term used to describe households, firms and the government as part of the economic actors that are included in a SAM.

intermediate inputs is measured as value added, which is distributed to the factors of production or the government in the form of a value-added tax. The activity accounts receive payments (row view) from sales to the domestic market, exports and export subsidies from the government.

The commodity account can be equated to a ‘supermarket’ that represents the domestic product markets. The separate definition of commodity and activity accounts is an important distinction because a specific sector can produce more than one type of commodity. For this reason, commodities and activities can have different sectoral definitions. The commodity accounts buy (column view) foreign and local commodities and receive payments (row view) from sales to the domestic market for intermediate inputs, from final demand purchases from households and the government as well as payments for investment goods sold to the capital account. The activity by commodity format helps to account for ‘non-characteristic’ production, for example the production of secondary or by-products (Miller & Blair, 2009:185). Table 5.2 illustrates the general SAM structure.

Table 5.2: The general structure of a SAM

Incomes →	1	2	3 Factors		**Expenditures** ↓ 4 Institutions			5	6	7
	Activities (Production activities)	**Commodities** (goods & services)	**Labour**	**Capital**	**Households**	**Firms**	**Government**	**Capital account** (savings-investment)	**Rest of the world**	**Total**
1 **Activities** (Production activities)		Domestic sales					Export subsidies		Exports	Production
2 **Commodities** (goods & services)	Intermediate demand				Households consumption		Government consumption	Investment		Domestic demand
3 **Factors** **Labour**	Wages								Factor incomes from abroad	GNP at factor cost (labour & capital incomes)
Capital	Rent									
4 **Institutions** **Households**			Labour income	Distributed Profits	Intra-household transfers	Transfers	Transfers			Households income
Firms				Non-distr. Profits	Transfers		Transfers			Firms Income
Government	Value-added Taxes	Tariffs Ind. taxes	Taxes on Income	Taxes on profits	Direct taxes	Taxes				Government income
5 **Capital account** (savings-investment)					Household saving	Firms savings	Government savings			Total savings
6 **Rest of the world**			Factor Payments			Current transfers abroad				Imports
7 **Total**	Production	Domestic supply	Factor payments		Households expenditure	Firms expenditure	Government expenditure	Total investment	Foreign exchange earnings	

Source: Adapted from Bellù (2012:3) and Sadoulet & de Janvry (1995:275)

The factor (factors of production) accounts comprise labour and capital. Rows indicate the income received by these production factors and the column illustrates the distribution of these incomes to the relevant institutions that own these production factors. The institution accounts comprise households, firms and the government. Here, the rows indicate income received by these institutions and columns indicate the payments they make in the form of transfers. The capital (savings-investment) account illustrates the flow of savings and investment. The 'rest of the world' account illustrates the flow of transactions between the domestic economy and the 'rest of the world' in terms of imports, exports, transfers, factor payments and factor receipts. Bellù (2012) identifies three objectives of a SAM:

1. To catalogue the social and economic structure of a country at a specific point in time (year).
2. To provide a summarised view of the flows of income and expenditure in the economic system.
3. To provide a statistical foundation to construct models of the economic system, to simulate the socio-economic impacts of government policies.

5.2.2 SAM multipliers

Public policies, such as government expenditure programmes, require an estimate of the potential economy-wide impact that a proposed policy will have on an economy. Similarly, policy-makers are interested in the economic impacts created by a specific sector in deciding which sectors to support in terms of economic development plans. Multiplier analysis is often used for this purpose and can be based on an IO table or SAM. The underlying idea is that, because industries are interconnected by forward and backward linkages, an increase in the demand (initial expenditure) for the output of a specific sector (or increased investment in a specific sector) will create additional impacts throughout the economy.

Multipliers are essentially based on the difference between an initial effect of an exogenous change and the total effects of that change (Miller & Blair, 2009:244). Multipliers can measure the impact on gross output, gross value added (GVA), household income or employment. A SAM can be used to derive a set of multipliers for each sector represented in the SAM. This is referred to as the Leontief inverse, the accounting multiplier matrix or the inverse matrix (matrix of multipliers). The above-mentioned multipliers can be derived to measure different levels of total impact, depending on the assumptions that are used in the model. The total effect can be defined according to two possible levels of impact, namely Type 1 (simple) and Type 2 (total) multipliers. Type 1 multipliers measure the total impact as the direct and indirect effects (households are exogenous). Type 2 multipliers measure the total impact as the direct, indirect and induced effects (households are endogenous). The direct effect is the initial (direct) increase in demand for a sector's output. In order to meet this demand, the sector will increase its demand for inputs; accordingly, the suppliers of these inputs will now demand more inputs (indirect effect) to produce their output and meet the new demand. The direct and indirect effects both increase incomes earned by households, which, in turn, leads to further expenditure (induced effect). The choice of which sectors are treated as endogenous or exogenous will have an important impact on the results obtained from multiplier models, for example treating households as endogenous or exogenous.

In terms of endogenous accounts, changes in the level of expenditure will directly follow any change in income, whereas changes in expenditure for exogenous accounts are assumed to be set independently of income (Sadoulet & de Janvry, 1995:288). The exogenous accounts are normally selected from the government, capital or the 'rest of the world' accounts, depending on the relevant macroeconomic theory and objectives of the analysis.

There are a number of steps involved when building a SAM multiplier model; the SAM in itself is not a model. The first step is to calculate the matrix of technical coefficients (the A matrix). The individual elements of the A matrix represent the inputs needed to produce R1 worth of output for a specific sector. The second step is to use the A matrix to derive the Leontief inverse. The elements of the Leontief inverse represent the sector multipliers for each sector and can be either Type 1 or Type 2 depending on the model closure that is used, i.e. whether households are treated as endogenous or exogenous. In this step, the choice of exogenous and endogenous accounts plays an important role in determining the Type of multiplier model that will be obtained. The final step is to apply the vector of change (exogenous change in final demand) by multiplying it with the Leontief inverse to determine the total economic impact. The Leontief inverse is represented as:

$$(I - A)^{-1} \tag{5.1}$$

Where I stands for the identity matrix and A for the matrix of technical coefficients. I is a square matrix where all the diagonal elements are equal to 1 and all the other elements are equal to 0 (United Nations, 1999). The vector of shocks is represented as:

$$\Delta F \tag{5.2}$$

The vector of impacts is represented as:

$$\Delta X = (I - A)^{-1} \Delta F \tag{5.3}$$

Where ΔX represents the total change or total multiplier impact in terms of the chosen multiplier measure, i.e. gross output, GVA, household income or employment. From the above, SAM multipliers can be used to estimate the multiplier impacts of the oil sector on a host country. The next two sections will review the limitations and previous applications of this technique.

5.2.3 Limitations of SAM multipliers

SAM multiplier models[46] have a number of limitations owing to the simplifying assumptions that are used. These limitations should be considered when interpreting SAM multiplier results. IO/SAM type models are based on fixed-coefficient linear production functions (United Nations, 1999). The behaviour of SAM accounts (agents) is based on fixed (column) coefficients (Robinson & Lofgren, 2005). For example, the activities accounts demand inputs in fixed input-output coefficients, while commodities use domestic and imported inputs in fixed proportions for production. Furthermore, a SAM model represents a static (snapshot) analysis that does not include any supply constraints or price adjustment dynamics. For this reason, multipliers may present an overestimate in cases where supply constrains in fact do exist, while the assumption of fixed prices will not allow for any substitution effects (Round, 2003). In the real world, prices could change in reaction to the change in demand, which would imply an overestimation based on the assumption of fixed prices. The distinction between endogenous and exogenous accounts holds a specific implication; there is a limit to the impacts measured in the multiplier model. The impact of the modelled shock is measured but other scenarios that could coincide with such a shock are not measured. For example, the initial shock may be an increase in export demand, but the government's possible policy reaction is not measured.

[46] See Parra & Wodon (2009a) for a detailed discussion of the strenghts and weaknesses of SAMs.

5.2.4 Past studies

A number of studies have used some form of IO/SAM multiplier analysis to calculate the macroeconomic impacts of the oil sector on a country or region's economy. The studies typically focus on the addition to value added (GDP), employment and labour income from the oil and gas or gas sector. For example, the National Petroleum Council (NPC, 2011) provides a useful comparison of two reports on the US economy by PWC (2011) on the impact of the oil and natural gas sector and IHS Global Insight (2009) on the impact of the natural gas sector. The NPC (2011) further highlights the importance of defining the specific sector that is being studied, for example including the upstream, downstream and the related construction and supporting activities. These national level results of these reports are summarised in Table 5.3.

Table 5.3: Economic impact studies on oil and gas industries in the USA

Study	**Scope**	**Year of impact**	**Variable**	**Direct**	**Indirect & induced**	**Total**	**Multiplier**
PWC (2011)	Oil & gas	2009	Value added ($bn)	$465	$617	$1082	2.33
			Employment ('000s)	2192	6968	9161	4.18
			Labour income ($bn)	$176	$357	$534	3.03
IHS Global Insight (2009)	Natural gas	2008	Value added ($bn)	$172	$213	$385	2.24
			Employment ('000s)	622	2206	2828	4.54
			Labour income ($bn)	$70	$111	$181	2.59

Source: NPC (2011)

The PWC report (2011) measures the direct impact of the oil and gas sector itself, the indirect impact created in the sector's supply chain and the induced impact created by the household spending from income earned directly or indirectly from the sector's spending. The report considers the sector's impact from operational spending as well as the capital investment spending. These impacts are all measured at the national level, while a further analysis of operational expenditure is done at the state (regional) level. The impact analysis for planning input-output modelling system was used as the basis of the analysis. There are currently (by 2015) no similar studies for Africa's oil sector[47]. SPA is an extension of multiplier analysis and is discussed in the following section.

5.3 Structural path analysis

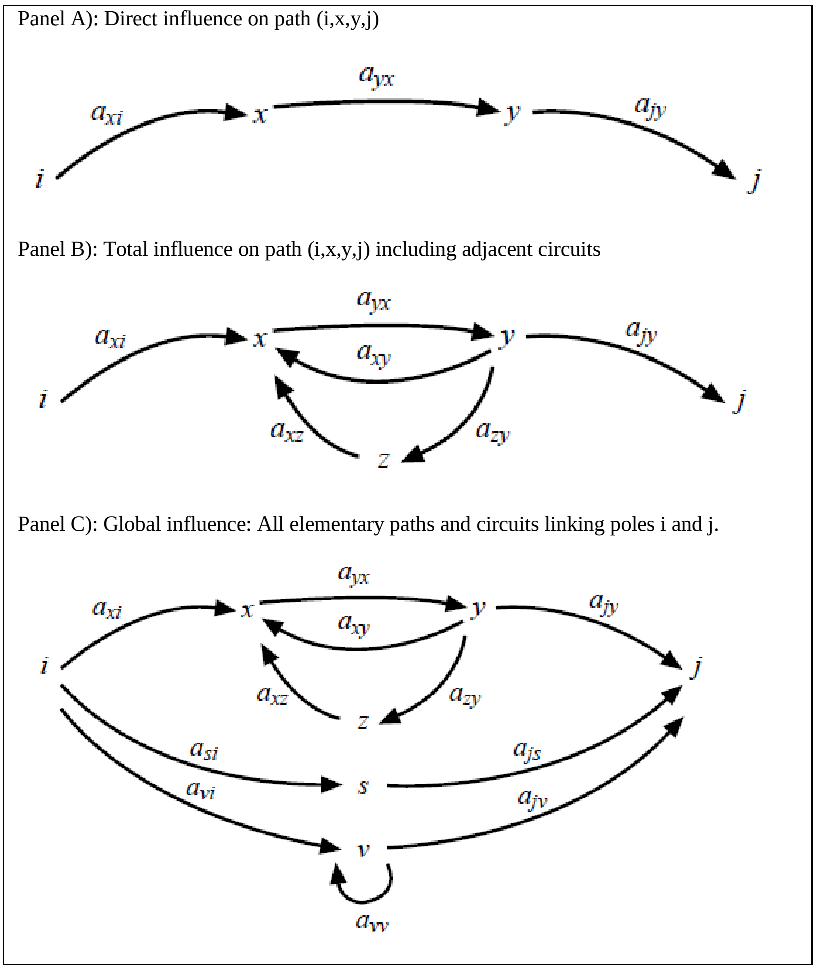
SAM multipliers, reflected by the Leontief inverse matrix, can be used to identify an economy's key sectors (multiplier decomposition[48]), based on the sector's potential for demand-led multiplier impacts (Ngandu, Garcia & Arndt, 2010). Without further analysis, multiplier results are generated in a 'black box' (Parra & Wodon, 2009b). Such an analysis can be complemented by SPA. SPA is a method that builds upon SAM analysis and transparently reveals the network of paths through which a multiplier effect travels through the economy, highlighting the mechanism underlying the economy-wide effects captured by multipliers. The SPA technique was first proposed by Lantner (1972), applying it to an IO table, and first applied to a SAM by Defourny and Thorbecke (1984).

SPA is focused on identifying the path followed by individual elements in creating the global influence measured by SAM multipliers. Accordingly, SPA traces the paths (transmission) followed based on structural relationships, from a change in an exogenous variable to the resulting changes in endogenous variables. This adds a level of detail that could not be derived from merely looking at inter-sector transactions or the overall sector multipliers derived from conventional multiplier decompositions (Roberts, 2005). For this reason, SPA can provide an enhanced view of the effects created by a shock to exogenous accounts. In addition to the overall multiplier effect measured by the SAM multipliers, SPA decomposes the multipliers into the direct and indirect components, while also providing a breakdown of the transmission paths through which these impacts propagate (Rossouw & Cloete, 2014). This highlights the variety and strength of a sector's inter-sector linkages and its position within the rest of the economy. Roberts (2005) identifies two objectives for SPA, namely the identification of important paths within an economy and the identification of important accounts ('poles') that are responsible for transmitting economic influence. The SPA literature uses the concept of influence as a metaphor for an additional flow of income or output (Azis & Mansury, 2003).

[47] This falls outside the scope of this study. However, there are two studies, by Econometrix (2012) and Wait & Rossouw (2014), which estimate the potential economic impact of developing shale gas resources in South Africa.
[48] See Pyatt & Round (1979) as well as Defourny & Thorbecke (1984).

The endogenous accounts are considered as 'poles' through which the influence travels, while poles are connected by an arc or elementary path (a path traveling through a pole only once). For example, consider the matrix of technical coefficients (A), where any two poles, *i* and *j*, are connected by an elementary path (arc), which originates at *i* and ends at *j*, giving the arc (*i*, *j*). The corresponding cell, a_{ji}, of A measures the influence (intensity) of the arc (*i*, *j*). A path is made up of the sequence of consecutive paths and the length of a path is determined by the number of arcs; a path that starts and ends at the same pole is called a circuit (Parra & Wodon, 2009b). A path starts where an exogenous shock occurs (origin) and ends at the final (destination) account where the changes are valued. The SPA measurements incorporate three impact measures, namely direct influences, total influences, and global influences (Yang, Thurlow, & Lahr, 2012). These influence measures are illustrated in Figure 5.2.

Figure 5.2: The network of influences identified in SPA



Source: Azis & Mansury (2003)

In Figure 5.2 above, panel A illustrates the basic direct influence that travels through an elementary path (forming a closed circuit) from pole *i* to *j*. Panel B illustrates the total influence, which includes the direct influence plus all the indirect circuits (creating feedback loops) along this path. Panel C illustrates the global influence that incorporates the direct, indirect and induced (feedback) effects (Azis & Mansury, 2003).

In line with the SAM limitations outlined in section 5.2.2, there are two assumptions that underlie SPA analysis. Firstly, there are no supply-side constraints, and demand determines output. Secondly, prices are assumed to be constant or preferences and technology correspond to Leontief assumptions of fixed coefficients. This translates into consumers who consume in fixed proportions since relative prices give no incentive for consumers to change consumption or that preferences and technology are in Leontief form. The assumptions will not hold in cases where the economy faces supply bottlenecks and this should be considered when interpreting SPA results. However, SPA does provide the benefit of simplicity and transparency (Rossouw & Cloete, 2014).

SPA is used to analyse the inter-sector linkages of Nigeria, Algeria and Chad's upstream oil sectors. Knowledge of these linkages and the associated economy-wide impacts will be used to produce the STI in Chapter 6. The following three sections outline the application of SPA for Nigeria, Algeria and Chad.

5.4. Empirical analysis: Nigeria

5.4.1 SAM structure for Nigeria

This analysis uses a 2006 SAM[49] for Nigeria, developed by the International Food Policy Research Institute (IFPRI) (Nwafor & Alpuerto, 2010). The SAM illustrates the structure of Nigeria's economy by including the linkages between production activities, the distribution of income, the consumption of goods and services, savings and investment as well as foreign trade of economic agents for 2006. The Nigeria SAM was primarily developed for agricultural policy analysis and includes 34 sectors for agriculture, 12 for manufacturing, two for mining (including crude petroleum and natural gas) and 13 service sectors. The endogenous accounts include the 61 sectors (activities) and 62 commodities (fertiliser was treated as commodity rather than activity). The factor accounts include labour, capital and land, while the institutions

[49] The Macro SAM is illustrated in Appendix I, Table I.1.

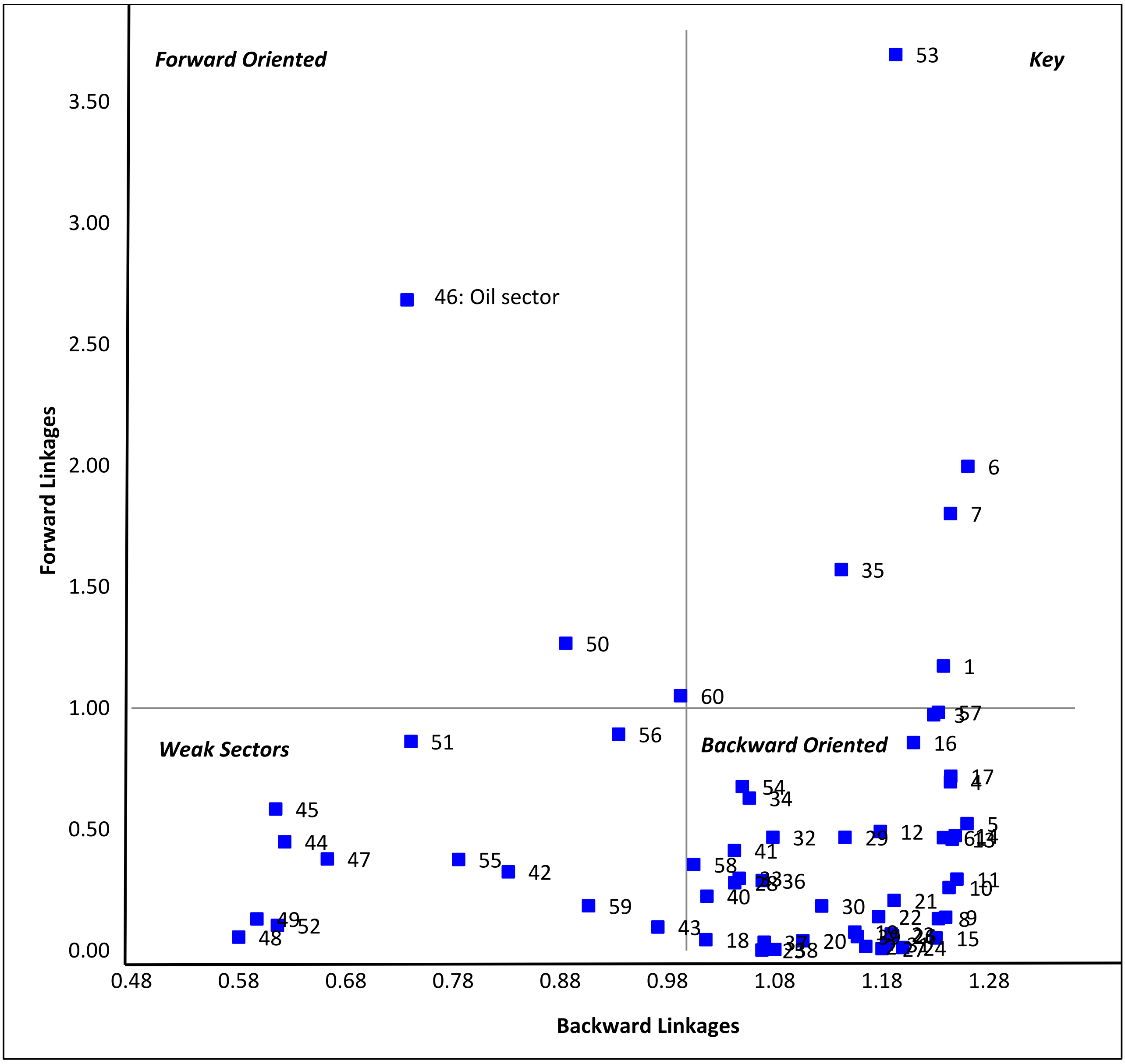
include enterprises and 12 household categories, which have been aggregated for this analysis. The exogenous accounts include the government (including government taxes), the capital account (savings and investment) and the 'rest of the world'.

Nigeria's oil sector is captured in the activity account (46) named crude petroleum and natural gas (acoil). The analysis will start by first considering the basic inter-linkages of the crude petroleum and natural gas account, hereafter referred to as the oil sector. This is done by considering the sector's forward and backward linkages based on the forward and backward multipliers in the Leontief inverse. Backward multipliers capture a sector's linkages with upstream industries (suppliers of inputs) and forward multipliers capture a sector's linkages with downstream industries (buyers of the industries output) (EU, 2007).

A weighted sectoral linkage illustrates the overall importance of a sector to provide inputs and/or outputs for the rest of the economy and differs from un-weighted sector linkages that illustrate the importance of a marginal change in a sector (Humavindu & Stage, 2013). The sectors are weighted by their share in aggregate income (Parra &Wodon, 2009c). The linkages are expressed in percentage terms. For example, the forward linkage of sector *j* measures the change of output in sector *j* relative to the average change in the economy due to a one-unit increase in final demand in all sectors. A forward linkage greater than 100% means that the change in sector *j*'s output will be higher than the average output change in the economy after the initial injection across all sectors. Conversely, sector *j*'s backward linkage measures the change in the economy-wide output relative to the average change in the economy due to a one-unit increase in final demand for sector *j*'s output. Accordingly, a key sector will have both forward and backward linkages of greater than 1. A forward-orientated sector will have forward linkages of greater than 1 and backward linkages of less than 1. Similarly, a backward-orientated sector will have a backward linkage of greater than 1 and a forward linkage of less than 1. If neither of the sector's forward or backward linkages are greater than 1, the sector is classified as weak.

Figure 5.3 illustrates the weighted forward and backward linkages for the activity accounts in the Nigerian SAM. The numbers in the figure below correspond to the order in which the activity accounts appear in the Nigeria SAM (see in Appendix I, Table I.2). Using weighted forward and backward linkages, Figure 5.3 classifies sectors into four possible quadrants, namely forward-orientated, backward-orientated, weak and key sectors. According to this analysis, Nigeria's oil sector is classified as forward orientated (in the top left quadrant).

Figure 5.3: Weighted backward and forward linkages: Nigeria, 2006 SAM



Source: Author using SimSIP SAM

The weighted sectoral linkages illustrate the overall importance of a sector to provide inputs and/or outputs for the rest of the economy and differ from un-weighted sector linkages that illustrate the importance of a marginal change in a sector (Humavindu & Stage, 2013).

5.4.2 Multiplier decomposition analysis for Nigeria

The first step of the analysis is to use multiplier decomposition as put forward by Pyatt and Round (1979) and Defourny and Thorbecke (1984), whereby multipliers are generated in a 'black box'. These accounting multipliers measure the effect of an exogenous shock (exogenous change in demand) on the endogenous accounts in the model. These results are then enhanced by using SPA to expose the network of paths through which a multiplier effect travels through the economy. The most significant accounting multipliers for Nigeria's oil sector are summarised in Table 5.4 below.

Table 5.4: Selected accounting multipliers: Nigeria

	Oil sector (Crude petroleum and natural gas)	Refined oil	Other transportation	Road transport	Health	Education	Public administration	Financial institutions, insurance, business services
Oil sector (Crude petroleum and natural gas)	1.00	0.45	0.04	0.03	0.02	0.02	0.02	0.02
Wholesale and retail trade	0.06	0.08	0.13	0.13	0.17	0.24	0.31	0.18
Cassava	0.04	0.04	0.06	0.07	0.09	0.10	0.10	0.10
Yams	0.04	0.04	0.05	0.06	0.08	0.09	0.09	0.09
Goat and sheep meat	0.03	0.03	0.05	0.06	0.07	0.08	0.08	0.08
Rice	0.03	0.02	0.04	0.04	0.06	0.06	0.06	0.06
Road transport	0.02	0.04	0.03	1.02	0.05	0.04	0.12	0.04
Electricity and water	0.02	0.07	0.04	0.04	0.26	0.16	0.11	0.08
Maize	0.02	0.02	0.03	0.03	0.05	0.05	0.05	0.05
Real estate	0.02	0.02	0.03	0.03	0.04	0.05	0.09	0.07
Vegetables	0.02	0.02	0.03	0.03	0.04	0.05	0.04	0.04
Financial & business services	0.02	0.02	0.03	0.03	0.04	0.04	0.08	1.08

Source: Author using SimSIP SAM

Note: Figures down the 1st column shows the oil sector's backward linkages, i.e. the oil sector purchases of inputs. Figures across the 1st row shows the purchases of oil sector output by other sectors, i.e. forward linkages

As established in Figure 5.3, Nigeria's oil sector is forward orientated. This means, as can be expected, that many industries buy inputs from the oil sector. The selected sectors, which represent the oil sector's largest forward multipliers, are presented in the 1st (highlighted) row of Table 5.4; figures across this row shows the purchases of oil sector output by other sectors, i.e. forward linkages. Figures down the first column (oil sector) of Table 5.4 shows the oil sector's backward linkages, i.e. the oil sector's purchases of inputs. The main focus of this analysis is backward inter-sector linkages through which an increase in the oil sector's output will create demand for intermediate inputs and create a further stimulus to sectors that are suppliers of the oil sector. The oil sector's largest backward multipliers are highlighted in the shaded column of Table 5.4 above. The oil sector's sectoral (total) backward multiplier is the sum of the oil sector's individual multipliers across all sectors. From all the sectors for which the oil sector has a backward multiplier, only the largest multipliers (value > 0.01) are shown in the table above. This is for ease of exposition and therefore the remaining multipliers are not included in the table above. However, these multipliers only represent 56% of Nigeria's overall sectoral multiplier for the oil sector. The analysis in Chapter 6 (section 6.2.1.1) includes most of the additional multipliers to be representative of the majority (97%) of the oil sector's overall sectoral multiplier.

An exogenous shock, for example an increase in demand for output from Nigeria's oil sector will increase the sector's demand for intermediate inputs (shaded column in Table 5.4). For example, assuming a hypothetical ₦1 billion expansion in export demand for crude petroleum and natural gas, the accounting multiplier for the wholesale and retail trade sector (0.06) indicates that sales in the specific sector are likely to increase with ₦ 60 million. Correspondingly, the increased output from the wholesale and retail trade sector will require further inputs from its supplying industries to meet the increased demand for the sector's output, thereby creating a further stimulus to sectors that are intermediate to wholesale and retail trade. Additional intermediate inputs are either produced locally, imported or a combination of these two options. Multiplier analysis deems financial flows to exogenous accounts, such as imports and taxes, as leakages from the system (Ngandu, Garcia & Arndt, 2010). However, the spending on domestically produced intermediate outputs remains within the system.

Increased output also requires an increase in the use of factors of production, such as labour and capital. Considering Nigeria's matrix of technical coefficients (derived from the SAM as the ratio of inputs to outputs), the oil sector is highly capital intensive with capital accounting for 92% of total production cost (factor usage), while labour accounts for only 0.25% (Nwafor & Alpuerto, 2010). Labour earns wages and salaries that are transferred to households; however, some incremental income leaks to taxes and retained earnings. The increase in households' income results in further purchases of commodities by households – the so-called induced impact. Capital earns the majority of factor income; however, in addition to retained earnings, corporate and factor taxes are a further leakage. Accordingly, a larger proportion of household earnings stem from interest on capital rather than from salaries and wages. The next step in the analysis is to expand the multiplier decomposition by using SPA.

5.4.3 SPA for Nigeria

This section presents the expanded results obtained from the SPA of Nigeria's oil sector. The SPA results expand on the macro-focus of the multiplier decomposition results by focusing on the specific network of paths through which the multiplier effect travels through the economy. The oil sector is used as the fixed origin, from where the impact originates and travels to various destination sectors in the economy. The SPA results illustrate the paths that are followed to reach the final destination sector (pole). The initial SPA analysis, with the oil sector as the fixed origin, was set to illustrate all destination sectors for which the backward multiplier value is at least 0.01 and the maximum number of paths (path length) was set to 10 paths. Selected from these results, the multiplier paths of sectors for which the oil sector's backward multipliers are largest,[50] as reflected in Table 5.4, are presented here. The results presented here are not exhaustive considering that any specific SAM can have thousands of possible paths. The SPA results are discussed in terms of production activities, factors and institutions.

5.4.3.1 Production activities

The SPA of the oil sector (acoil) on other production activities, in terms of the largest backward multipliers, is shown in Table 5.5 below. Due to the high level of detail, only the first path for each case is shown. The detailed path analysis for activities is given in Appendix I, Table I.4.

[50] Multipliers with a value > 0.01.

Table 5.5: SPA for selected activities: Nigeria

Case	Origin	Dest.	Global infl.	Path[51]	Direct infl.	Path mult.	Total infl.	Prop. (in %)
I	acoil	Wholesale and retail trade	0.06	acoil / fcap / ent / Households / cgsmt / agsmt / ctrad / atrad	0.002	2.53	0.005	8.4
II	acoil	Cassava	0.04	acoil / fcap / ent / Households / ccass / acass	0.017	2.42	0.041	94.1
III	acoil	Yams	0.04	acoil / fcap / ent / Households / cyams / ayams	0.015	2.41	0.037	94.3
IV	acoil	Goat and sheep meat	0.03	acoil / fcap / ent / Households / cgsmt / agsmt	0.014	2.34	0.032	94.6
V	acoil	Rice	0.03	acoil / fcap / ent / Households / crice / arice	0.010	2.35	0.024	94.6
VI	acoil	Road transport	0.02	acoil / crtra / artra	0.014	1.03	0.014	59.0
VII	acoil	Electricity and water	0.02	acoil / fcap / ent / Households / cutil / autil	0.008	2.35	0.018	80.1
VIII	acoil	Maize	0.02	acoil / fcap / ent / Households / cmaze / amaze	0.009	2.35	0.020	94.4
IX	acoil	Real estate	0.02	acoil / fcap / ent / Households / crest / arest	0.008	2.34	0.018	92.8
X	acoil	Vegetables	0.02	acoil / fcap / ent / Households / cveg / aveg	0.008	2.35	0.018	94.6
XI	acoil	Financial inst., Insurance, Business services	0.02	acoil / fcap / ent / Households / cbser / abser	0.005	2.45	0.012	73.3

Source: Author using SimSIP SAM
Note: dest., destination; inst., institutions; infl., influence; mult., multiplier; prop., proportion

To interpret the results, consider the following example: the impact of a hypothetical injection of ₦1 billion into the oil sector. This injection could take various forms, for example an increased demand for the oil sector's output, or oil sector investment leading to increased production. This injection will have a multiplier effect on the rest of the economy. In terms of backward multipliers, i.e. the oil sector's purchases of inputs, the 4th column of Table 5.5 shows the global influence or accounting multiplier. The path column shows the multiplier path that is followed, originating at the oil sector and flowing through various nodes before reaching the final destination sector. The proportion (prop.) column indicates the percentage share of the particular path in explaining the overall multiplier (global influence column).

For example, case II – an injection of ₦1 billion into the oil sector will create an additional[52] ₦43 million worth of sales in the cassava sector. The proportion column for case II shows that approximately 94.1% of this additional production (multiplier of 0.04) is caused by this specific path, i.e. flowing from the oil sector to capital to enterprises to households who buy commodities (ccass) supplied by the cassava sector (acass). Next consider case I – an injection of ₦1 billion into the oil sector will create an additional ₦ 60 million worth of sales in the wholesale and retail trade sector. The proportion column, for case I, shows that approximately

[51] See Appendix I, Table I.2 and I.3 for a full discription of SAM account names.
[52] The impact value is calculated as the injection (in this example ₦1 billion) multiplied with the specific multiplier (in this example 0.04, in the 4th column/3rd row of Table 5.5).

only 8.4% of this additional production (multiplier of 0.06) is caused by this particular path, i.e. the path flowing from the oil sector through capital and enterprises to households who buy goat and sheep meat (commodity) supplied by the goat and sheep meat sector (activity), which distributes output through wholesale and retail trade (commodity) from the wholesale and retail trade sector (activity). The remaining paths can be seen in Table I.4 of Appendix I. Common nodes of these paths are capital, enterprises and households who purchase a commodity that is distributed through wholesale and retail trade. Case VI is an example of a more elementary path, flowing from the oil sector to the road transport commodity (crtra) to the road transport sector (artra). The particular path explains approximately 59% (see proportion column, Table 5.5) of this additional production.

5.4.3.2 Factors

The influence of a stimulus to the oil sector on production factors can be seen from the SPA results shown in Table 5.6 below, i.e. the exogenous increase in expenditure requires the use of the production factors, capital, labour and land. In addition to the overall impact that can be derived from the accounting multipliers, SPA identifies the sectoral sources of increased factor usage (Ngandu, Garcia & Arndt, 2010). The accounting multiplier for capital is 0.98 (column 4, case I), accordingly a ₦1 billion expansion of the oil sector will require ₦980 million worth of capital to be used as factor input. From the path results, 98.77% comes directly from the oil sector itself, while the rest flows through other sectors. These include road transport (crtra / artra) with 0.35%, other manufactured products (comfc / aomfc) with 0.23% and finally transportation and other equipment (cemfc / aemfc) with 0.21%.

The accounting multiplier for labour[53] is 0.30 (column 4, case II), accordingly a ₦1 billion expansion of the oil sector will require ₦300 million worth of labour input. This is in line with the relative importance of capital and labour that was noted[54] from the SAM. In contrast to capital, the impact from the oil sector on labour follows a greater number of indirect paths before reaching labour. The most common nodes through which the flows travel are from the oil sector to capital to enterprises to households, households purchase other commodities, which then flow to labour. From this, most of the flows go to households as the owners of capital rather than labour. It is only once households then spend their earnings from capital on other commodities that these sectors then need to employ additional labour. These sectors

[53] This only refers to the value of labour that will be required and not to the number of jobs.
[54] The technical coefficients for labour and capital (derived from the SAM) where noted on page 117-118.

include: cassava (acass); yams (ayams); real estate (arest); goat and sheep meat (agsmt); rice (arice); maize(amaze); road transport (artra); vegetables (aveg); private non-profit organisations, other services (aoser) and finally electricity and water (autil).

The accounting multiplier for land is 0.01 (column 4, case III), and accordingly a ₦1 billion expansion of the oil sector will require ₦10 million worth of land input. The most common nodes through which the flows travel are from the oil sector to capital to enterprises to households, households purchase other commodities, which then flow to land. These sectors include: cassava (acass); yams (ayams); rice (arice); vegetables (aveg); maize(amaze); fruits (afrt); sorghum (asorg); groundnuts (agnut); beans (abean) and millet (amilt). It seems the connection to land mainly flows through households' purchases of agricultural outputs that require land.

The first two paths account for the largest share of the accounting multiplier. With capital by far the most prominent nodes, from these paths the cassava and yams sectors have the largest influence, with these two paths accounting for 14.97% and 14.85% respectively.

Table 5.6: SPA for factors: Nigeria

Case	Origin	Dest.	Global infl.	Path	Direct infl.	Path mult.	Total infl.	Prop. (in %)	Accum. Prop.
I	acoil	Capital	0.98	acoil / fcap	0.918	1.05	0.965	98.8	98.8
				acoil / crtra / artra / fcap	0.003	1.07	0.003	0.4	99.1
				acoil / comfc / aomfc / fcap	0.002	1.10	0.002	0.2	99.4
				acoil / cemfc / aemfc / fcap	0.002	1.09	0.002	0.2	99.6
II	acoil	Labour	0.3	acoil / fcap / ent / Households / ccass / acass / flab	0.009	2.42	0.022	7.4	7.4
				acoil / fcap / ent / Households / cyams / ayams / flab	0.008	2.41	0.019	6.2	13.6
				acoil / fcap / ent / Households / crest / arest / flab	0.007	2.34	0.015	5.2	18.7
				acoil / fcap / ent / Households / cgsmt / agsmt / flab	0.006	2.34	0.014	4.6	23.3
				acoil / fcap / ent / Households / crice / arice / flab	0.006	2.35	0.013	4.4	27.8
				acoil / fcap / ent / Households / cmaze / amaze / flab	0.005	2.35	0.011	3.8	31.6
				acoil / crtra / artra / flab	0.005	1.98	0.010	3.4	34.9
				acoil / fcap / ent / Households / cveg / aveg / flab	0.004	2.35	0.009	3.0	37.9
				acoil / fcap / ent / Households / coser / aoser / flab	0.004	2.34	0.008	2.8	40.6
				acoil / fcap / ent / Households / cutil / autil / flab	0.003	2.35	0.008	2.8	43.4
III	acoil	Land	0.01	acoil / fcap / ent / Households / ccass / acass / flnd	0.006	2.42	0.015	15.0	15.0
				acoil / fcap / ent / Households / cyams / ayams / flnd	0.006	2.41	0.014	14.9	29.8
				acoil / fcap / ent / Households / crice / arice / flnd	0.004	2.35	0.009	9.3	39.1
				acoil / fcap / ent / Households / cveg / aveg / flnd	0.003	2.35	0.008	8.0	47.1
				acoil / fcap / ent / Households / cmaze / amaze / flnd	0.003	2.35	0.007	7.2	54.3
				acoil / fcap / ent / Households / cfrt / afrt / flnd	0.003	2.34	0.007	6.7	61.0
				acoil / fcap / ent / Households / csorg / asorg / flnd	0.002	2.35	0.005	5.6	66.6
				acoil / fcap / ent / Households / cgnut / agnut / flnd	0.002	2.36	0.004	4.1	70.7
				acoil / fcap / ent / Households / cbean / abean / flnd	0.002	2.37	0.004	4.0	74.7
				acoil / fcap / ent / Households / cmilt / amilt / flnd	0.002	2.34	0.004	4.0	78.7

Source: Author using SimSIP SAM. Note: Dest., destination; infl., influence; mult., multiplier; prop., proportion; accum.; accumulated

5.4.3.3 Institutions

The last portion of the SPA pertains to the distribution of incremental income to institutions (households and enterprises), shown in Table 5.7 below. From case I, the majority of the addition to household income (94.65%) flows from the oil sector to capital (fcap) to enterprises (ent) and finally to households. The other indirect nodes include road transport (crtra/artra); labour (flab); financial institutions, insurance, business services (cbser/abser); other manufactured products (comfc/aomfc); transportation and other equipment (cemfc/aemfc); trade costs (trc); and finally wholesale and retail trade (ctrad/atrad).

Table 5.7: SPA for institutions: Nigeria

Case	Origin	Dest.	Global infl.	Path	Direct infl.	Path mult.	Total infl.	Prop. (in %)	Accum. Prop.
I	acoil	Households	0.69	acoil / fcap / ent / Households	0.280	2.34	0.657	94.7	94.7
				acoil / crtra / artra / flab / Households	0.005	2.36	0.012	1.7	96.4
				acoil / flab / Households	0.003	2.34	0.006	0.9	97.2
				acoil / crtra / artra / fcap / ent / Households	0.001	2.36	0.002	0.3	97.5
				acoil / cbser / abser / flab / Households	0.001	2.45	0.002	0.3	97.9
				acoil / comfc / aomfc / fcap / ent / Households	0.001	2.42	0.002	0.2	98.1
				acoil / cemfc / aemfc / fcap / ent / Households	0.001	2.42	0.001	0.2	98.3
				acoil / cemfc / trc / ctrad / atrad / flab / Households	0.000	2.61	0.001	0.2	98.4
				acoil / cemfc / aemfc / flab / Households	0.000	2.42	0.001	0.2	98.6
				acoil / comfc / aomfc / flab / Households	0.000	2.42	0.001	0.2	98.8
II	acoil	Enterprises	0.55	acoil / fcap / ent	0.518	1.05	0.545	98.8	98.8
				acoil / crtra / artra / fcap / ent	0.002	1.07	0.002	0.4	99.1
				acoil / comfc / aomfc / fcap / ent	0.001	1.10	0.001	0.2	99.4
				acoil / cemfc / aemfc / fcap / ent	0.001	1.093	0.001	0.2	99.6

Source: Author using SimSIP SAM
Note: Dest., destination; infl., influence; mult., multiplier; prop., proportion; accum., accumulated

From case II, enterprises receive the majority of their income (98% of global influence) from the direct path through capital. Production activities that participate in the paths of income generation for institutions (households and enterprises) are road transport, other manufactured products, as well as transportation and other equipment.

5.4.4 Concluding remarks

The SAM for Nigeria was used as the underlying database to analyse the structural linkages of Nigeria's oil sector. In terms of the weighted forward and backward linkages, Nigeria's oil sector is strongly forward orientated, as was shown in Figure 5.3. However, it is backward linkages that can create the most impact throughout the rest of the economy. For this reason, the multiplier decomposition analysis focused on the oil sector's backward (accounting) multipliers by highlighting the largest backward multipliers. These backward multipliers create demand for intermediate inputs from the following sectors: wholesale and retail trade, cassava; yams; goat and sheep meat; rice; road transport; electricity and water; maize; real estate; vegetables; and financial and business services. Considering Nigeria's matrix of technical coefficients[55] (derived from the SAM), the oil sector is highly capital intensive with capital accounting for 92% of total production cost (factor usage), while labour accounts for only 0.25%.

The SPA results shed further light on the paths through which the multiplier effect travels through the economy. The results were presented in terms of production activities, factors and institutions. In terms of production activities, the common nodes of these paths are capital, enterprises and households who purchase a commodity that could be distributed through wholesale and retail trade.

In terms of factors, the majority of capital flows directly between the oil sector and capital (98.77%). For labour, the most common nodes through which the flows travel are from the oil sector to capital to enterprises to households. Households purchase other commodities, which then flow to labour. From this, most of the flows go to households as the owners of capital rather than labour. It is only once households then spend their earnings from capital on other commodities that these sectors need to employ additional labour. In terms of land, the most common nodes through which the flows travel are from the oil sector to capital to enterprises to households, households purchase other commodities, which then flow to land.

In terms of household institutions, the majority of the addition to household income (94.65%) flows from the oil sector to capital (fcap) to enterprises (ent) and finally to households. In terms of enterprises, the majority of their income (98% of global influence) is received from the direct path through capital.

[55] The technical coefficients for labour and capital (derived from the SAM) were noted on pages 117-118.

For additional detail, the SPA results are graphically illustrated in Appendix I, Figure I.1-I.16. Note that the thickness of the lines illustrates the strength of the particular path, i.e. thicker lines are interpreted as stronger multiplier paths.

5.5 Empirical analysis: Algeria

5.5.1 SAM structure for Algeria

This analysis uses a 2002 SAM[56] for Algeria, developed by Bouazouni (2008). The SAM illustrates the structure of Algeria's economy by including the linkages between production activities, the distribution of income, the consumption of goods and services as well as foreign trade of economic agents for 2002.

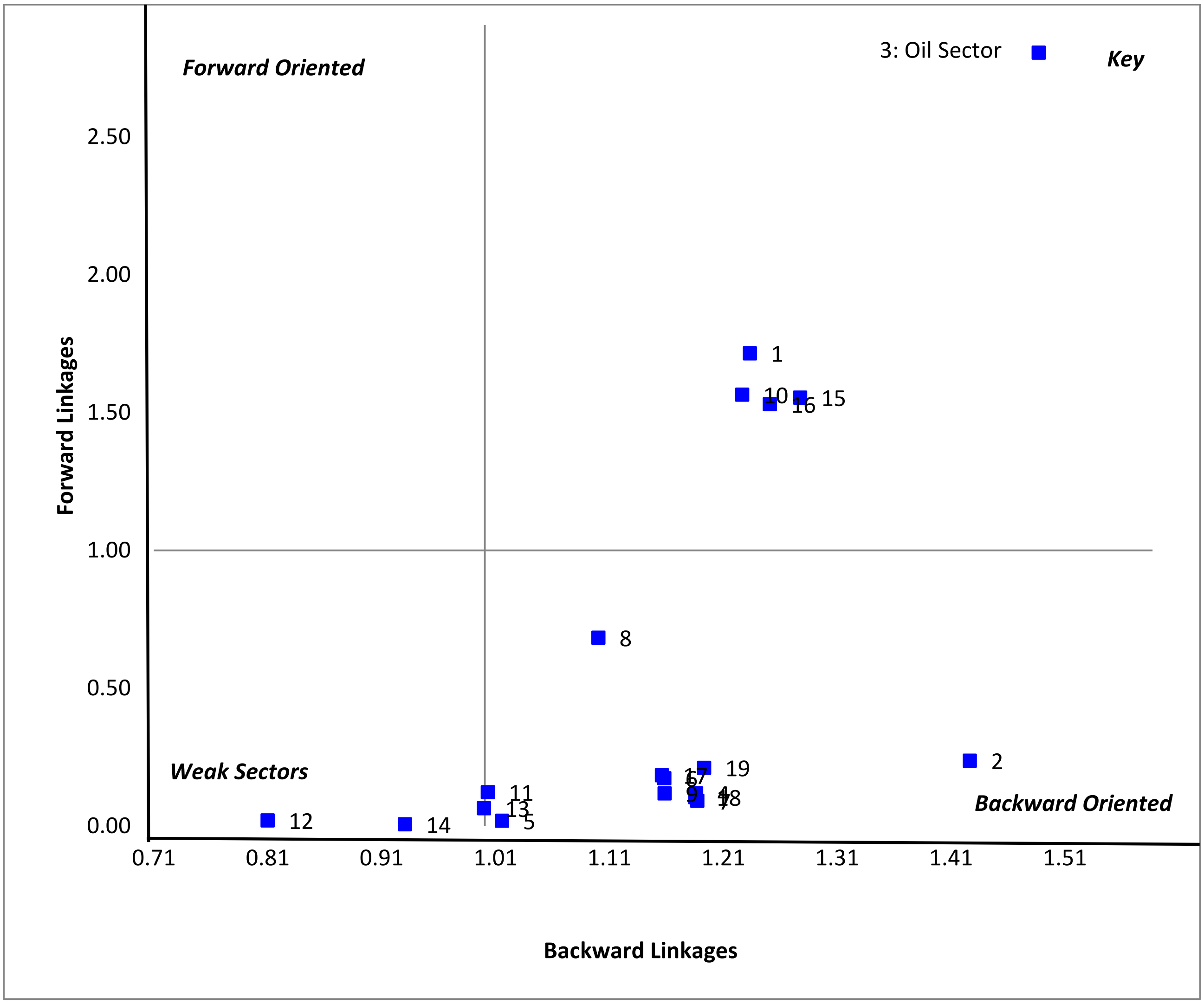
The Algeria SAM's endogenous accounts include 19 sectors (activities) and 19 commodities. The factor accounts include labour and capital, while the institutions include enterprises and households. The exogenous accounts include the government and the 'rest of the world'. The energy, mining and construction sectors accounted for include water and energy, hydrocarbons (petroleum), services and construction for petroleum, mining and quarrying, the metal sector, construction materials, building and construction. There is also an aggregate account for agriculture. Secondary sectors include the chemicals, rubber and plastic sector; food processing, textiles, leather and footwear, wood and paper, and other manufacturing. Tertiary sectors accounted for include transport and communication, trade, hotels and restaurants, other private services as well as public services.

Algeria's oil sector is captured in the activity account (3) named hydrocarbons (aHydrocarbons). The analysis will start by first considering the basic inter-linkages of the hydrocarbons account, hereafter referred to as the oil sector. This is done by considering the sector's forward and backward linkages based on the forward and backward multipliers in the Leontief inverse. Figure 5.4 illustrates the weighted forward and backward linkages for the activity accounts in the Algeria SAM. The numbers in Figure 5.4 correspond to the order in which the activity accounts appear in the Algeria SAM (see in Appendix B, Table B5.2). Using weighted forward and backward linkages, Figure 5.4 classifies sectors into four possible quadrants, namely forward-orientated, backward-orientated, weak and key sectors. According

[56] The Macro SAM is illustrated in Appendix II, Table II.1.

to this analysis, Algeria's oil sector is both forward and backward orientated and can therefore be classified as a key sector in Algeria's economy (in the top right quadrant).

Figure 5.4: Weighted Backward and Forward Linkages: Algeria, 2002 SAM



Source: Author using SimSIP SAM

5.5.2 Multiplier decomposition analysis for Algeria

The first step of the analysis is to conduct a multiplier decomposition of Algeria's accounting multipliers. These results are then enhanced by using SPA to expose the network of paths through which a multiplier effect travels through the economy. The most significant accounting multipliers for Algeria's oil sector are summarised in Table 5.8 below.

Table 5.8: Selected accounting multiplier: Algeria

	Oil sector (Hydrocarbons)	Water and Energy	Services and construction for petroleum	Mining and quarrying	Metal sector	Construction materials	Chemicals, Rubber and Plastic	Textiles
Oil sector (Hydrocarbons)	1.23	0.430	0.209	0.109	0.357	0.188	0.358	0.263
Transport and communications	0.12	0.100	0.191	0.168	0.127	0.156	0.102	0.096
Food processing	0.09	0.107	0.126	0.108	0.090	0.110	0.121	0.089
Agriculture	0.09	0.105	0.132	0.117	0.091	0.111	0.101	0.086
Trade	0.08	0.110	0.124	0.171	0.150	0.131	0.135	0.173
Services and construction for petroleum	0.02	0.005	1.050	0.001	0.004	0.002	0.004	0.003
Water and Energy	0.01	1.034	0.019	0.029	0.031	0.022	0.020	0.031
Other private services	0.01	0.006	0.029	0.005	0.007	0.006	0.007	0.006
Public services	0.01	0.015	0.015	0.015	0.012	0.016	0.012	0.012
Hotels and restaurants	0.01	0.011	0.017	0.013	0.011	0.013	0.010	0.009
Metal sector	0.01	0.009	0.017	0.044	1.032	0.017	0.010	0.006
Textiles	0.01	0.008	0.009	0.008	0.007	0.009	0.008	1.185

Source: Author using SimSIP SAM
Note: Figures down the 1st column shows the oil sector's backward linkages, i.e. the oil sector's purchases of inputs. Figures across the 1st row shows the purchases of the oil sector's output by other sectors, i.e. forward linkages.

As established in Figure 5.4, Algeria's oil sector is both forward and backward orientated, i.e. a key sector. This means that not only do many industries buy inputs from the oil sector (forward linkages), but also that the oil sector buys (backward linkages) inputs from other sectors that have linkages with the rest of the economy. The selected sectors, which represent the oil sector's largest forward multipliers, are presented in the 1st (highlighted) row of Table 5.8; figures across this row shows the purchases of oil sector output by other sectors, i.e. forward linkages. Figures down the first column (oil sector) of Table 5.8 shows the oil sector's backward linkages, i.e. the oil sector's purchases of inputs. However, the main focus of this analysis is backward inter-sector linkages through which an increase in the oil sector's output will create demand for intermediate inputs and create a further stimulus to sectors that are suppliers of the oil sector. The oil sector's largest backward multipliers (value > 0.004) are highlighted in the shaded column of Table 5.8. These multipliers represent 97% of Algeria's overall sectoral multiplier for the oil sector.

An exogenous shock, for example an increase in demand for output from Algeria's oil sector, will increase the sector's demand for intermediate inputs. Increased output also requires an increase in the use of factors of production, such as labour and capital. Considering Algeria's matrix of technical coefficients (derived from the SAM as the ratio of inputs to outputs), Algeria's oil sector is also capital intensive with capital accounting for 54% of total production cost (factor usage), while labour accounts for only 2% (Bouazouni 2008). However, in comparison with Nigeria's oil sector, Algeria's oil sector is relatively less capital intensive and slightly more labour intensive.

5.5.3 SPA for Algeria

This section presents the expanded results obtained from the SPA of Algeria's oil sector. The SPA results expand on the macro-focus of the multiplier decomposition results by focusing on the specific network of paths through which the multiplier effect travels through the economy. The oil sector is used as the fixed origin, from where the impact originates and travels to various destination sectors in the economy. The SPA results illustrate the paths that are followed to reach the final destination sector (pole). The initial SPA analysis, with the oil sector as the fixed origin, was set to illustrate all destination sectors for which the backward multiplier value is at least 0.01 and the maximum number of paths (path length) was set to 10 paths. Selected from these results, the multiplier paths of sectors for which the oil sector's backward multipliers are largest (Table 5.8), are presented here. The results presented here are not exhaustive considering that any specific SAM can have thousands of possible paths. The SPA results are discussed in terms of production activities; factors and institutions.

5.5.3.1 Production activities

The SPA of the oil sector (aHydrocarbons) on other production activities, in terms of the largest backward multipliers, is shown in Table 5.9 below. Due to the high level of detail, only the first path for each case is shown. The detailed path analysis for activities is given in Appendix II, Table II.4.

Table 5.9: SPA for selected activities: Algeria

Case	Origin	Dest.	Global infl.	Path[57]	Direct infl.	Path mult.	Total infl.	Prop. (in %)
I	aHydrocarbons	Transport and communications	0.12	aHydrocarbons / cTrans&comms / aTrans&comms	0.037	1.44	0.01	46.4
II	aHydrocarbons	Food processing	0.09	aHydrocarbons / Cap / HH / cAgroFood / aAgroFood	0.036	1.82	0.01	72.8
III	aHydrocarbons	Agriculture	0.09	aHydrocarbons / Cap / HH / cAgri / aAgri	0.025	1.74	0.04	51.3
IV	aHydrocarbons	Trade	0.08	aHydrocarbons / Cap / HH / cShops / aShops	0.030	1.62	0.05	58.7
V	aHydrocarbons	Services and construction for petroleum	0.02	aHydrocarbons / cPW&PetroServ / aPW&PetroServ	0.012	1.29	0.02	100
VI	aHydrocarbons	Water and Energy	0.01	aHydrocarbons / Cap / HH / cW&Ener / aW&Ener	0.004	1.64	0.01	42.4
VII	aHydrocarbons	Other private services	0.01	aHydrocarbons / cServicestoCo / aServicestoCo	0.010	1.25	0.01	84.8
VIII	aHydrocarbons	Public services	0.01	aHydrocarbons / Cap / HH / cServicestoHH / aServicestoHH	0.005	1.61	0.01	74.3
IX	aHydrocarbons	Hotels and restaurants	0.01	aHydrocarbons / Cap / HH / cHotels&Restaur / aHotels&Restaur	0.004	1.61	0.01	63.0
X	aHydrocarbons	Metal sector	0.01	aHydrocarbons / Cap / HH / cMetalSteelMecelectric / aMetalSteelMecelectric	0.002	1.65	0.003	39.8
XI	aHydrocarbons	Textiles	0.01	aHydrocarbons / Cap / HH / cTextiles / aTextiles	0.003	1.89	0.005	77.9

Source: Author using SimSIP SAM
Note: dest., destination; inst., institutions; infl., influence; mult., multiplier; prop., proportion

To interpret the results, consider the following example: the impact of a hypothetical injection of DA1 billion into the oil sector. For example, case I – an injection of DA1 billion into the oil sector will create an additional DA120 million worth of sales in the transport and communications sector. The proportion column shows that approximately 46.42% of this additional production is caused by flowing from the oil sector to transport and communications commodities and then to the transport and communications sector. Case V is another example of an elementary path, flowing from the oil sector to the commodity services and construction for petroleum (cPW&PetroServ) to the services and construction for petroleum sector (aPW&PetroServ). The particular path explains approximately 100% of this additional production. In this case, an injection of DA1 billion into the oil sector will create an additional DA20 million worth of sales in the services and construction for petroleum sector. Next, consider case II – an injection of DA1 billion into the oil sector will create an additional DA90 million worth of sales in the food processing sector. In this example, the initial injection will have to travel through various sectors (i.e. follow various paths) before reaching the food

[57] See Appendix II, Table II.2 and II.3 for a full discription of SAM account names.

processing sector. The proportion column shows that approximately 72.79% of this additional production is caused indirectly by flowing from the oil sector to capital to households that buy processed foods (commodities), which flows to the food processing sector. The remaining paths can be seen in Table B5.4 of Appendix B. Common nodes of these paths are capital and households.

5.5.3.2 Factors

The influence of a stimulus to the oil sector on production factors can be seen from the SPA results shown in Table 5.10 below, i.e. the exogenous increase in expenditure requires the use of factors. In addition to the overall impact that can be derived from the accounting multipliers, SPA identifies the sectoral sources of increased factor usage (Ngandu, Garcia & Arndt, 2010).

The accounting multiplier for capital is 0.90 (column 4, case I), and accordingly a DA1 billion expansion of the oil sector will require DA900 million worth of capital to be used as factor input. From the path results, 89.86% comes directly from the oil sector itself, while the rest flows through other sectors. These sectors include transport and communications (cTrans&comms / aTrans&comms) with 3.57%, and trade (cShops / aShops) with 1.37%.

The accounting multiplier for labour[58] is 0.07 (column 4, case II). Accordingly, a DA1 billion expansion of the oil sector will require ₦70 million worth of labour input. This is in line with the relative importance of capital and labour that was noted from the SAM. However, in terms of a relative comparison, the labour multiplier is smaller than that of Nigeria. In contrast to capital, the impact from the oil sector on labour follows a greater number of indirect paths before reaching labour. However, 33.77% of the multiplier is explained by the direct path from the oil sector to labour. The other most common nodes through which the flows travel are from the oil sector to capital to households, households purchase other commodities, which then flow to labour. In contrast to Nigeria where the flows first go to enterprises before flowing to labour, Algeria's flow is more direct from capital to households. From this, most of the flows go to households as the owners of capital rather than labour. It is only once households then spend their earnings from capital on other commodities that these sectors need to employ additional labour. These sectors include: transport and communications (cTrans&comms/aTrans&comms), agriculture (cAgri/aAgri), trade (cShops/aShops), other

[58] This only refers to the value of labour that will be required and not to the number of jobs.

private services (cServicestoCo/aServicestoCo), services and construction for petroleum (cPW&PetroServ/aPW&PetroServ), food processing (cAgroFood/aAgroFood), public services (cServicestoHH/aServicestoHH), water and energy (cW&Ener/aW&Ener), hotels and restaurants (cHotels&Restaur/aHotels&Restaur) and finally textiles (cTextiles / aTextiles).

5.5.3.3 Institutions

The last portion of the SPA pertains to the distribution of incremental income to institutions (households and enterprises), shown in Table 5.11 below. From case I, the majority of the addition to household income (81.88%) flows from the oil sector to capital (Cap) to households (HH). From case II, enterprises receive the majority of their income (88.64% of global influence) from the direct path through capital. Production activities that participate in these paths of income generation for institutions (households and enterprises) are transport and communications (cTrans&comms/aTrans&comms) as well as trade (cShops/Shops).

Table 5.10: SPA for factors: Algeria

Case	Origin	Dest.	Global infl.	Path	Direct infl.	Path mult.	Total infl.	Prop. (in %)	Accum. Prop.
I	aHydrocarbons	Capital	0.9	aHydrocarbons / Cap	0.540	1.49	0.807	89.9	89.9
				aHydrocarbons / cTrans&comms / aTrans&comms / Cap	0.019	1.67	0.032	3.6	93.4
				aHydrocarbons / cShops / aShops / Cap	0.008	1.53	0.012	1.4	94.8
II	aHydrocarbons	Labour	0.07	aHydrocarbons / Lab	0.019	1.33	0.025	33.8	33.8
				aHydrocarbons / cTrans&comms / aTrans&comms / Lab	0.004	1.52	0.007	8.9	42.6
				aHydrocarbons / Cap / HH / cTrans&comms / aTrans&comms / Lab	0.003	1.77	0.005	6.9	49.5
				aHydrocarbons / Cap / HH / cAgri / aAgri / Lab	0.003	1.74	0.004	6.0	55.5
				aHydrocarbons / Cap / HH / cShops / aShops / Lab	0.003	1.62	0.004	6.0	61.5
				aHydrocarbons / cServicestoCo / aServicestoCo / Lab	0.003	1.34	0.004	5.0	66.5
				aHydrocarbons / cPW&PetroServ / aPW&PetroServ / Lab	0.002	1.39	0.003	4.4	70.9
				aHydrocarbons / Cap / HH / cAgroFood / aAgroFood / Lab	0.002	1.82	0.003	3.7	74.5
				aHydrocarbons / Cap / HH / cAgroFood / aAgroFood / cAgri / aAgri / Lab	0.001	1.95	0.002	2.8	77.3
				aHydrocarbons / cShops / aShops / Lab	0.001	1.42	0.002	2.1	79.3
				aHydrocarbons / Cap / HH / cServicestoHH / aServicestoHH / Lab	0.001	1.61	0.001	1.8	81.2
				aHydrocarbons / Cap / HH / cW&Ener / aW&Ener / Lab	0.001	1.64	0.001	1.2	82.3
				aHydrocarbons / Cap / HH / cHotels&Restaur / aHotels&Restaur / Lab	0.001	1.61	0.001	1.1	83.5
				aHydrocarbons / Cap / HH / cTextiles / aTextiles / Lab	0.000	1.89	0.001	1.0	84.5

Source: Author using SimSIP SAM
Note: Dest., destination; infl., influence; mult., multiplier; prop., proportion; accum., accumulated

Table 5.11: SPA for institutions: Algeria

Case	Origin	Dest.	Global infl.	Path	Direct infl.	Path mult.	Total infl.	Prop. (in %)	Accum. Prop.
I	aHydrocarbons	Households	0.53	aHydrocarbons / Cap / HH	0.270	1.61	0.434	81.9	81.9
				aHydrocarbons / Lab / HH	0.019	1.61	0.030	5.7	87.6
				aHydrocarbons / cTrans&comms / aTrans&comms / Cap / HH	0.010	1.77	0.017	3.2	90.8
				aHydrocarbons / cTrans&comms / aTrans&comms / Lab / HH	0.004	1.77	0.008	1.4	92.2
				aHydrocarbons / cShops / aShops / Cap / HH	0.004	1.62	0.007	1.2	93.4
				aHydrocarbons / cServicestoCo / aServicestoCo / Lab / HH	0.003	1.62	0.004	0.8	94.3
				aHydrocarbons / cServicestoCo / aServicestoCo / Cap / HH	0.002	1.62	0.004	0.7	95.0
				aHydrocarbons / cPW&PetroServ / aPW&PetroServ / Lab / HH	0.002	1.68	0.004	0.7	95.7
				aHydrocarbons / cPW&PetroServ / aPW&PetroServ / Cap / HH	0.002	1.68	0.003	0.5	96.2
				aHydrocarbons / Cap / Ent / HH	0.001	1.61	0.002	0.4	96.6
				aHydrocarbons / cShops / aShops / Lab / HH	0.001	1.62	0.002	0.3	96.9
				aHydrocarbons / cAgroFood / aAgroFood / Cap / HH	0.001	1.82	0.001	0.2	97.1
				aHydrocarbons / cW&Ener / aW&Ener / Cap / HH	0.001	1.64	0.001	0.2	97.4
				aHydrocarbons / cAgroFood / aAgroFood / cAgri / aAgri / Cap / HH	0.001	1.95	0.001	0.2	97.5
				aHydrocarbons / cBuild&civil / aBuild&civil / Lab / HH	0.001	1.61	0.001	0.2	97.7
				aHydrocarbons / cBuildingM / aBuildingM / Lab / HH	0.001	1.62	0.001	0.1	97.8
				aHydrocarbons / cW&Ener / aW&Ener / Lab / HH	0.000	1.64	0.001	0.1	98.0
II	aHydrocarbons	Enterprises	0.46	aHydrocarbons / Cap / Ent	0.270	1.50	0.405	88.6	88.6
				aHydrocarbons / cTrans&comms / aTrans&comms / Cap / Ent	0.010	1.67	0.016	3.5	92.2
				aHydrocarbons / cShops / aShops / Cap / Ent	0.004	1.53	0.006	1.4	93.5

Source: Author using SimSIP SAM
Note: Dest., destination; infl., influence; mult., multiplier; prop., proportion; accum., accumulated

5.5.4 Concluding remarks

The SAM for Algeria was used as the underlying database to analyse the structural linkages of Algeria's oil sector. In terms of the weighted forward and backward linkages, Algeria's oil sector is both forward and backward orientated, i.e. a key sector, as was shown in Figure 5.4. However, it is backward linkages that can create the most impact throughout the rest of the economy. For this reason, the multiplier decomposition analysis focused on the oil sector's backward (accounting) multipliers by highlighting the largest backward multipliers.

These backward multipliers create demand for intermediate inputs from the following sectors: transport and communications, food processing, agriculture, trade, services and construction for petroleum, water and energy, other private services, public services, hotels and restaurants, the metal sector and textiles. Considering Algeria's matrix of technical coefficients (derived from the SAM), the oil sector is relatively capital intensive with capital accounting for 54% of total production cost (factor usage), while labour accounts for only 2%. However, in comparison with Nigeria's oil sector, Algeria's oil sector is significantly less capital intensive and slightly more labour intensive.

The SPA results shed further light on the paths through which the multiplier effect travels through the economy. The results were presented in terms of production activities, factors and institutions. In terms of production activities, the common nodes of these paths are capital, labour, households as well as services and construction for petroleum.

In terms of factors, the majority of capital flows directly between the oil sector and capital (89.86%). For labour, the most common nodes through which the flows travel are from the oil sector to capital to households, households purchase other commodities, which then flow to labour. From this, most of the flows go to households as the owners of capital rather than labour. It is only once households then spend their earnings from capital on other commodities that these sectors need to employ additional labour

In terms of household institutions, the majority of the addition to household income (81.88%) flows from the oil sector to capital (Cap) to households (HH). In terms of enterprises, the majority of their income (88.64%) is received from the direct path through capital. For additional detail, the SPA results are graphically illustrated in Appendix II, Figure II.1-II.15.

Note that the thickness of the lines illustrates the strength of the particular path, i.e. thicker lines are interpreted as stronger multiplier paths.

5.6 Empirical analysis: Chad

5.6.1 SAM structure for Chad

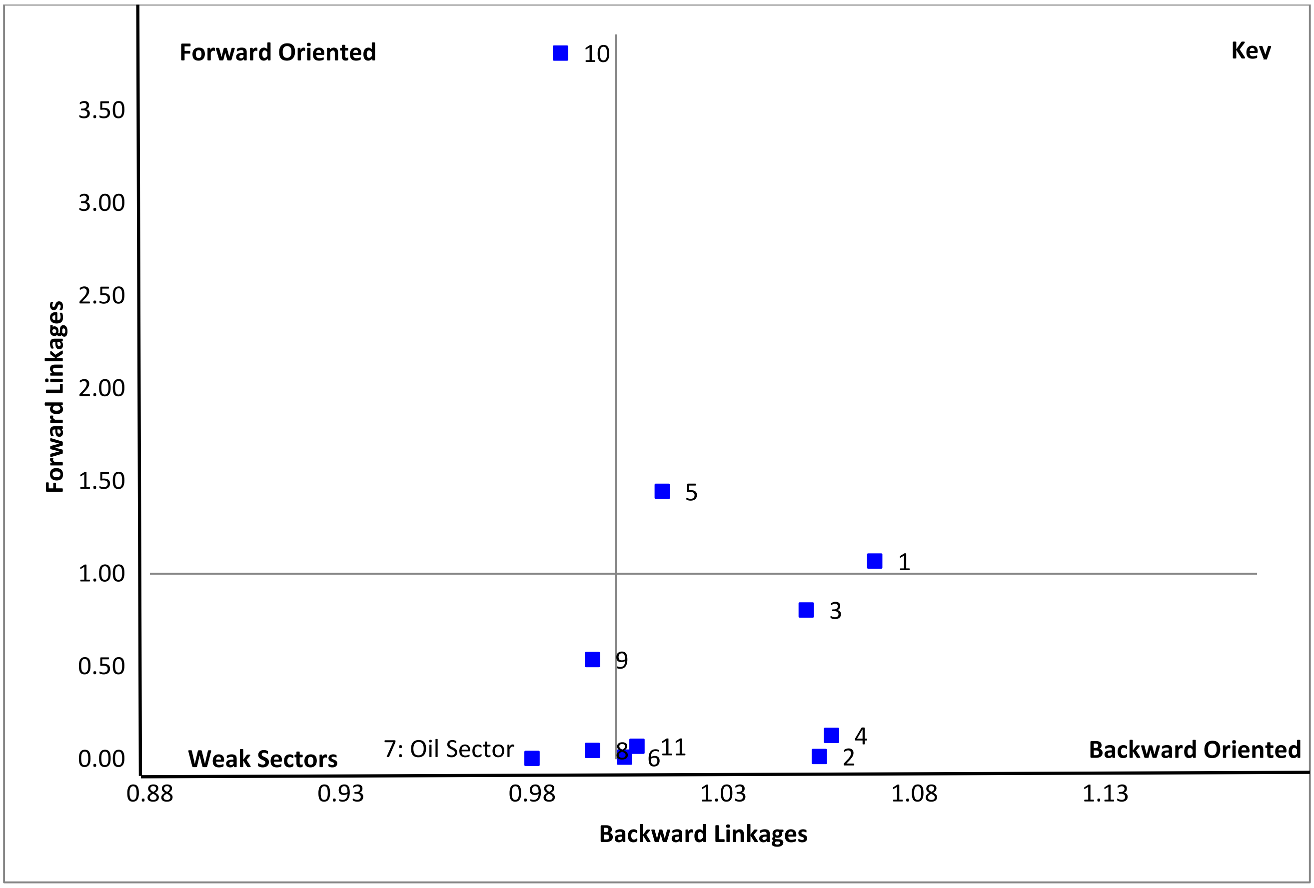
This analysis uses a 2000 SAM[59] for Chad, developed by Garber (2014a). The SAM has been used by Garber (2009, 2014b) to specifically analyse the potential socio-economic outcomes of alternative revenue spending regimes for Chad's oil sector. Importantly, as emphasised before, revenue management and allocation is a separate issue that falls outside the scope of this thesis. Importantly, this SAM database is useful in assessing the oil sector's economy-wide impacts, which are separate from the impact of oil sector rents received and used by the host government.

The SAM illustrates the structure of Chad's economy by including the linkages between production activities, the distribution of income, the consumption of goods and services as well as foreign trade of economic agents for 2000. The Chad SAM's endogenous accounts include 11 sectors (activities) and 11 commodities. The factor accounts include labour, capital and land, while the institutions include enterprises and six household categories, which have been aggregated for this analysis. The exogenous accounts include the government, the capital account (aggregated for this analysis) and the 'rest of the world'.

Chad's oil sector is captured in the activity account (7), named oil field development (a-dev). The analysis will start by first considering the basic inter-linkages of the oil field development account, hereafter referred to as the oil sector. This is done by considering the sector's forward and backward linkages based on the forward and backward multipliers in the Leontief inverse. Figure 5.5 illustrates the weighted forward and backward linkages for the activity accounts in the Chad SAM. The numbers in the figure below correspond to the order in which the activity accounts appear in the Chad SAM (see in Appendix III, Table III.2). Using weighted forward and backward linkages, Figure 5.5 classifies sectors into four possible quadrants, namely forward-orientated, backward-orientated, weak and key sectors.

[59] The Macro SAM is illustrated in Appendix III, Table III.1

Figure 5.5: Weighted backward and forward linkages: Chad, 2000 SAM



Source: Author using SimSIP SAM

According to this analysis, Chad's oil sector has very weak forward linkages with weak backward linkages, and can therefore be classified as a weak sector in Chad's economy (in the bottom left quadrant). While the BP (2014) Statistical Review of World Energy's first account of oil reserves for Chad was in 2000 (the 'dawn' of Chad's oil sector), the first account of production was not until 2003. However, according to the World Bank (2006), IOCs started oil exploration in Chad in the early years of its independence (1960), with the first discoveries being made in the mid-1970s. However, due to local instability and global oil market conditions at the time, the resources were not developed. In 1988, an agreement was signed with a joint venture consortium to grant a 10-year permit for exploration that was subsequently extended to a 30-year lease to develop three oilfields in the vicinity of Doba in southern Chad and to export the crude oil produced from these fields. From 1999, improvements in Chad's stability and investment climate brought renewed interest in Chad's oil resources. Chad's landlocked position required an oil pipeline through Cameroon to reach the Cameroon coast. This led to the Chad-Cameroon petroleum development and pipeline project initiated by the consortium in collaboration with the World Bank. The project was launched in 2000. From the launch up until December 2005, the consortium's project spending, in terms of subcontracting and the purchase of goods and services in Chad, amounted to close to US$610 million.

Although construction of the oil fields did begin as early as 2000, the bulk of oil development activities did not begin until 2001 (Garber, 2014a). Accordingly, the 2000 SAM provides a useful snapshot of Chad's pre-oil economy. Furthermore, the data available for 2000 is more complete and consistent than for later years. For these reasons, the 2000 SAM is currently the best available for this analysis. It is likely that the oil sector should show stronger linkages for the more recent years starting from 2003 when production commenced. This can be evaluated as soon as a more recent SAM becomes available. At this stage the current analysis of Chad's 'pre-oil economy' is a useful supplement to the analysis of the mature producers, i.e. Nigeria and Algeria.

5.6.2 Multiplier decomposition analysis for Chad

The first step of the analysis is to conduct a multiplier decomposition of Chad's accounting multipliers. These results are then enhanced by using SPA to expose the network of paths through which a multiplier effect travels through the economy. The most significant backward accounting multipliers for Chad's oil sector are summarised in Table 5.12 below. These multipliers (highlighted column) represent the global influence produced by an exogenous change in demand for the output of Chad's oil sector. Since the 2000 SAM accounts for the 'pre-production' period, there are no forward linkages for the oil sector, i.e. the multipliers are equal to zero. Similar to Algeria and Nigeria, only the most important (representative) backward multipliers are analysed here. However, the Chad SAM only accounts for 11 sectors (including oil). The oil sector has no backward connection (multiplier of 0) to two of these sectors (cotton agriculture and cotton fibre manufacturing). Therefore, the eight multipliers shown in Table 5.12 represent 100% of the oil sector's overall sectoral multiplier.

Table 5.12: Selected accounting multipliers: Chad

	Oil sector (oil field development)	Services	Non-cotton, non-oil formal manufacturing	Non-cotton agriculture	Livestock	Construction and public works	Informal manufacturing
Oil sector (oil field development)t	1	0	0	0	0	0	0
Services	5.17	5.77	4.83	4.84	4.85	4.79	4.99
Non-cotton, non-oil formal manufacturing	1.90	1.80	2.99	1.92	1.89	1.97	1.97
Non-cotton agriculture	1.21	1.24	1.31	2.50	1.42	1.28	1.26
Livestock	0.97	0.93	1.44	1.04	2.00	1.02	1.01
Construction and public works	0.59	0.60	0.64	0.73	0.72	1.74	0.62
Informal manufacturing	0.25	0.04	0.04	0.04	0.04	0.04	1.05
Forestry, fishing, (non-oil) mining	0.17	0.14	0.15	0.17	0.16	0.16	0.31
Public administration	0.02	0.02	0.02	0.02	0.02	0.02	0.02

Source: Author using SimSIP SAM
Note: Figures down the 1st column shows the oil sector's backward linkages, i.e. the oil sector's purchases of inputs. Figures across the 1st row shows the purchases of the oil sector's output by other sectors, i.e. forward linkages.

The oil sector's largest backward multipliers are highlighted in the shaded column of Table 5.12. An exogenous shock, for example an increase in demand for output from Chad's oil sector, will increase the sector's demand for intermediate inputs. Increased output also requires an increase in the use of factors of production, such as labour and capital. Based on the matrix of technical coefficients for the nascent/pre-production oil sector, capital accounts for 9% of total production cost (factor usage), while labour accounts for only 3% (Garber, 2014a). This is in contrast to the mature producers, Nigeria and Algeria, analysed in the previous sections. Nigeria's oil sector is mostly capital intensive, while Algeria's oil sector is relatively less capital intensive and slightly more labour intensive. Notably, Chad's nascent oil sector has relatively larger activity multipliers in comparison to Nigeria and Algeria. However, it can be assumed that the larger and established oil sectors in Nigeria and Algeria will have a larger impact, even though the sector multipliers are smaller, since the multiplicand (injection from the sector) should be larger than Chad's nascent oil sector.

Nonetheless, caution must be used when interpreting the multiplier and SPA results for Chad. The Chad SAM is more aggregated than the Nigeria and Algeria SAMs, which could also contribute to the larger multiplier values. However, these results are based on the latest available SAM for Chad and the results are therefore included for consideration in this chapter.

5.6.3 SPA for Chad

This section presents the expanded results obtained from the SPA of Chad's oil sector. The SPA results expand on the macro-focus of the multiplier decomposition results by focusing on the specific network of paths through which the multiplier effect travels through the economy. The oil sector is used as the fixed origin, from where the impact originates and travels to various destination sectors in the economy. The SPA results illustrate the paths that are followed to reach the final destination sector (pole). The initial SPA analysis, with the oil sector as the fixed origin, was set to illustrate all destination sectors for which the backward multiplier value is at least 0.01 and the maximum number of paths (path length) was set to 10 paths. Selected from these results, the multiplier paths of sectors for which the oil sector's backward multipliers are largest (Table 5.12), are presented here. The results presented here are not exhaustive considering that any specific SAM can have thousands of possible paths. The SPA results are discussed in terms of production activities, factors and institutions.

5.6.3.1 Production activities

The SPA of the oil sector (a_dev) on other production activities, in terms of the largest backward multipliers, is shown in Table 5.13 below. Due to the high level of detail, only the first path for each case is shown. The detailed path analysis for activities is given in Appendix III, Table III.4

Table 5.13: SPA for selected activities: Chad

Case	Origin	Dest.	Global infl.	Path[60]	Direct infl.	Path mult.	Total infl.	Prop. (in %)
I	a_dev	a_serv	5.17	a_dev / c_serv / a_serv	0.438	5.77	2.524	48.8
II	a_dev	a_man	1.90	a_dev / c_man / a_man	0.121	4.20	0.508	26.8
III	a_dev	a_ag	1.21	a_dev / c_serv / a_serv / f_labour / households / c_ag / a_ag	0.022	11.49	0.255	21.1
IV	a_dev	a_live	0.97	a_dev / c_man / a_man / c_live / a_live	0.052	4.48	0.231	23.9
V	a_dev	a_inf	0.59	a_dev / c_serv / a_serv / f_labour / households / c_inf / a_inf	0.013	12.05	0.155	26.4
VI	a_dev	a_con	0.25	a_dev / c_con / a_con	0.213	1.05	0.223	88.4
VII	a_dev	a_fish	0.17	a_dev / c_con / a_con / c_fish / a_fish	0.034	1.28	0.043	25.0
VIII	a_dev	a_gov	0.02	a_dev / c_serv / a_serv / f_labour / households / c_gov / a_gov	0.0004	10.86	0.004	23.0

Source: Author using SimSIP SAM
Note: dest., destination; inst., institutions; infl., influence; mult., multiplier; prop., proportion

To interpret the results, consider the following example: the impact of a hypothetical injection of FCFA1 billion into the oil sector. For example, case I – an injection of FCFA1 billion into the oil sector will create an additional FCFA5170.82 million worth of sales in the services sector. The multiplier of 5.17 is unusually high and may likely be an overestimate. The proportion column shows that approximately 48.81% of this additional production is caused by flowing from the oil sector to services commodities and then to the services sector. Case VI is another example of an elementary path, flowing from the oil sector to the commodity informal manufacturing (c_con) to the informal manufacturing sector (a_con). The particular path explains approximately 88.35% of this additional production. In this case, an injection of FCFA1 billion into the oil sector will create an additional FCFA252.92 million worth of sales in the informal manufacturing sector.

Next consider case VIII – an injection of FCFA1 billion into the oil sector will create an additional FCFA18.3 million worth of services in the public administration sector. In this example, the initial injection will have to travel through various sectors (i.e. follow various paths) before reaching the public administration sector. The proportion column shows that approximately 23% of this additional production is caused indirectly by flowing from the oil sector via the path services commodities, services sector, labour, households, public

[60] See Appendix III, Table III.2 and III.3 for a full discription of SAM account names.

administration commodities and finally the public administration sector. The remaining paths can be seen in Table III.4 of Appendix III.

5.6.3.2 Factors

The influence of a stimulus to the oil sector on production factors can be seen from the SPA results shown in Table 5.14 below, i.e. the exogenous increase in expenditure requires the use of factors. In addition to the overall impact that can be derived from the accounting multipliers, SPA identifies the sectoral sources of increased factor usage (Ngandu, Garcia & Arndt, 2010). Although the nascent oil sector's use of capital and labour is relatively low, the capital and labour multipliers are still significant; this can be attributed to economy-wide effects through other sectors connected to the oil sector rather than direct factor use by the oil sector itself.

The accounting multiplier for capital is 2.41 (column 4, case I), and accordingly a FCFA1 billion expansion of the oil sector will require FCFA 2410 million worth of capital to be used as factor input. From the path results, the path from the oil sector to capital that flows through formal manufacturing (non-cotton, non-oil), livestock, labour, households and services, explains 81.95% of this multiplier. The accounting multiplier for labour[61] is 3.20 (column 4, case II), and accordingly a FCFA 1 billion expansion of the oil sector will require FCFA3200 million worth of labour input. From the path results, the path from the oil sector to labour that flows through informal manufacturing, capital, enterprises and services explains 80.41% of this multiplier. In terms of a relative comparison, Chad's capital and labour multipliers are significantly larger than that of the mature producers, Nigeria and Algeria. As was mentioned, Chad's oil sector impact could be smaller since the multiplicand (injection from the sector) will most likely be smaller than that of the mature producers.

The accounting multiplier for land is 0.41 (column 4, case III), and accordingly a FCFA1 billion expansion of the oil sector will require FCFA410 million worth of land input. The path from the oil sector to labour, households, agriculture (non-cotton) and finally land represents 65.77% of this multiplier. The Algeria SAM does not account for land. For this reason, only capital and labour will be used in the subsequent analysis in Chapter 6.

[61] This only refers to the value of labour that will be required and not to the number of jobs.

Table 5.14: SPA for factors: Chad

Case	Origin	Dest.	Global infl.	Path	Direct infl.	Path mult.	Total infl.	Prop. (in %)	Accum. Prop.
I	a_dev	Capital	2.41	a_dev / c_serv / a_serv / f_capital	0.163	5.87	0.959	39.9	39.9
				a_dev / c_man / c_serv / a_serv / f_capital	0.03	8.62	0.263	10.9	50.8
				a_dev / f_capital	0.087	2.85	0.249	10.3	61.1
				a_dev / c_man / a_man / f_capital	0.015	6.42	0.095	3.9	65.1
				a_dev / c_con / a_con / c_man / c_serv / a_serv / f_capital	0.01	8.71	0.089	3.7	68.8
				a_dev / c_con / a_con / c_serv / a_serv / f_capital	0.015	5.95	0.089	3.7	72.5
				a_dev / c_con / a_con / f_capital	0.029	2.91	0.086	3.6	76.0
				a_dev / c_serv / a_serv / c_man / a_man / f_capital	0.006	8.62	0.053	2.2	78.2
				a_dev / c_con / a_con / c_man / a_man / f_capital	0.005	6.50	0.032	1.3	79.5
				a_dev / c_serv / a_serv / f_labour / households / c_inf / a_inf / f_capital	0.003	12.05	0.032	1.3	80.9
				a_dev / c_man / a_man / c_live / a_live / f_labour / households / c_serv / a_serv / f_capital	0.002	13.67	0.026	1.1	81.9
II	a_dev	Labour	3.20	a_dev / c_serv / a_serv / f_labour	0.102	9.44	0.965	30.1	30.1
				a_dev / c_man / a_man / c_live / a_live / f_labour	0.034	7.45	0.252	7.9	38.0
				a_dev / c_man / c_serv / a_serv / f_labour	0.019	12.15	0.232	7.2	45.2
				a_dev / c_serv / a_serv / c_man / a_man / c_live / a_live / f_labour	0.014	12.23	0.172	5.4	50.6
				a_dev / f_labour	0.033	4.36	0.143	4.5	55.0
				a_dev / c_con / a_con / c_fish / a_fish / f_labour	0.027	4.60	0.126	3.9	59.0
				a_dev / c_con / a_con / f_labour	0.026	4.42	0.115	3.6	62.6
				a_dev / f_capital / h_ent / c_serv / a_serv / f_labour	0.012	9.55	0.114	3.6	66.1
				a_dev / c_serv / a_serv / c_ag / a_ag / f_labour	0.011	10.16	0.113	3.5	69.7
				a_dev / c_con / a_con / c_serv / a_serv / f_labour	0.009	9.53	0.089	2.8	72.4
				a_dev / c_con / a_con / c_man / a_man / c_live / a_live / f_labour	0.011	7.53	0.086	2.7	75.1
				a_dev / c_con / a_con / c_man / c_serv / a_serv / f_labour	0.006	12.26	0.079	2.5	77.6

Table 5.14: Continued

Case	Origin	Dest.	Global infl.	Path	Direct infl.	Path mult.	Total infl.	Prop. (in %)	Accum. Prop.
				a_dev / c_serv / a_serv / f_capital / households / c_ag / a_ag / f_labour	0.005	11.49	0.053	1.6	79.2
				a_dev / c_con / a_con / f_capital / h_ent / c_serv / a_serv / f_labour	0.004	9.64	0.039	1.2	80.4
III	a_dev	Land	0.407291	a_dev / c_man / a_man / c_live / a_live / f_land	0.014	4.66	0.067	16.5	16.5
				a_dev / c_serv / a_serv / c_man / a_man / c_live / a_live / f_land	0.006	9.13	0.055	13.5	30.0
				a_dev / c_serv / a_serv / f_labour / households / c_ag / a_ag / f_land	0.002	11.49	0.026	6.3	36.3
				a_dev / c_serv / a_serv / f_labour / households / c_man / a_man / c_live / a_live / f_land	0.002	13.67	0.023	5.8	42.1
				a_dev / c_con / a_con / c_man / a_man / c_live / a_live / f_land	0.005	4.73	0.023	5.6	47.7
				a_dev / c_serv / a_serv / c_ag / a_ag / f_land	0.002	8.61	0.013	3.2	50.9
				a_dev / c_serv / a_serv / f_labour / households / c_live / a_live / f_land	0.001	11.01	0.009	2.1	53.0
				a_dev / c_serv / a_serv / f_capital / households / c_ag / a_ag / f_land	0.001	11.49	0.007	1.7	54.7
				a_dev / c_man / a_man / c_live / a_live / f_labour / households / c_ag / a_ag / f_land	0.001	9.23	0.007	1.7	56.4
				a_dev / c_serv / a_serv / f_capital / households / c_man / a_man / c_live / a_live / f_land	0	13.67	0.007	1.6	58.0
				a_dev / f_capital / h_ent / c_serv / a_serv / c_man / a_man / c_live / a_live / f_land	0.001	9.20	0.007	1.6	59.6
				a_dev / c_man / c_serv / a_serv / f_labour / households / c_ag / a_ag / f_land	0	14.45	0.006	1.5	61.1
				a_dev / c_con / a_con / c_fish / a_fish / f_land	0.003	1.68	0.005	1.3	62.3
				a_dev / c_con / a_con / c_serv / a_serv / c_man / a_man / c_live / a_live / f_land	0.001	9.23	0.005	1.2	63.5
				a_dev / f_labour / households / c_man / a_man / c_live / a_live / f_land	0.001	8.60	0.005	1.2	64.7
				a_dev / f_labour / households / c_ag / a_ag / f_land	0.001	6.01	0.004	1.1	65.8

Source: Author using SimSIP SAM
Note: Dest., destination; infl., influence; mult., multiplier; prop., proportion; accum., accumulated

5.6.3.3 Institutions

The last portion of the SPA pertains to the distribution of incremental income to institutions (households and enterprises), shown in Table 5.15 below. From case I, the majority (84.08%) of the addition to household income is explained by the path from the oil sector through informal manufacturing, capital, enterprises, services, labour and finally to households. From case II, the majority (77.25%) of the addition to the income received by enterprises is explained by the path from the oil sector through services, labour, households, construction and public works, capital and finally to enterprises.

Table 5.15: SPA for institutions: Chad

Case	Origin	Dest.	Global infl.	Path	Direct infl.	Path mult.	Total infl.	Prop. (in %)	Accum. Prop.
I	a_dev	households	4.21	a_dev / c_serv / a_serv / f_labour / households	0.102	10.86	1.110	26.4	26.4
				a_dev / c_serv / a_serv / f_capital / households	0.028	10.86	0.308	7.3	33.7
				a_dev / c_man / a_man / c_live / a_live / f_labour / households	0.034	8.58	0.290	6.9	40.6
				a_dev / c_man / c_serv / a_serv / f_labour / households	0.019	13.67	0.261	6.2	46.8
				a_dev / c_serv / a_serv / c_man / a_man / c_live / a_live / f_labour / households	0.014	13.67	0.192	4.6	51.3
				a_dev / f_labour / households	0.033	5.47	0.179	4.3	55.6
				a_dev / c_con / a_con / c_fish / a_fish / f_labour / households	0.027	5.73	0.157	3.7	59.3
				a_dev / c_con / a_con / f_labour / households	0.026	5.53	0.144	3.4	62.7
				a_dev / f_capital / h_ent / c_serv / a_serv / f_labour / households	0.012	10.86	0.130	3.1	65.8
				a_dev / c_serv / a_serv / c_ag / a_ag / f_labour / households	0.011	11.49	0.127	3.0	68.9
				a_dev / f_capital / households	0.015	7.96	0.121	2.9	71.7
				a_dev / c_con / a_con / c_serv / a_serv / f_labour / households	0.009	10.96	0.102	2.4	74.2
				a_dev / c_con / a_con / c_man / a_man / c_live / a_live / f_labour / households	0.011	8.67	0.099	2.3	76.5
				a_dev / c_con / a_con / c_man / c_serv / a_serv / f_labour / households	0.006	13.79	0.089	2.1	78.6
				a_dev / c_man / c_serv / a_serv / f_capital / households	0.005	13.67	0.072	1.7	80.3
				a_dev / c_man / a_man / c_live / a_live / f_land / households	0.008	8.60	0.069	1.6	82.0
				a_dev / c_serv / a_serv / c_man / a_man / c_live / a_live / f_land / households	0.003	13.67	0.046	1.1	83.0
				a_dev / c_con / a_con / f_capital / h_ent / c_serv / a_serv / f_labour / households	0.004	10.96	0.044	1.0	84.1

Table 5.15: Continued

Case	Origin	Dest.	Global infl.	Path	Direct infl.	Path mult.	Total infl.	Prop. (in %)	Accum. Prop.
II	a_dev	Enterprises	1.86	a_dev / c_serv / a_serv / f_capital / h_ent	0.114	5.87	0.669	36.0	36.0
				a_dev / c_man / c_serv / a_serv / f_capital / h_ent	0.021	8.62	0.183	9.9	45.8
				a_dev / f_capital / h_ent	0.061	2.98	0.182	9.8	55.6
				a_dev / c_man / a_man / f_capital / h_ent	0.010	6.48	0.067	3.6	59.2
				a_dev / c_con / a_con / f_capital / h_ent	0.020	3.04	0.062	3.4	62.5
				a_dev / c_con / a_con / c_man / c_serv / a_serv / f_capital / h_ent	0.007	8.71	0.062	3.4	65.9
				a_dev / c_con / a_con / c_serv / a_serv / f_capital / h_ent	0.010	5.95	0.062	3.3	69.2
				a_dev / c_man / a_man / c_live / a_live / f_land / h_ent	0.006	6.74	0.043	2.3	71.5
				a_dev / c_serv / a_serv / c_man / a_man / f_capital / h_ent	0.004	8.62	0.037	2.0	73.5
				a_dev / c_serv / a_serv / c_man / a_man / c_live / a_live / f_land / h_ent	0.003	9.13	0.024	1.3	74.8
				a_dev / c_con / a_con / c_man / a_man / f_capital / h_ent	0.003	6.56	0.023	1.2	76.1
				a_dev / c_serv / a_serv / f_labour / households / c_inf / a_inf / f_capital / h_ent	0.002	12.05	0.022	1.2	77.2

Source: Author using SimSIP SAM
Note: Dest., destination; infl., influence; mult., multiplier; prop., proportion; accum., accumulated

5.6.4 Concluding remarks

The SAM for Chad was used as the underlying database to analyse the structural linkages of Chad's oil sector. In terms of the weighted forward and backward linkages, Chad's oil sector has very weak (close to 0) forward linkages (not yet producing) with weak backward linkages, and can therefore be classified as a weak sector in Chad's economy. The 2000 SAM is currently the best available for this analysis. It is likely that the oil sector should show stronger linkages for the more recent years starting from 2003 when production commenced. This can be evaluated as soon as a more recent SAM becomes available. At this stage, the current analysis of Chad's 'pre-oil economy' is a useful supplement to the analysis of the mature producers, i.e. Nigeria and Algeria.

Considering Chad's 'pre-oil' matrix of technical coefficients, in terms of oil sector costs, capital accounts for 9% of total production cost (factor usage), while labour accounts for only 3%. The SPA results shed further light on the paths through which the multiplier effect travels through the economy. The results were presented in terms of production activities, factors and institutions. In terms of production activities, the common nodes of these paths are capital, labour, households as well as services, informal manufacturing, formal manufacturing (non-cotton, non-oil), livestock and the aggregated forestry, fishing and mining (non-oil) sector.

In terms of factors, the path from the oil sector to capital that flows through formal manufacturing (non-cotton, non-oil), livestock, labour, households and services, explains 81.95% of this multiplier. For labour, the path from the oil sector to labour that flows through informal manufacturing, capital, enterprises and services explains 80.41% of this multiplier. For land, the path from the oil sector to labour, households, agriculture (non-cotton) and finally land represents 65.77% of this multiplier.

In terms of household institutions, the majority (84.08%) of the addition to household income is explained by the path from the oil sector through informal manufacturing, capital, enterprises, services, labour and finally to households. In terms of enterprises, the majority (77.25%) of the addition to the income received by enterprises is explained by the path through services, labour, households, construction and public works, capital and finally to enterprises. For additional detail, the SPA results are graphically illustrated in Appendix III, Figure III.1-III.15. Note that the thickness of the lines illustrates the strength of the particular path, i.e. thicker lines are interpreted as stronger multiplier paths.

5.7 Conclusion

This chapter addressed the first part of the petroleum tax question, namely to identify and evaluate the oil sector's country-specific linkages that produce economy-wide impacts. In order to measure and evaluate these linkages, a SAM-based multiplier decomposition and structural path analysis were used. This was done by considering the case of Nigeria, Algeria and Chad. The applicable data (SAM) are not yet available for Angola and for this reason Angola was excluded from the empirical analysis. Nigeria and Algeria represent the case for mature oil producers, while Chad represents a nascent oil producer.

Multiplier analysis is often used to evaluate the potential economy-wide impact of government expenditure programmes or the economic impacts created by a specific sector. The underlying idea is that, because industries are interconnected through forward and backward linkages, an increase in the demand (initial expenditure) for the output of a specific sector (or increased investment in a specific sector) will create additional impacts throughout the economy. Multipliers are essentially based on the difference between an initial effect of an exogenous change and the total effects of that change. Multipliers can measure the impact on gross output, gross value added (GVA), household income or employment. A SAM can be used to derive a set of multipliers for each sector represented in the SAM. This is referred to as the Leontief inverse, the accounting multiplier matrix or the inverse matrix (matrix of multipliers).

SAM multipliers, reflected by the Leontief inverse matrix, can be used to identify an economy's key sectors (multiplier decomposition), based on the sector's potential for demand-led multiplier impacts. Such an analysis can be complemented by SPA. SPA is a method that builds upon SAM analysis and transparently reveals the network of paths through which a multiplier effect travels through the economy, highlighting the mechanism underlying the economy-wide effects captured by multipliers. This adds a level of detail that could not be derived from merely looking at inter-sector transactions or the overall sector multipliers derived from conventional multiplier decompositions

In terms of the linkage based sectoral classification, Nigeria's oil sector was found to be mostly forward orientated (a weak classification) and accordingly weaker (less inter-connected) than Algeria's sector, which has both strong forward and backward linkages (a key sector classification). Chad's 'pre-oil' economy has a weak sector classification based on the lack of forward multipliers tied with weak backward multipliers. However, the main focus of this thesis is backward inter-sector linkages through which an increase in the oil sector's output will create demand for intermediate inputs and create a further stimulus to sectors that are suppliers of the oil sector. The analysis of backward linkages considered the oil sector's impact on other sectors (activities), the factors of production and households.

From the analysis, Nigeria's oil sector is mostly forward orientated and policies should focus on improving the oil sector's backward linkages with the rest of the economy. The greater use of local content for physical inputs as well as labour could improve the oil sector's backward linkages and inter-connectedness with the rest of the economy. Nigeria's largest backward multipliers create demand for intermediate inputs from the following sectors: wholesale and retail trade; cassava; yams; goat and sheep meat; rice; road transport; electricity and water; maize; real estate; vegetables; and financial and business services. Considering Nigeria's matrix of technical coefficients (derived from the SAM), the oil sector is highly capital intensive with capital accounting for 92% of total production cost (factor usage), while labour accounts for only 0.25%. From the SPA results, in terms of factors, the majority of capital flows directly between the oil sector and capital (98.77%). For labour, the most common nodes through which the flows travel are from the oil sector to capital to enterprises to households, households purchase other commodities, which then flow to labour. In terms of household institutions, the majority of the addition to household income (94.65%) flows from the oil sector to capital (fcap) to enterprises (ent) and finally to households.

Algeria's oil sector is more inter-connected with the rest of Algeria's economy (key sector) as opposed to Nigeria's oil sector that is mostly forward orientated. Algeria's largest backward multipliers create demand for intermediate inputs from the following sectors: transport and communications, food processing, agriculture, trade, services and construction for petroleum, water and energy, other private services, public services, hotels and restaurants, the metal sector and textiles. Considering Algeria's matrix of technical coefficients (derived from the SAM), the oil sector is relatively capital intensive with capital accounting for 54% of total production cost (factor usage), while labour accounts for only 2%. However, in comparison with Nigeria's oil sector, Algeria's oil sector is significantly less capital intensive and slightly more labour intensive. From the SPA results, in terms of factors, the majority of capital flows directly between the oil sector and capital (89.86%). For labour, the most common nodes through which the flows travel are from the oil sector to capital to households, households purchase other commodities, which then flow to labour. In terms of household institutions, the majority of the addition to household income (81.88%) flows from the oil sector to capital (Cap) to households (HH).

Considering Chad's 'pre-oil' matrix of technical coefficients, in terms of oil sector costs, capital accounts for 9% of total production cost (factor usage), while labour accounts for only 3%. Notably, Chad's nascent oil sector has relatively larger activity multipliers in comparison to Nigeria and Algeria. In terms of a relative comparison, Chad's capital and labour multipliers are significantly larger than that of the mature producers, Nigeria and Algeria. However, Chad's oil sector impact could be smaller since the multiplicand (injection from the sector) will most likely be smaller than that of the mature producers. In terms of household institutions, the majority (84.08%) of the addition to household income is explained by the path from the oil sector through informal manufacturing, capital, enterprises, services, labour and finally to households. In terms of enterprises, the majority (77.25%) of the addition to the income received by enterprises is explained by the path through services, labour, households, construction and public works, capital and finally to enterprises.

The analysis in this chapter identified the largest oil sector multipliers, as well as the relevant multiplier paths, for Nigeria, Algeria and Chad. In terms of factors of production, the Algerian SAM does not account for land. For this reason, only capital and labour will be used in the subsequent analysis of production factors in Chapter 6. Chapter 5's multiplier results form the foundation measurements that are used as component inputs to develop the Structural Take Indicator in the following chapter.

Chapter 6: Developing a Structural Take Indicator

"I believe the government take statistic suffers from both under-use and over-use. When people are unaware of the weaknesses (and I believe few are intimate with all the weaknesses associated with the 'take' statistics), then over-use is extremely likely." – Daniel Johnston, (2002).

6.1 Introduction

Host governments are tasked with being the custodians of their countries' natural resources. Accordingly, it is host governments that design, evaluate and implement petroleum fiscal systems. Within this context, the fiscal system must secure a fair share of economic rent for the host country, while still being conducive towards attracting upstream investment. From the government policy perspective, government take is one of the main considerations. However, in terms of the 'government' viewpoint, there is no measurement instrument that considers the economy-wide impacts of the upstream oil sector's activities, made possible by upstream investment. Therefore, this additional and important dimension is not part of the process for evaluating petroleum fiscal systems. For this reason, the Structural Take Indicator (**STI**)[62] developed in this chapter answers a critical gap in the literature.

In terms of economy-wide impacts of the upstream sector, the SPA results in Chapter 5 illustrated the oil sector's inter-sector linkages in Nigeria, Algeria and Chad. The results further illustrated the paths through which these economic multipliers travel to reach the destination sectors. The aim of this chapter is to further develop this analysis and derive an STI. The purpose of this STI is to incorporate a measurement of the oil sector's macroeconomic impacts in Nigeria, Algeria and Chad by considering the structure and inter-linkages of these respective economies. The STI can serve as a policy evaluation tool when evaluating a petroleum fiscal system. The STI provides an additional metric to the standard measure of government take. By taking cognisance of the oil sector's broader economic impacts, policy-makers will be able to better evaluate petroleum fiscal systems and in so doing provide a better balance of benefits between the host government and IOC.

As was discussed in Chapter 2, the 'take' statistic is the most commonly used statistic to evaluate the fiscal terms of oil contracts. According to Johnston (2007), the government take

[62] The STI derives its name from incorporating the structure and inter-linkages of a country's economy.

statistic (although commonly used) is plagued by a number of shortcomings. It is often calculated on unrealistic assumptions, fails to adequately account for risk, ignores timing of payments (undiscounted) and leaves out other key elements, specifically the economy-wide impacts of the oil sector. This is also highlighted in Johnston (2003), defined in terms of the macroeconomic scope of government take being too narrow, by not measuring everything that is important to a government, i.e. economy-wide impacts. Although there have been studies that have estimated the economic impacts from the oil sector (see section 5.2.4), none of these studies have attempted to incorporate these results into the evaluation of petroleum fiscal systems. Therefore, this additional and important dimension is not currently part of the process to evaluate petroleum fiscal systems. For this reason, the Structural Take Indicator developed in the following sections fills a research gap and represents a new contribution to the field. The rest of this chapter develops a framework from which the Structural Take Indicator can be constructed and finally applies this framework to Nigeria, Algeria and Chad.

6.2 Components and calculation of the STI

The first step in deriving the STI is to decide on and calculate the individual components of the STI. From the analysis in Chapter 5, the oil sector can influence the host country's economy in terms of three categories: the impact on other sectors (activities) through backward linkages, the use of factors of production (capital and labour) and the impact on households. The SAMs used in Chapter 5 are the latest that are available for the respective countries. As was noted, there is not yet any SAM available for Angola, although there are attempts to develop such a SAM. The SAM-based indices developed in this chapter provide a baseline to incorporate the oil sector's economy-wide impacts as an additional consideration for the evaluation and development of a petroleum fiscal system from the viewpoint of African countries, specifically Nigeria, Algeria and Chad.

Firstly, the oil sector has an influence on the other sectors of the economy. The main concern is to estimate the oil sector's structural impact on the rest of the host economy. This impact can most directly be measured by the oil sector's backward linkages, which embody the oil sector's purchases of outputs from other sectors to enable the production of the oil sector's output. The oil sector's Leontief multipliers can be used as a component of the STI, which incorporates the oil sector's impact on other sectors.

Secondly, the oil sector requires specific inputs of capital and labour (factors) to produce its output. Therefore, a second component to the STI is the capital and labour requirements/impacts of the oil sector. The third STI component is the oil sector's impact on households. For a sensitivity analysis, the STI can be calculated to include capital and labour and compared to an STI that excludes capital. Accordingly, this chapter develops the STI by incorporating the three components of sectors (activities), factors and households. It is important to note that the focus here is on backward linkages, it is the extent of these backward linkages that determines how connected the oil sector is to the rest of a country's economy through purchasing inputs from other sectors, from factors of production and the subsequent impact this holds for households.

The SAM analysis[63] of Chapter 5 highlighted the interconnectedness of the oil sector in the economies of Nigeria, Algeria and Chad (see Figures 5.3, 5.4 & 5.5). Furthermore, these SPA results are graphically illustrated in Appendices I, II and III. At this point, it is important and interesting to note that the three respective oil sectors show distinct differences in terms of inter-sector linkages responsible for economy-wide impacts. Nigeria's oil sector is mostly forward oriented and leans towards a 'weak' sector classification. Algeria's oil sector is on the opposite side, exhibiting strong inter-sector connections in terms of both forward and backward linkages. Accordingly, Algeria's oil sector can be classified as a key sector. It is backward linkages that create the desired economy-wide impacts. Based on the analysis in Chapter 5, Chad's pre-oil economy has an oil sector characterised by very weak forward linkages and weak backward linkages. This provides an example of a young oil sector that can be contrasted with mature producers such as Nigeria and Algeria. From the above, it is important to take note of the structural differences between these three economies. This is illustrated in Table 6.1 below. It is important to note that the structural analysis that follows is based on the latest available data, while the multiplier/SPA analysis is based on the latest available SAMs with base years of 2006 (Nigeria), 2002 (Algeria) and 2000 (Chad).

[63] Note: there is a lack of compressive and reliable data on African countries. SAM-based models are the standard method used to estimate economy-wide impacts. Furthermore, the only alternative method would be the estimation of structural equation models, which are highly data intensive. The data availability issue rules out the use of such methods. For these reasons, the SAM-based model can be said to comply with the principle of Occam's razor.

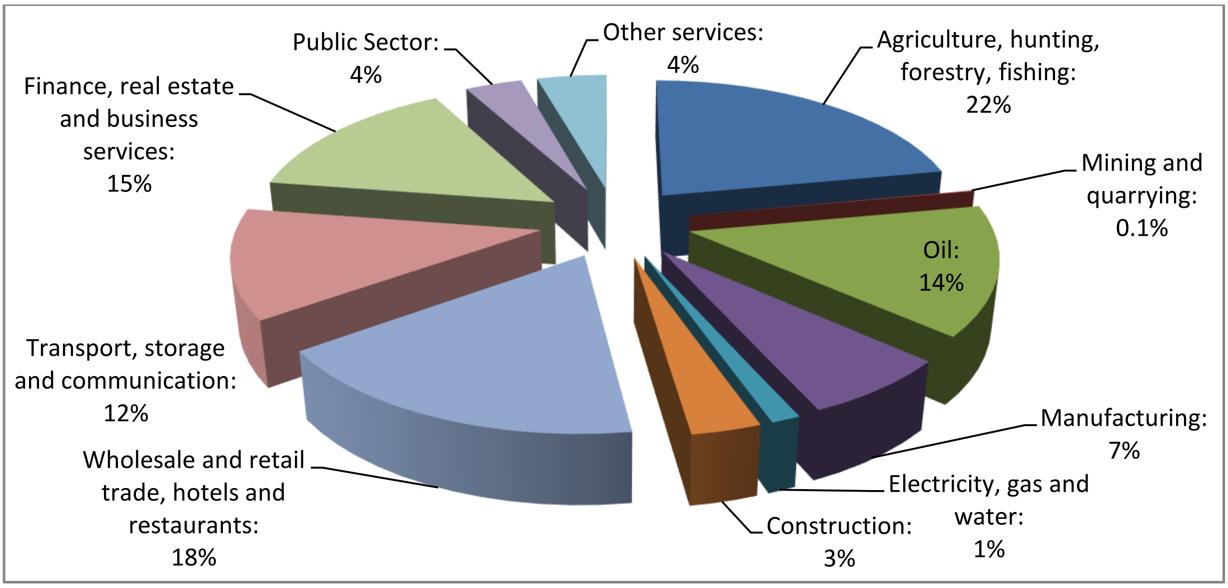
Table 6.1: GDP, oil and government revenue, 2013

Country	GDP ranking (From a total of 192 countries)	GDP ranking within Africa	GDP (millions of US dollars)	Government oil revenue % of GDP (estimates)	Oil sector % of GDP
Nigeria	25th	1st	521 803	11.1%	14.4%
Algeria[64]	49th	4th	210 183	26.0%	35.9%
Chad	123rd	25th	13 514	14.7%	23.9%

Source: Author using data from the World Bank (2014b) and Africa Economic Outlook (2014a)

The above table illustrates a number of important structural differences. Firstly, in terms of mature producers, Nigeria's economy is much larger than Algeria's economy. For example, in terms of the World Bank's 2013 GDP rankings, Nigeria is ranked 25th (US$521 803 million) as opposed to Algeria that is ranked 49th (US$210 183) (World Bank, 2014b). Accordingly, it can be expected that Nigeria's oil sector should have larger sector multipliers. Although oil is an important part of Nigeria's economy, the economy has been more diversified, which is evident from the oil sector accounting for only 14.4% of GDP and 11.1% (estimated) of government revenue in 2013 (Africa Economic Outlook, 2014a). The composition of Nigeria's economy is illustrated using GDP by sector (2013) in Figure 6.1.

Figure 6 1: Nigeria's GDP by sector, 2013 (in % share)

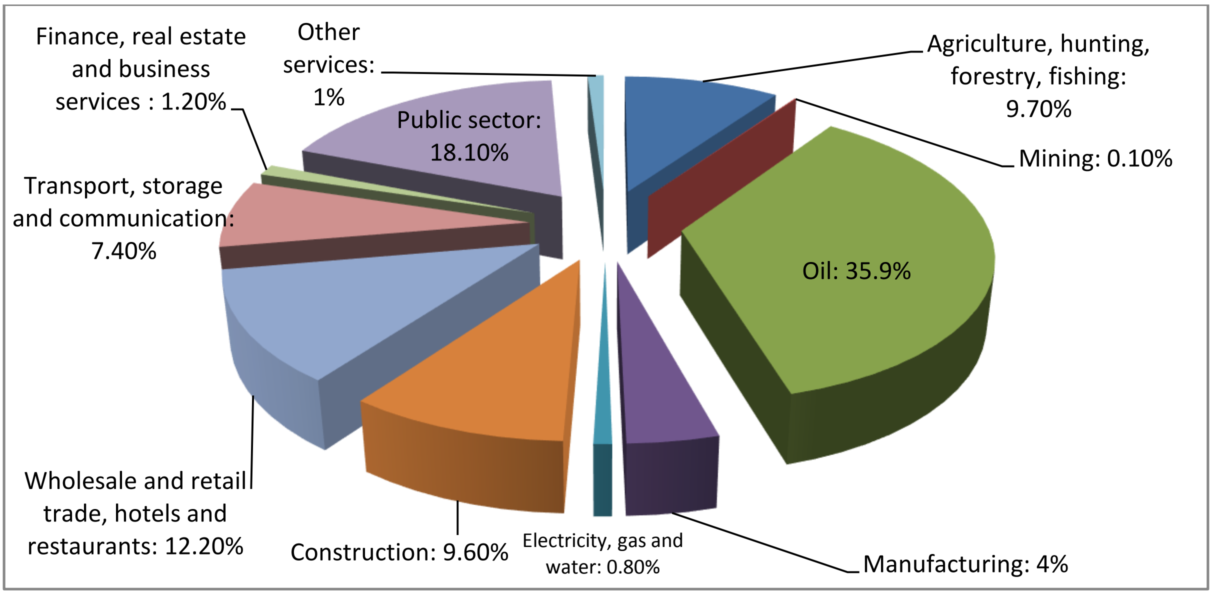


Source: Author using data from the Africa Economic Outlook (2014a)

[64] Algeria's oil as percentage of GDP is for 2012.

Accordingly, it can be expected that Nigeria's oil sector should have larger sector multipliers. Although oil is an important part of Nigeria's economy, the economy has been more diversified, which is evident from the oil sector accounting for only 14.4% of GDP and 11.1% of government revenue in 2013 (Africa Economic Outlook, 2014a). The oil sector is currently the 4th largest sector in Nigeria's economy. In Algeria's smaller and less diversified economy, the oil sector accounted for 35.9% of GDP in 2012 and contributed to 26% (estimated) of government revenue in 2013. The oil sector is by far the largest sector in Algeria's economy. The composition of Algeria's economy is illustrated using GDP by sector (2012) in Figure 6.2.

Figure 6.2: Algeria's GDP by sector, 2012 (in % share)

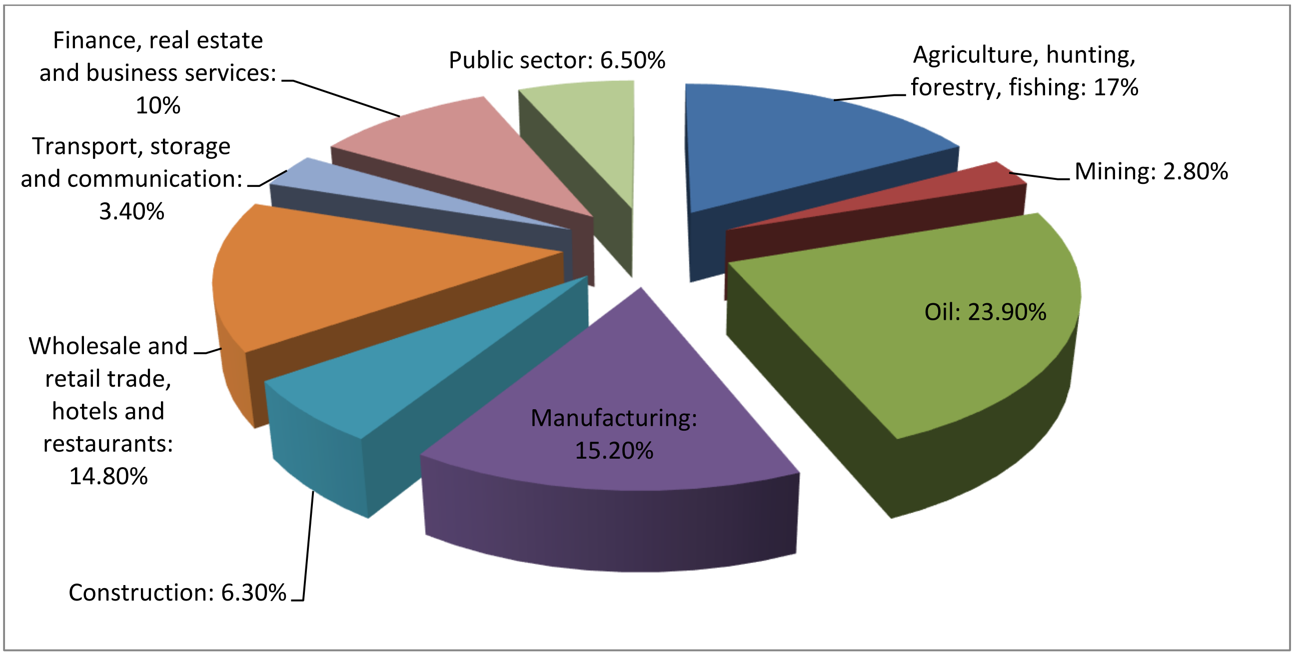


Source: Author using data from the Africa Economic Outlook (2014a)

From this analysis, the oil sector in Nigeria is part of a relatively larger and more diversified economy relative to Algeria. In terms of the multiplier/SPA results, Nigeria's oil sector has a larger multiplier impact than Algeria and this could be attributed to the characteristic of a larger and more diversified economy. However, in terms of linkages, Algeria's oil sector is more connected to the rest of the economy through both forward and backward linkages, while Nigeria's oil sector is mostly forward orientated.

Secondly, in terms of an emerging oil economy, Chad's oil sector has very weak forward linkages with weak backward linkages, and is therefore classified as a weak sector in Chad's economy. However, Chad's economy is significantly smaller than Nigeria and Algeria's economies, being ranked 123rd (US$13 514 million) in terms of 2013 GDP (World Bank, 2014b). The composition of Chad's economy is illustrated using GDP by sector (2013) in Figure 6.3.

Figure 6.3: Chad's GDP by sector, 2013 (in % share)



Source: Author using data from the Africa Economic Outlook (2014a)

From the above, in terms of diversification away from oil, Chad's economy is less diversified than Nigeria, but more diversified than Algeria. Since the development and production of oil resources in 2003, the oil sector has been a significant part of Chad's economy.

While the multiplier analysis in Chapter 5 was based on the 2000 SAM (latest available), oil production only started in 2003. Accordingly, the oil sector's contribution will have grown as the oil sector moved from exploration investment to actual production. For example, in 2005, the oil sector's contribution to government revenue amounted to 4.3% of GDP and increased to an estimated 14.7% for 2013 (Africa Economic Outlook, 2014a). Currently, the oil sector is by far the largest sector in Chad's economy.

The distinction between nascent and mature producers is particularly important when interpreting the STI. The following sections outline the calculation of the individual STI components.

6.2.1 The sector component

The sector component is a measure of the oil sector's economy-wide impacts on the producing sectors of the economy. It is important to note that although the oil sector itself may in some instances have a relatively smaller direct impact, it is the extent to which the sector is connected to other sectors that will produce additional economy-wide macroeconomic impacts. These impacts are easily ignored if the oil sector is judged on 'face value' alone. The multiplier decomposition and SPA results from Chapter 5 are used to calculate the sector component for Nigeria, Algeria and Chad. Deriving this component requires the estimation of economic impact from an expansion of output in the oil sector, which is used as a proxy for oil sector investment. The reasoning is that exploration investment leads to the discovery and development of oil resources. The associated output expansion requires inputs from other sectors (backward linkages), which therefore propagate to the rest of the economy to create economy-wide impacts. To estimate such impacts, hypothetical injections of ₦10 billion (Nigeria), DA10 billion (Algeria) and FCFA10 billion (Chad) into the respective oil sectors are assumed. The sector component incorporates the majority (97-100%) of the oil sector's backward sector multipliers obtained from the matrix of multipliers (Leontief inverse) derived from the SAMs for Nigeria, Algeria and Chad. For ease of exposition, the largest and most important[65] sector multipliers were analysed in Chapter 5 (see Tables 5.4, 5.8 & 5.12). Furthermore, the SPA results further illustrated the extent of these inter-sector connections.

The sector component includes 97% (for Nigeria and Algeria) and 100% (for Chad) of the oil sector's backward sector multipliers. For Nigeria, the largest multipliers (value > 0.01) analysed in Chapter 5 only represent 56% of the total sector multiplier impact. For this reason, Nigeria's sector component includes the additional smaller multipliers, which together represent 97% of the oil sector's backward sector multipliers. The Nigerian SAM is highly disaggregated (61 sectors) and a large portion of the multipliers are relatively small. In contrast, the Algerian SAM is more aggregated (19 sectors) and the majority of the multiplier impacts stem from the backward multipliers (value > 0.004) analysed in Chapter 5. For this reason, these multipliers already represent 97% of the backward sector multipliers. The Chadian SAM only accounts for 11 sectors (including oil). The oil sector has no backward connection (multiplier of 0) to two of these sectors (cotton agriculture and cotton fibre manufacturing). Therefore, the eight multipliers analysed in Chapter 5 represent 100% of the oil sector's overall

[65] Representing 97% of the oil sector's overall sectoral multiplier in Nigeria and Algeria and 100% in Chad.

sectoral multiplier. Based on this majority (97% & 100%) criterion, the sectoral output multiplier (M_{Oil}) for the oil sector can be represented as the sum of the changes in X (gross output) over the change in F (final demand for oil sector output):

$$M_{oil} = \frac{\sum_i \Delta X_i}{\Delta F_j} \quad (6.1)$$

6.2.1.1 Nigeria

Wholesale and retail trade, a number of agricultural sectors and financial, insurance and business services are some of the sectors for which Nigeria's oil sector has the largest backward multipliers. Nigeria's top forty backward sector multipliers for the oil sector (acoil) are shown in Table 6.2. The sector level impact of a hypothetical injection of ₦10 billion (increase in final demand) is shown in the last column.

Table 6.2: Multiplier impact on selected activities: Nigeria

Case	Origin	Destination	Multiplier	Impact of ₦10 billion ΔF In ₦ million
I	acoil	Wholesale and retail trade	0.06	600
II	acoil	Cassava	0.04	400
III	acoil	Yams	0.04	400
IV	acoil	Goat and sheep meat	0.03	300
V	acoil	Rice	0.03	300
VI	acoil	Road transport	0.02	200
VII	acoil	Electricity and water	0.02	200
VIII	acoil	Maize	0.02	200
VIII	acoil	Real estate	0.02	200
X	acoil	Vegetables	0.02	200
XI	acoil	Financial & business services	0.02	200
XII	acoil	Fruits	0.02	200
XIII	acoil	Other manufactured products	0.02	200
XIV	acoil	Sorghum	0.02	200
XV	acoil	Beef	0.01	100
XVI	acoil	Hotel and restaurants	0.01	100
XVII	acoil	Transportation and other equipment	0.01	100
XVIII	acoil	Millet	0.01	100
XVIII	acoil	Beans	0.01	100
XX	acoil	Private non-profit organisations, Other services	0.01	100
XXI	acoil	Fish and fish meat	0.01	100
XXII	acoil	Groundnuts	0.01	100
XXIII	acoil	Soyabeans	0.01	100

Table 6.2: Continued

XXIV	acoil	Refined oil	0.01	100
XXV	acoil	Live goats and sheep	0.01	100
XXVI	acoil	Processed food products (excluding beverages)	0.01	100
XXVII	acoil	Forestry	0.01	100
XXVIII	acoil	Banana and plantain	0.01	100
XXVIII	acoil	Textiles and leather products	0.01	100
XXX	acoil	Poultry meat	0.01	100
XXXI	acoil	Sweet potato	0.01	100
XXXII	acoil	Telecommunications, Post, broadcasting	0.01	100
XXXIII	acoil	Cattle	0.01	100
XXXIV	acoil	Education	0.005	50
XXXV	acoil	Beverages and tobacco products	0.004	40
XXXVI	acoil	Oil palm	0.004	40
XXXVII	acoil	Live poultry	0.003	30
XXXVIII	acoil	Other transportation	0.003	30
XXXIX	acoil	Irish potato	0.003	30
XL	acoil	Cocoyams	0.003	30
Total impact				5950

Source: Author using SimSIP SAM

Wholesale and retail trade has the largest multiplier impact, followed by the agricultural activities for cassava, yams, goat and sheep meat, and rice. The oil sector's sectoral multiplier, consisting of the top sectors (97% of sectoral multiplier), can be shown as:

$$M_{oil} = \frac{5\,950\,000\,000}{10\,000\,000\,000} = 0.595 \quad (6.2)$$

The above sectoral multiplier can serve as an indication of the oil sector's potential economic impact in terms of the top backward linkages that represent 97% of the oil sector's overall sectoral multiplier, i.e. the sector component.

6.2.1.2 Algeria

Algeria's oil sector (aHydrocarbons) is most interconnected with transport and communications, food processing, agriculture, trade, services and construction for petroleum, water and energy, and finally other private services are the sectors. The top eleven multipliers represent 97% of the oil sector's backward sector multipliers and are shown in Table 6.3. The sector level impact of a hypothetical injection of DA10 billion (increase in final demand) is shown in the last column.

Table 6.3: Multiplier impact on selected activities: Algeria

Case	Origin	Destination	Multiplier	Impact of a ₦10 billion ΔF In DA Million
I	aHydrocarbons	Transport and communications	0.115	1151.88
II	aHydrocarbons	Food processing	0.089	888.53
III	aHydrocarbons	Agriculture	0.085	850
IV	aHydrocarbons	Trade	0.083	828.92
V	aHydrocarbons	Services and construction for petroleum	0.015	154
VI	aHydrocarbons	Water and energy	0.015	147
VII	aHydrocarbons	Other private services	0.014	140.57
VIII	aHydrocarbons	Public services	0.012	116.8
IX	aHydrocarbons	Hotels and restaurants	0.009	91.66
X	aHydrocarbons	Metal sector	0.007	65.42
XI	aHydrocarbons	Textiles	0.006	63.08
Total Impact				4497.86

Source: Author using SimSIP SAM

Transport and communications, food processing, agriculture, trade as well as services and construction for petroleum have the largest multiplier impacts. The oil sector's sectoral multiplier, consisting of the top sectors (97% of sectoral multiplier), can be shown as:

$$M_{oil} = \frac{4497\ 860\ 000}{10\ 000\ 000\ 000} = 0.450 \qquad (6.3)$$

The above sectoral multiplier can serve as an indication of the oil sector's potential economic impact in terms of the top backward linkages that represent 97% of the oil sector's overall sectoral multiplier, i.e. the sector component.

6.2.1.3 Chad

Services, non-cotton formal (non-oil) manufacturing, non-cotton agriculture, livestock as well as construction and public works are some of the sectors for which Chad's oil sector has the largest backward multipliers. Chad's backward sector multipliers for the oil sector (a_dev) are shown in Table 6.4. The sector level impact of a hypothetical injection of FCFA10 billion (increase in final demand) is shown in the last column.

Table 6.4: Multiplier impact on selected activities: Chad

				Impact of a ₦10 billion ΔF
Case	**Origin**	**Destination**	**Multiplier**	**In FCFA Million**
I	a_dev	**Services**	5.17	51708.2
II	a_dev	**Non-cotton, non-oil formal manufacturing**	1.90	18998.98
III	a_dev	**Non-cotton agriculture**	1.21	12096.1
IV	a_dev	**Livestock**	0.97	9666.18
V	a_dev	**Construction and public works**	0.59	5866.58
VI	a_dev	**Informal manufacturing**	0.25	2529.24
VII	a_dev	**Forestry, fishing, (non-oil) mining**	0.17	1729.42
VIII	a_dev	**Public administration**	0.02	183.03
Total impact				102777.73

Source: Author using SimSIP SAM

The oil sector's sectoral multiplier can be shown as:

$$M_{oil} = \frac{102777730000}{10\ 000\ 000\ 000} = 10.28 \qquad (6.4)$$

However, the Chad SAM multipliers are very large, especially for services, non-cotton (non-oil) manufacturing and non-cotton agriculture. Upon closer inspection, these sectors on their own also hold relatively large multipliers, for example the sectoral multiplier for the services sector (excluding service's link to itself) is 4.76, the sectoral multiplier for non-cotton (non-oil) manufacturing (excluding the link to itself) is 8.43 and for non-cotton agriculture (excluding the link to itself) is 8.77.

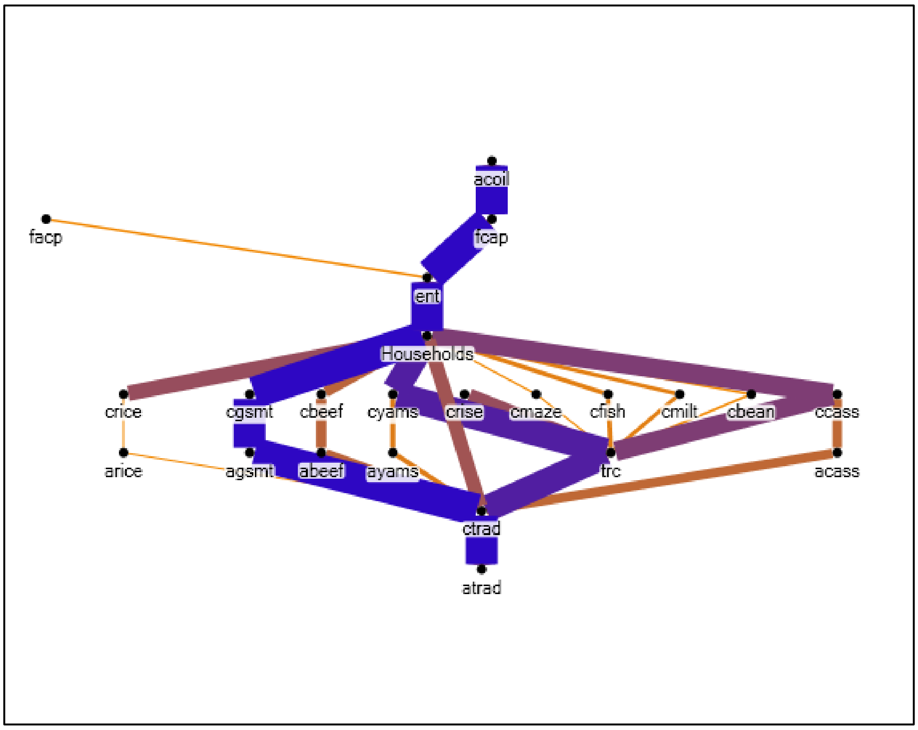
The above sectoral multiplier can serve as an indication of the oil sector's potential economic impact in terms of the backward linkages that represent 100% of the oil sector's overall sectoral multiplier, i.e. the sector component.

6.2.1.4 Relative multipliers

This section considers the respective (largest) relative sector multipliers, firstly between Nigeria and Algeria and then in comparison to Chad's multipliers. As was noted, Algeria's oil sector is more connected to the rest of the economy than is Nigeria's oil sector. This can also be seen when comparing the relative size of the largest backward multipliers. Nigeria's largest backward multiplier for the oil sector is 0.06 (wholesale and retail trade) compared to 0.115

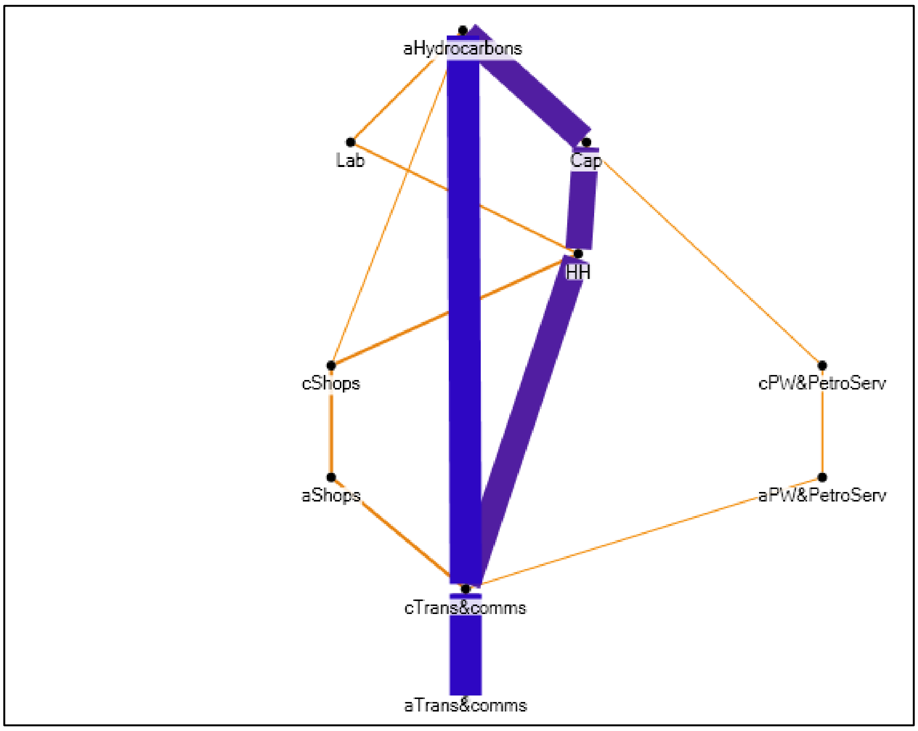
(transport and communication) for Algeria. Algeria's first four multipliers are larger than those for Nigeria, but from the 5th multiplier Nigeria's multipliers are marginally larger than Algeria's multipliers (see Tables 6.2 and 6.3). Therefore, it seems the majority (80%) of Algeria's economy-wide (sector) impacts stem from four sectors, i.e. transport and communications, food processing, agriculture and finally trade. However, it is particularly interesting to compare the number and strength of the paths that are followed from the oil sector to the final destination sector. This is graphically illustrated in Figures 6.4 to 6.15 below. Note that the thickness of the lines illustrates the strength of the particular path, i.e. thicker lines are interpreted as stronger multiplier paths. Nigeria's oil sector is labelled 'acoil' and Algeria's oil sector as 'aHydrocarbons'.

Figure 6.4: Wholesale and retail trade multiplier (Case I, atrad): Nigeria



Note: Figure created using the weighted graph scheme of NodeXL. Paths depicted explain 49% of the accounting multiplier.

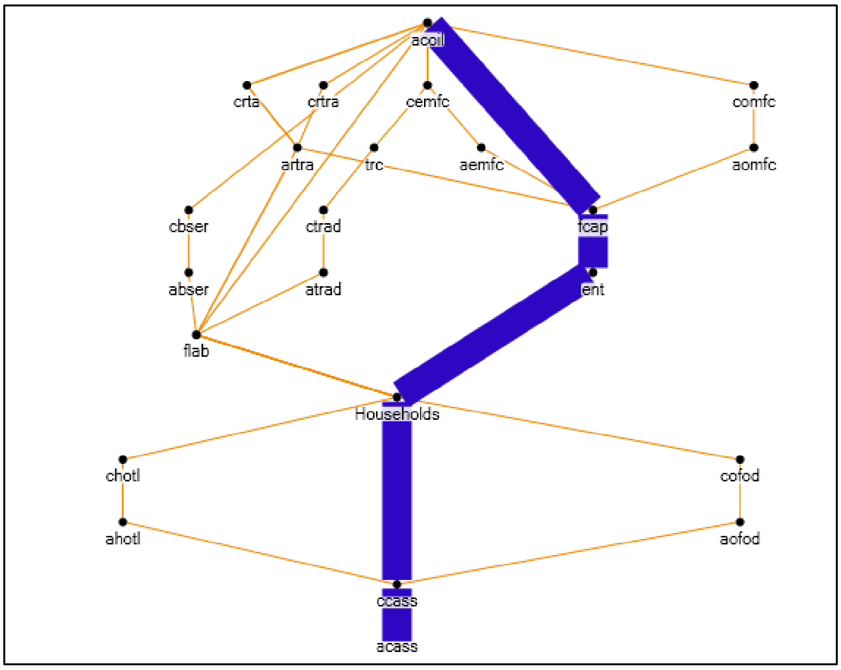
Figure 6.5: Transport and communications multiplier (Case I, aTrans&comms): Algeria



Note: Figure created using the weighted graph scheme of NodeXL. Paths depicted explain 93% of the accounting multiplier.

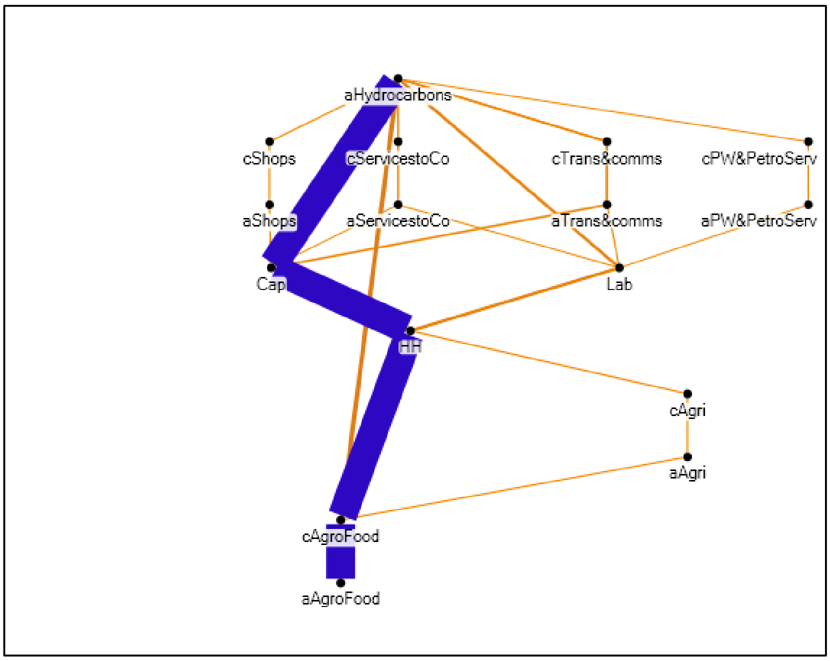
From Figures 6.4 and 6.5, it appears that the Nigerian Case I multiplier follows a larger (and stronger) number of paths, while the Algerian Case I multiplier follows mainly two strong paths and three weaker paths. Figures 6.6 and 6.7 illustrate the multipliers for Case II.

Figure 6.6: Cassava multiplier (Case II, acass): Nigeria



Note: Figure created using the weighted graph scheme of NodeXL. Paths depicted explain 98% of the accounting multiplier.

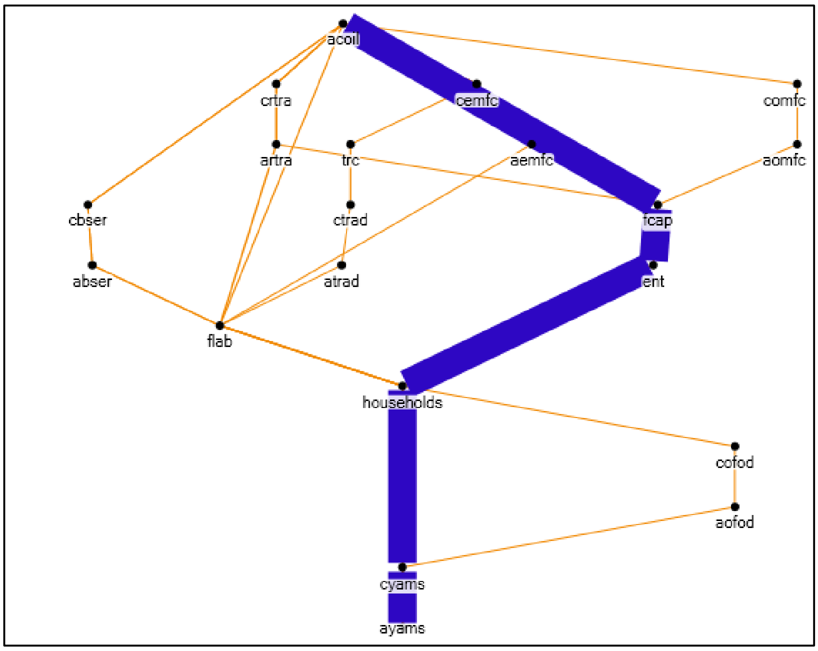
Figure 6.7: Food processing (Case II, aAgroFood): Algeria



Note: Figure created using the weighted graph scheme of NodeXL. Paths depicted explain 95% of the accounting multiplier.

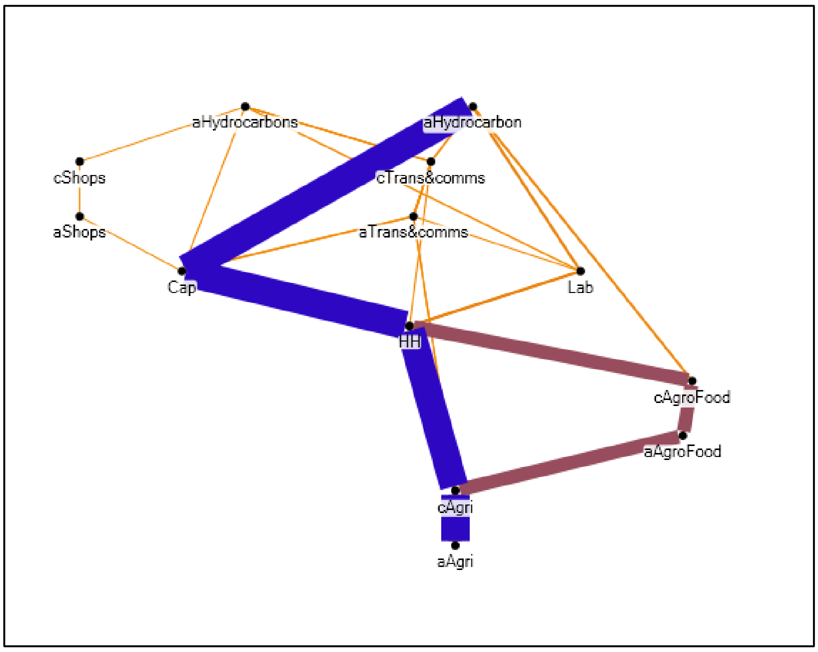
Case II for Nigeria and Algeria seem very similar, but with Algeria's multiplier of 0.089 exceeding Nigeria's multiplier of 0.043. Figures 6.8 and 6.9 illustrate the multipliers for Case III.

Figure 6.8: Yams multiplier (Case III, ayams): Nigeria



Note: Figure created using the weighted graph scheme of NodeXL. Paths depicted explain 99% of the accounting multiplier.

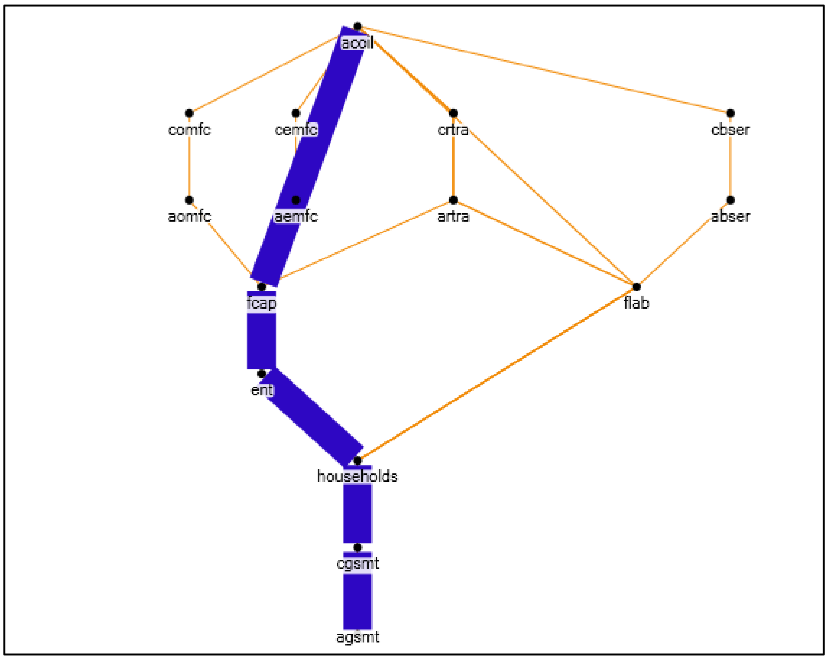
Figure 6.9: Agriculture multiplier (Case III, aAgri): Algeria



Note: Figure created using the weighted graph scheme of NodeXL. Paths depicted explain 90% of the accounting multiplier.

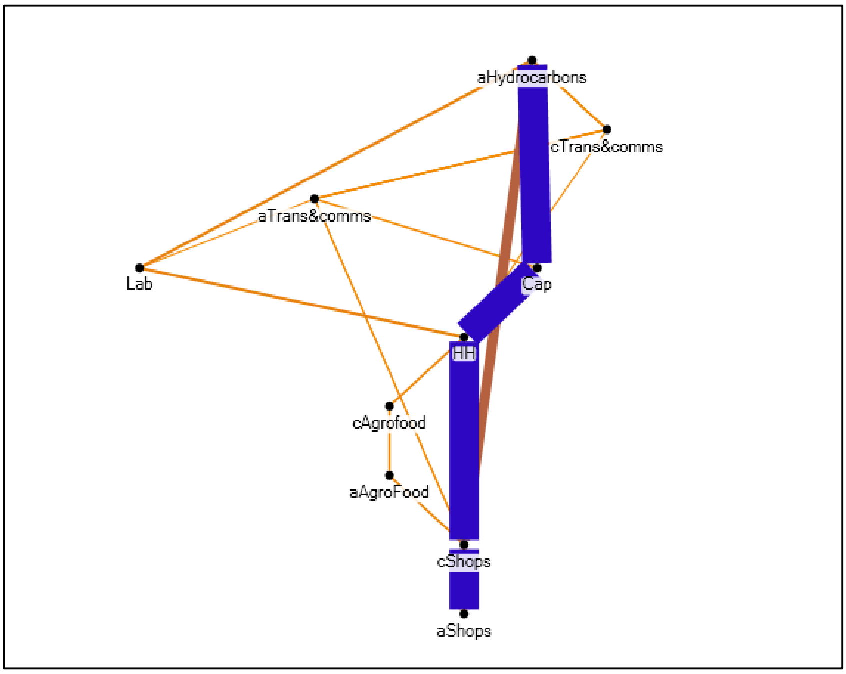
From Case III, Algeria's multiplier follows a few more paths, which also have stronger connections (seen by the thickness of the lines). Figures 6.10 and 6.11 illustrate the multipliers for Case IV.

Figure 6.10: Goat and sheep meat multiplier (Case IV, agsmt): Nigeria



Note: Figure created using the weighted graph scheme of NodeXL. Paths depicted explain 98% of the accounting multiplier.

Figure 6.11: Trade multiplier (Case IV, aShops): Algeria

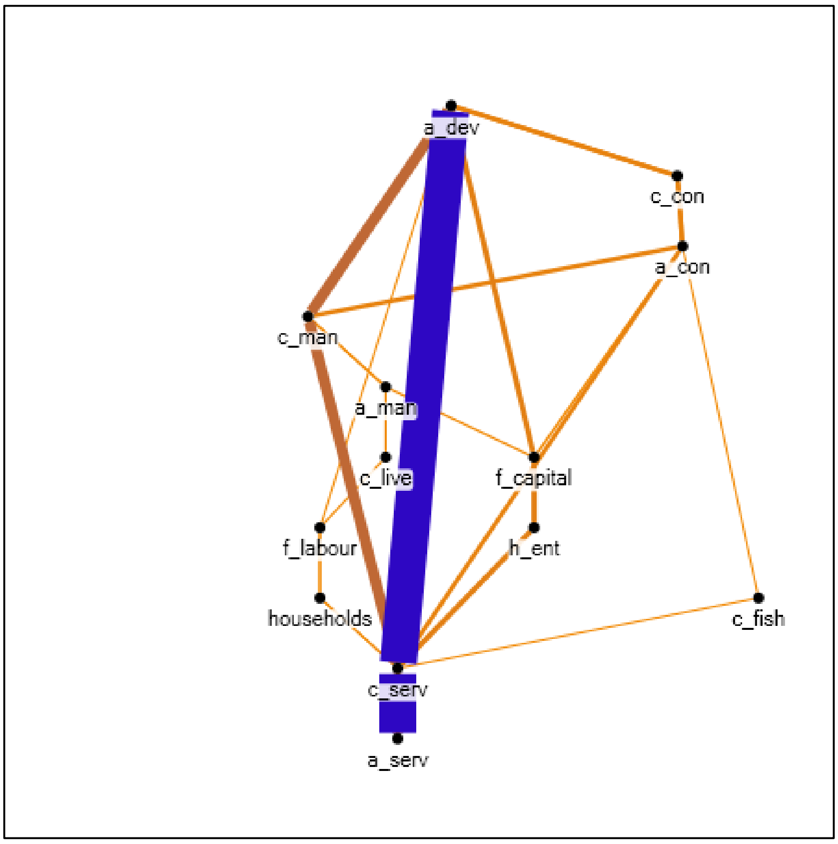


Note: Figure created using the weighted graph scheme of NodeXL. Paths depicted explain 90% of the accounting multiplier.

From Case IV, Algeria's multiplier follows a few more paths, which also have stronger connections (seen by the thickness of the lines). The next section considers the oil sector's linkage to and usage of the factors of production (capital and labour) as well as the linkage to households. Nigeria and Algeria are both mature producers; the comparison now turns to Chad, the emerging oil producer.

While Chad's oil sector exhibits (Figure 5.5) very weak forward linkages with weak backward linkages, the individual multipliers are very high and result in a particularly high STI score. In general, the multipliers from the Chadian SAM are relatively larger than for Nigeria and Algeria (compare Tables 5.4, 5.8 and 5.12). However, Nigeria and Algeria's economies (and oil sectors) are much larger than that of Chad. Therefore, it can be assumed that the larger and established oil sectors in Nigeria and Algeria will have a larger impact, even though the sector multipliers are smaller, since the multiplicand (injection from the sector) should be larger than that in Chad's nascent oil sector. For this reason, caution must be used when interpreting the STI results for Chad. The Chadian SAM is more aggregated than the Nigerian and Algerian SAMs, which could also contribute to the larger multiplier values. Bearing this in mind, Chad's four largest sector multipliers are graphically illustrated in Figures 6.12 to 6.15. Chad's oil sector is labelled a_dev (oil field development).

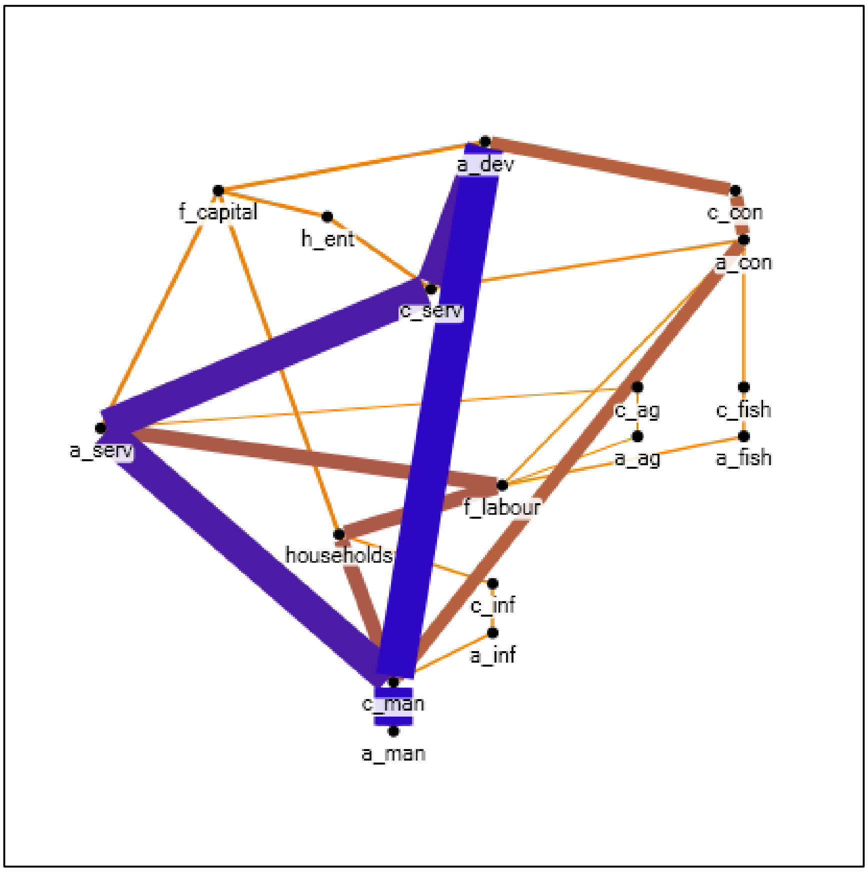
Figure 6.12: Services multiplier (Case I, a_serv): Chad



Note: Figure created using the weighted graph scheme of NodeXL. Paths depicted explain 84% of the accounting multiplier.

Chad's Case I multiplier follows two main paths, the strongest (thickest line) flows from the oil sector (a_dev) to the commodity services (c_serv) and then to the services sector (a_serv) itself. The second strongest path flows from the oil sector (a_dev) to the commodity manufacturing (non-cotton, non-oil) (c-man) to the commodity services (c_serv) and finally to the services sector (c-serv) itself. Nigeria's Case I multiplier follows a variety of strong paths, while Algeria and Chad's Case I multiplier follows through two strong paths and then a large number of weaker (thin lines) paths. Figure 6.13 illustrates the multiplier for Case II.

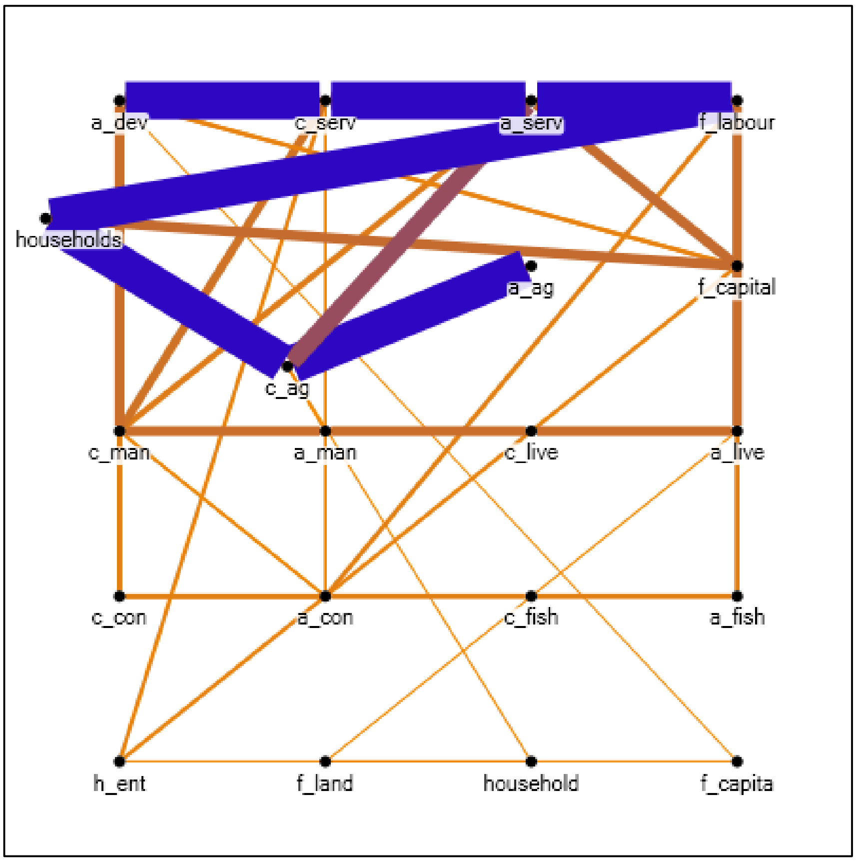
Figure 6.13: Manufacturing (Case II, a_man): Chad



Note: Figure created using the weighted graph scheme of NodeXL. Paths depicted explain 87% of the accounting multiplier.

Chad's Case II multiplier, formal manufacturing (non-cotton, non-oil), is very high at 1.9. There are two main (thick) paths, two slightly weaker (medium thick lines) paths and a range of weaker (thin) paths. Nigeria and Algeria's Case II multipliers follow a single strong (thick) path followed by a number of weaker (thin) paths. Figure 6.14 illustrates Chad's multiplier for Case III.

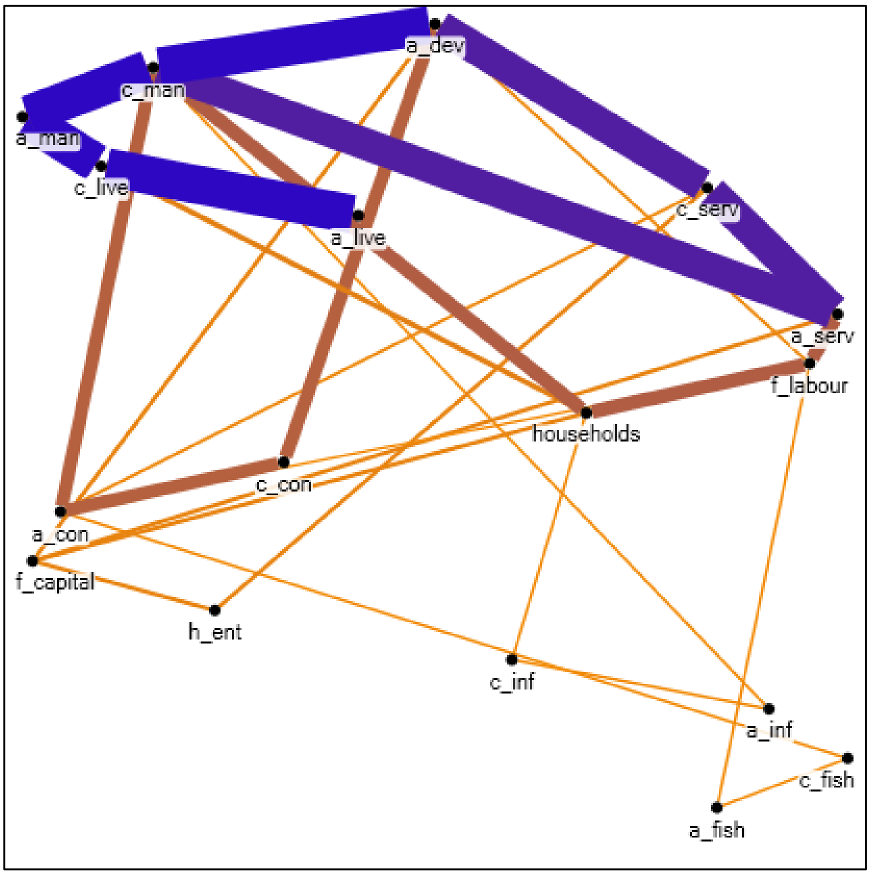
Figure 6:14: Non-cotton agriculture (Case III, a_ag): Chad



Note: Figure created using the weighted graph scheme of NodeXL. Paths depicted explain 80% of the accounting multiplier.

Chad's Case III multiplier, non-cotton agriculture (a_ag), follows a number of strong paths. The strongest path flows from the oil sector (a_dev) to services to labour to households and finally to agriculture. Chad's Case III multiplier follows a more diverse and stronger set of paths than that of Nigeria and Algeria's Case III multiplier. Figure 6.15 illustrates Chad's multiplier for Case IV.

Figure 6.15: Livestock (Case IV, a_live): Chad



Note: Figure created using the weighted graph scheme of NodeXL. Paths depicted explain 79% of the accounting multiplier.

Chad's Case IV multiplier, livestock, follows an intricate network of strong and weaker paths. This network is much more elaborate than that followed by Nigeria and Algeria's Case IV multiplier.

6.2.2 The factor and household components

Capital and labour are two of the main factor inputs for production. The oil sector is generally more capital intensive. The argument is often made that the oil sector does not employ many workers directly or, especially in Africa, makes use of highly skilled foreign workers instead of the local population whom often does not possess the required technical skills. However, local content policy and IOC investments in developing such skills in the host country are making a difference. However, what is often missed is that the more important factor impact stems from the employment, which the oil sector indirectly supports through the backward linkages it has to other sectors in the domestic economy. Furthermore, capital and labour are connected to households through their ownership of these factors. For Nigeria and Algeria, from the SPA analysis in Chapter 5, most of the flows go to households as the owners of capital rather than labour. It is only once households then spend their earnings from capital on other commodities that these sectors need to employ additional labour. In the case of Chad, the oil sector is more labour intensive. Accordingly, from the SPA analysis in Chapter 5, most of the flows go to labour and then households as opposed to flowing directly from capital to households as owners of capital.

To consider the impact on capital, labour and households, the capital and labour multipliers are used as measures for the factor component of the STI, while the household multiplier is the basis for the household component of the STI.

6.2.2.1 Nigeria

Considering Nigeria's matrix of technical coefficients (derived from the SAM), the oil sector is highly capital intensive with capital accounting[66] for 92% of total production cost (factor usage), while labour accounts for only 0.25%. The accounting multiplier[67] for capital is 0.98; and accordingly a ₦10 billion expansion of the oil sector will require ₦9800 million worth of capital to be used as factor input. From the path results, 98.77% come directly from the oil sector itself, while the rest flows through other sectors. The accounting multiplier for labour is 0.30; accordingly, a ₦10 billion expansion of the oil sector will require ₦3000 million worth of labour input. This is in line with the importance of capital and more subdued need for labour that was noted from the SAM. In contrast to capital, the impact from the oil sector on labour follows a greater number of indirect paths before reaching labour. The most common nodes through which the flows travel are from the oil sector to capital to enterprises to households, households purchase other commodities, which then flow to labour. Using equation 6.1, the 'combined' factor multiplier (0.98 for capital and 0.3 for labour) can be shown as:

$$M_{oil} = \frac{12800000000}{10\ 000\ 000\ 000} = 1.28 \qquad (6.5)$$

[66] These proportions were calculated from the SAM as the ratio of inputs to outputs (technical coefficients) and introduced in Chapter 5 on p117.

[67] As was shown in Chapter 5, Table 5.6 illustrates the accounting multiplier and SPA for both capital and labour. The Nigerian SAM included an account for land, but these results are not incorporated here since the Algerian SAM does not account for land.

In terms of the oil sector's impact on households, the household multiplier is 0.69 (case I in Table 5.7) and a ₦10 billion expansion of the oil sector would translate into a ₦6900 million impact for households. Accordingly, the multiplier component for the factors multiplier is 1.28 and 0.69 for households.

6.2.2.2 Algeria

Considering Algeria's matrix of technical coefficients (derived from the SAM)[68], the oil sector is highly capital intensive with capital accounting for 54.03% of total production cost (factor usage), while labour accounts for only 1.87%. Relative to Nigeria's oil sector, it appears that Algeria's oil sector is less capital intensive and slightly more labour intensive. This could be explained by the greater extent of backward multipliers present in Algeria's oil sector.

The accounting multiplier[69] for capital is 0.90, and accordingly a DA10 billion expansion of the oil sector will require DA 9000 million worth of capital to be used as factor input. From the path results, 89.86% comes directly from the oil sector itself, while the rest flows through other sectors. The accounting multiplier for labour is 0.07; accordingly, a DA10 billion expansion of the oil sector will require ₦700 million worth of labour input. This is in line with the relative importance of capital and labour that was noted from the SAM. Using equation 6.1, the 'combined' factor multiplier (0.90 for capital and 0.07 for labour) can be shown as:

$$M_{oil} = \frac{9700000000}{10\,000\,000\,000} = 0.97 \qquad (6.6)$$

In terms of the oil sector's impact on households, the household multiplier is 0.53 (case I in Table 5.10) and a ₦10 billion expansion of the oil sector would translate into a ₦5298 million impact for households. Accordingly, the multiplier component for the factor multiplier is 0.97 and 0.53 for households.

6.2.2.3 Chad

Considering Chad's matrix of technical coefficients (derived from the SAM)[70], capital accounts for 9% of total production cost (factor usage), while labour accounts for only 3% (Garber, 2014a). However, these input requirements are based on the nascent (pre-oil production)

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[68] These proportions were calculated from the SAM as the ratio of inputs to outputs (technical coefficients) and introduced in Chapter 5 on p117.
[69] As was shown in Chapter 5, Table 5.10 illustrates the accounting multiplier and SPA for both capital and labour.
[70] These proportions were calculated from the SAM as the ratio of inputs to outputs (technical coefficients) and introduced in Chapter 5 on p117.

economy captured in the 2000 SAM. This is in contrast to the mature producers, Nigeria and Algeria, which are much more capital intensive.

The accounting multiplier for capital[71] is 2.41, and accordingly a FCFA10 billion expansion of the oil sector will require FCFA 24064.42 million worth of capital to be used as factor input. From the path results, the direct path from the oil sector to capital can explain 61.12% of this multiplier, while the rest flows through other sectors. The accounting multiplier for labour is 3.20; accordingly, a FCFA10 billion expansion of the oil sector will require FCFA32039.93 million worth of labour input. Using equation 6.1, the 'combined' factor multiplier (2.41 for capital and 3.20 for labour) can be shown as:

$$M_{oil} = \frac{56104350000}{10\ 000\ 000\ 000} = 5.61 \qquad (6.7)$$

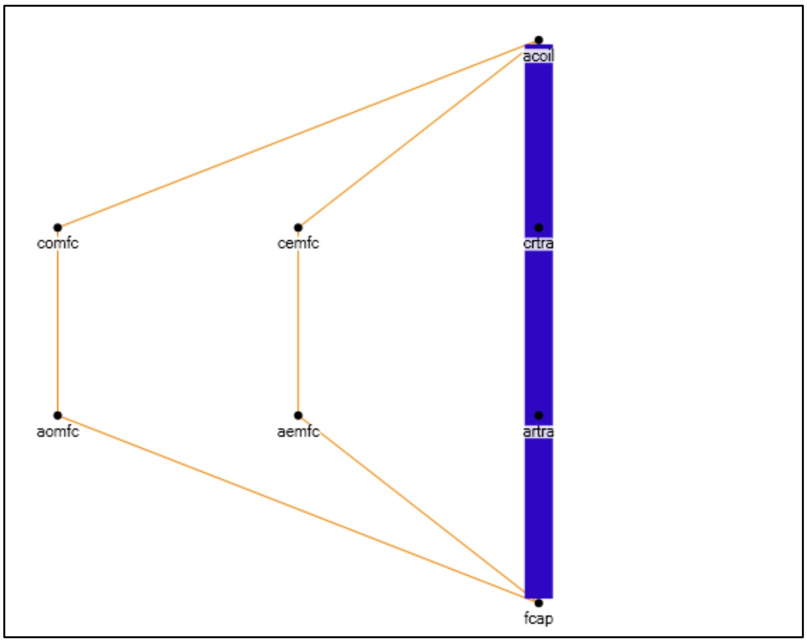
In terms of the oil sector's impact on households, the household multiplier is 4.21 (case I in Table 5.15) and a FCFA10 billion expansion of the oil sector would translate into a FCFA 42095.97 million impact for households. Accordingly, the multiplier component for the factors multiplier is 5.61 and 4.21 for households.

[71] As was shown in Chapter 5, Table 5.14 illustrates the accounting multiplier and SPA for both capital and labour. The Chadian SAM included an account for land, but these results are not incorporated here since the Algerian SAM does not account for land.

6.2.2.4 Relative multipliers

This section considers the respective relative factor and household multipliers, firstly between Nigeria and Algeria and then in comparison to Chad's multipliers. In terms of a relative comparison, Algeria's labour and capital multipliers are smaller than that of Nigeria. In contrast to capital, labour follows a greater number of indirect paths for both Nigeria and Algeria. In terms of households, Nigeria's multiplier flows through one additional node, enterprises, before reaching households, as opposed to Algeria's flow that is more direct from the oil sector to capital to households. Nigeria and Algeria's multiplier paths for capital are compared in Figures 6.16 and 6.17.

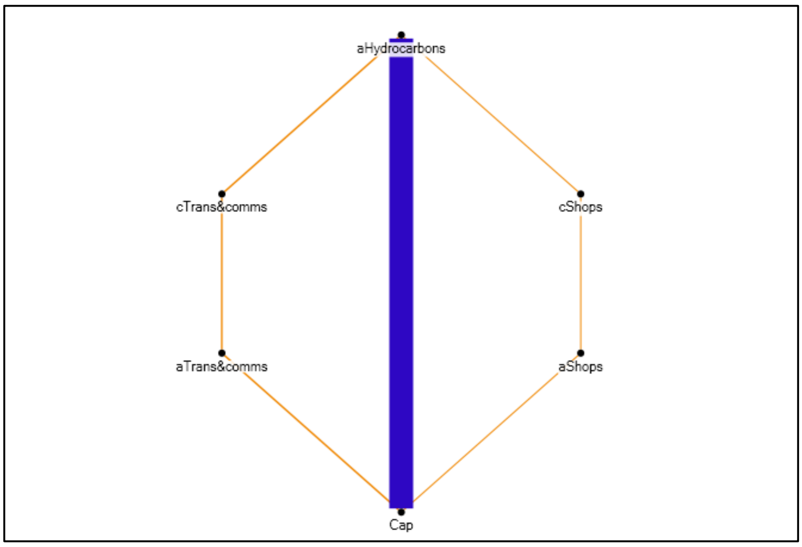
Figure 6.16: Capital multiplier: Nigeria



Note: Figure created using the weighted graph scheme of NodeXL. Paths depicted explain 100% of the accounting multiplier.

In terms of Nigeria's capital multiplier, the majority of the impact flows directly from the oil sector (acoil) to road transport (crtra / artra) to capital (fcap). The rest of the impact flows through manufactured products (comfc / aomfc) as well as transportation and other equipment (cemfc / aemfc).

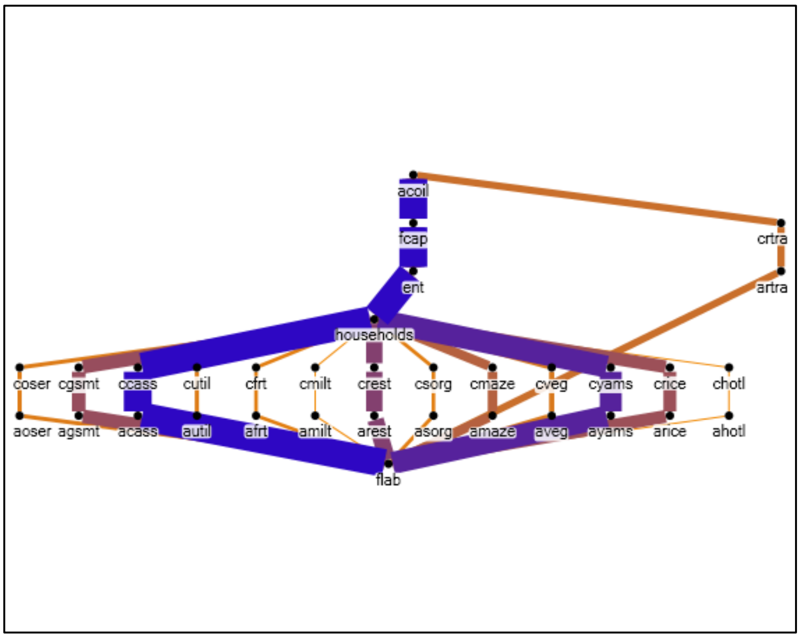
Figure 6.17: Capital multiplier: Algeria



Note: Figure created using the weighted graph scheme of NodeXL. Paths depicted explain 95% of the accounting multiplier.

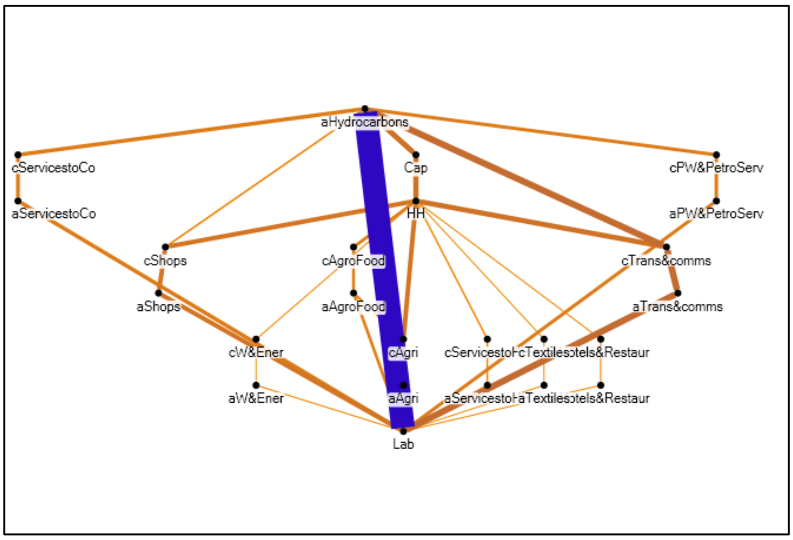
In terms of Algeria's capital multiplier, there is a more direct flow from the oil sector (aHydrocarbons) to capital (cap) and a few indirect flows via transport and communications (cTrans&comms / aTrans&comms), and trade (cShops / aShops). Nigeria and Algeria's multiplier paths for labour are compared in Figures 6.18 and 6.19.

Figure 6.18: Labour multiplier: Nigeria



Note: Figure created using the weighted graph scheme of NodeXL. Paths depicted explain 53% of the accounting multiplier.

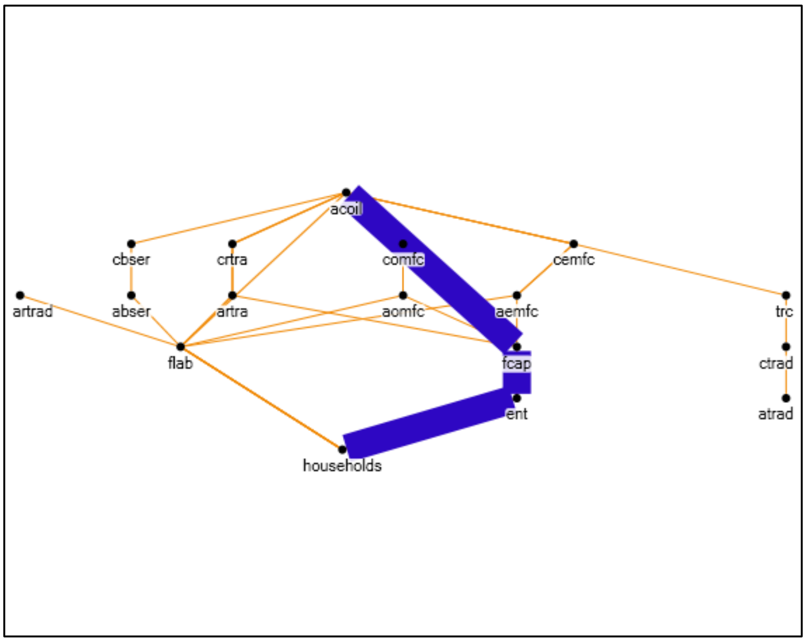
Figure 6.19: Labour multiplier: Algeria



Note: Figure created using the weighted graph scheme of NodeXL. Paths depicted explain 85% of the accounting multiplier.

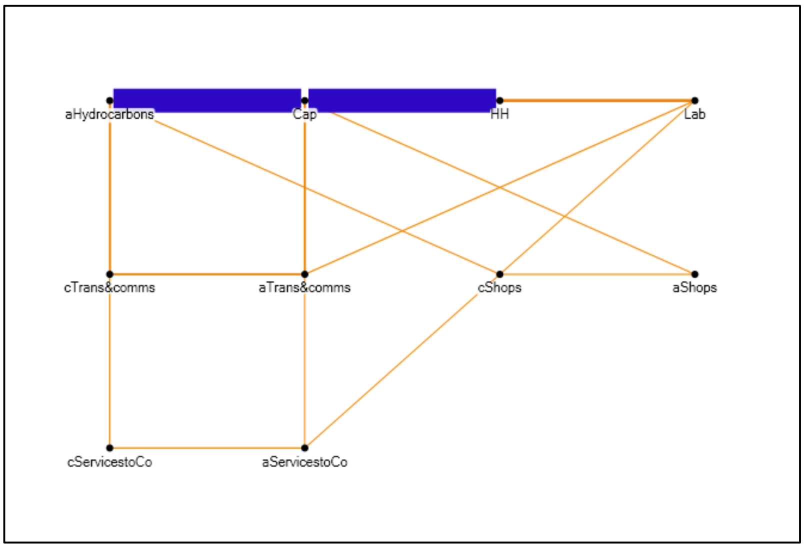
Both Nigeria and Algeria's labour multipliers follow extended paths; however, Nigeria's relatively larger labour multiplier is also evident from the more intricate and stronger (thicker) paths. Nigeria and Algeria's multiplier paths for households are compared in Figures 6.20 and 6.21.

Figure 6.20: Household multiplier: Nigeria



Note: Figure created using the weighted graph scheme of NodeXL. Paths depicted explain 99% of the accounting multiplier.

Figure 6.21: Household multiplier: Algeria

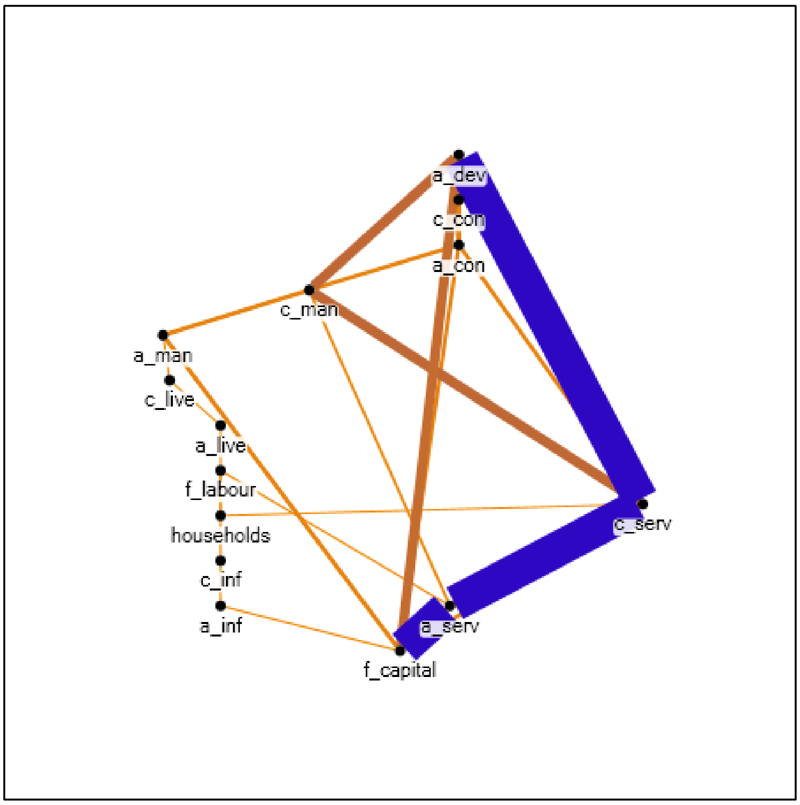


Note: Figure created using the weighted graph scheme of NodeXL. Paths depicted explain 95% of the accounting multiplier.

Nigeria's household multiplier (0.69) flows from the oil sector (acoil) to capital (fcap) to enterprises (ent) and finally to households. Algeria's household multiplier (0.53) flows through one less node, from the oil sector (aHydrocarbons) to capital (cap) and finally to households (HH).

As was noted, the multipliers from the Chadian SAM are relatively larger and caution should be taken when interpreting these multipliers. In the case of Chad, the oil sector is more labour intensive. Accordingly, from the SPA analysis in Chapter 5, most of the flows go to labour and then households as opposed to flowing directly from capital to households as owners of capital. Bearing this in mind, Chad's capital, labour and household multiplier paths are illustrated in Figures 6.22 to 6.24 below.

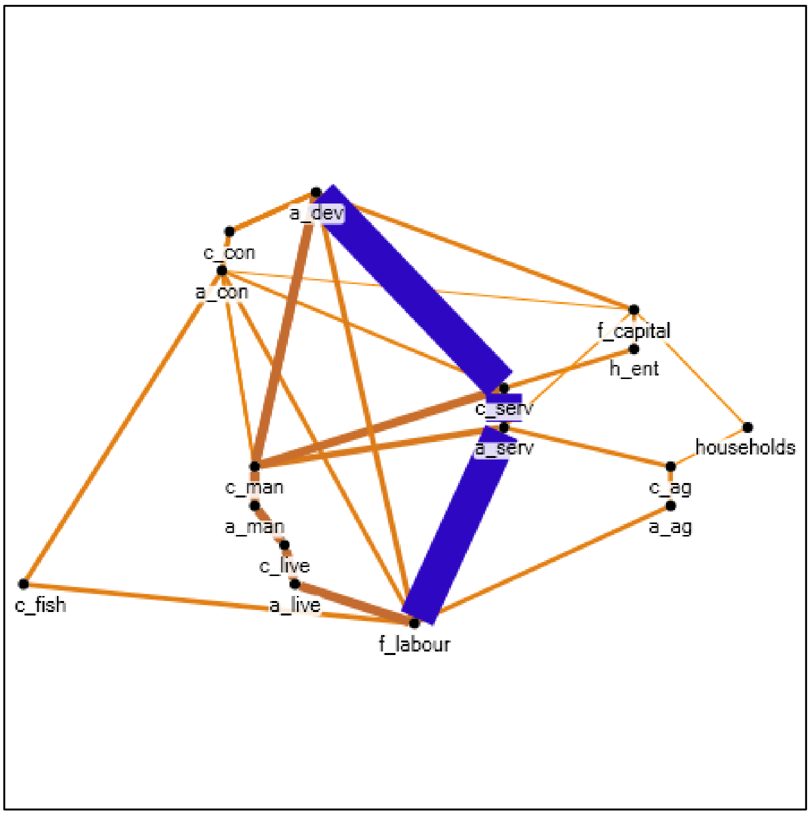
Figure 6.22: Capital multiplier: Chad



Note: Figure created using the weighted graph scheme of NodeXL. Paths depicted explain 82% of the accounting multiplier.

The main path flows from the oil sector to services and then to capital. Secondary paths include the path from the oil sector to informal manufacturing (c_con and a_con) to capital (f_capital) and from the oil sector to formal manufacturing (c_man) to services (c_serv and a_serv) and finally to capital (f_capital). In Nigeria's capital multiplier, the majority of the impact flows directly from the oil sector (acoil) to road transport (crtra / artra) to capital (fcap) while for Algeria the main direct flow is from the oil sector (aHydrocarbons) directly to capital (cap).

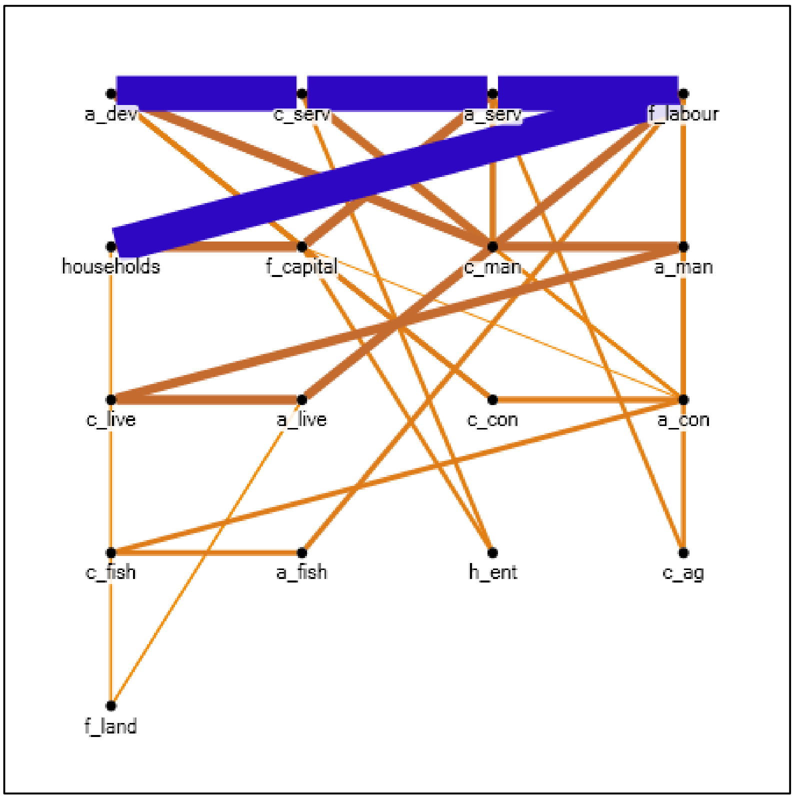
Figure 6.23: Labour multiplier: Chad



Note: Figure created using the weighted graph scheme of NodeXL. Paths depicted explain 80% of the accounting multiplier.

Chad's labour multipliers follows a very strong path from the oil sector to services (c_serv and a_serv) and then to labour (f_labour). Then there are also a number of weaker paths. The labour multiplier is also much larger than for Nigeria or Algeria. Chad's oil sector is more skewed to the use of labour and accordingly has a much larger labour multiplier. In terms of Nigeria and Algeria's labour multipliers, both follow extended paths; however, Nigeria's relatively larger (compared to Algeria) labour multiplier is also evident from the more intricate and stronger (thicker) paths.

Figure 6.24: Household multiplier: Chad



Note: Figure created using the weighted graph scheme of NodeXL. Paths depicted explain 84% of the accounting multiplier.

In contrast to Nigeria and Algeria, Chad's main path for households is from the oil sector to services (c_serv and a_serv) to labour (f_labour) and then to households. For Algeria's household multiplier, the main path flows from the oil sector to capital (cap) and then to households. For Nigeria's household multiplier, the paths follows from the oil sector to capital (fcap) to enterprises (ent) and finally to households.

The final step in this analysis is to combine the sector, factor and household components into a single Structural Take Indicator.

6.2.3 The Structural Take Indicator

This thesis has emphasised the current gap in the literature, namely that the oil sector's economy-wide impacts are not currently considered in the evaluation of petroleum fiscal systems. In order to address this key issue and to make a new contribution to the petroleum fiscal system literature, this thesis considered the structural connections or backward linkages of the oil sectors in Nigeria, Algeria and Chad in an attempt to provide a base case assessment of the respective oil sectors' impact. The foundation for this quantification was laid in Chapter 5 using SAM and SPA analyses. Up to this point, the separate impact components have been addressed. The final step is to now combine these impact components into a single indicator, the Structural Take Indicator. In order to construct the indicator, each of the three components (sectors: SC, factors: FC & households: HC) have to be assigned a specific weight of importance within the overall indicator. This is illustrated in Table 6.5.

Table 6.5: The Structural Take Indicator structure

Sectors	**Factors[72]**	**Institutions**
Sector component: SC	**Factor component: FC (capital & labour)**	**Households component: HC**
Relative country weight		
SC_W (%)	**FC_W (%)**	**HC_W (%)**
STI = (SC x SC_W) + (FC x FC_W) + (HC x HC_W)		

Source: Own calculations

From Table 3.6, each of the components is multiplied by its assigned weight (%) and these values are then aggregated to calculate the STI score. The calculation of the individual components was outlined in previous sections (6.3.1 & 6.3.2). The main question that remains is the relative weights (SC_W, FC_W & HC_W) that must be assigned to each of the three components. In line with the economy-wide impact approach of this thesis, the focus is on the structure of the individual economies and how this determines the extent of the oil sector's economic impacts. For this reason, the economic structure is used as the basis to determine the respective weights. The calculation of the STI is shown by equations 6.8 to 6.12 below.

$$TSI = SC + FC + HC \tag{6.8}$$

Where TSI is the total structural impact, SC is the sector component, FC is the factor component and HC is the household component. The individual component weights can then be calculated as:

$$SC_W = SC/TSI \tag{6.9}$$

Where SC_W is the sector component weight.

[72] For sensitivity analysis, capital can be excluded from factors to only consider the impact on labour and the resulting change in the overall STI score.

$$FC_W = FC/TSI \quad (6.10)$$

Where FC_W is the factor component weight.

$$HC_W = HC/TSI \quad (6.11)$$

Where HC_W is the household component weight. It follows that the STI can be calculated as:

$$STI = \sum(SC.SC_W)\ (FC.FC_W)\ (HC.HC_W) \quad (6.12)$$

The STI value can be interpreted in terms of the following:

$$STI \geq 0 \quad (6.13)$$

STI values that are close to zero indicate weak inter-sector connections and an oil sector with a limited economic (structural) impact. STI values that move away from zero indicate stronger inter-sector connections and larger economic (structural) impacts. In terms of evaluating fiscal systems, host countries with a high (close to 1 or above) oil sector STI may consider taking a more lenient fiscal (taxation) stance toward investors in order to gain more upstream investment and accordingly more of the associated economic impacts (benefits). Host countries with a relatively low (close to zero) STI will have to consider policies that could aid in expanding the oil sector's economic linkages to the rest of the host economy before any easing of fiscal terms is considered. Furthermore, the stage of oil sector development will also influence the extent of economic linkages. For a country with a nascent but not yet producing oil sector, the sector will have limited inter-sector linkages, since the sector is still very small. However, in such an instance, a low STI would not be a reason to increase the stance on fiscal take, since the sector is dependent on upstream investment to develop. Once the sector is more mature, as is the case in Nigeria and Algeria, the STI can be considered as part of the overall upstream fiscal stance in terms of taxation, investment promotion and the extension of oil sector linkages.

At this point, it is important to again highlight the following issues. The focus of this thesis is on expanding the evaluation of petroleum fiscal systems, which entails the relationship between the collection of revenue (government take) and the promotion of oil sector investment, through the development of the STI to incorporate the oil sector's economic impacts as part of the overall fiscal system evaluation. However, this thesis does not consider the 'expenditure side' of fiscal policy that deals with the policies governments use to manage the revenues it receives from the oil sector. Revenue management and allocation is a separate issue that falls under the revenue management[73] side of the literature and is outside the scope of this thesis. The revenue management literature is concerned with the spending and use of resource revenues with the aim of avoiding the so-called ‘resource curse’.

The STI method outlined above is used to calculate the STI for Nigeria, Algeria and Chad in the following three sections.

6.2.3.1 Nigeria

Nigeria’s Structural Take Indicator is calculated as 0.732, as illustrated in Table 6.6 below. The capital component has the largest impact and a corresponding weight of 38%. This is followed by households with a weight of 27%, sectors with a weight of 23% and labour with a weight of 12%.

Table 6.6: The Structural Take Indicator for Nigeria

Sectors	Capital	Labour	Households
0.595	**0.98**	**0.3**	**0.69**
Weight			
23%	**38%**	**12%**	**27%**
Component value			
0.13685	**0.3724**	**0.036**	**0.1863**
Structural Take Indicator Score: 0.732			

Source: Author’s calculations based on equations 6.8-6.12

The overall STI score suggests that Nigeria’s oil sector has a significant impact. The strongest impact is through capital and households, while the sector impact also makes a significant impact. The smallest impact stems from labour since the oil sector is mostly capital intensive. It could be argued that the majority of capital inputs may stem from imported sources and would therefore not have such a significant impact on the domestic economy. The focus of the STI is to capture the oil sector’s economic impact. In the case of a capital intensive oil sector, which uses a large proportion of imported capital, the impact from capital may be less significant than from a sector that uses more labour (assuming local labour is used). For this reason, the STI can also be calculated by excluding capital and this is shown in Table 6.7.

[73] See Van Ingen, Wait & Kleynhans (2014) for more on revenue management.

Table 6.7: Structural Take Indicator for Nigeria, excluding capital

Sectors	Labour	Households
0.595	0.3	0.69
Weight		
38%	19%	44%
Component value		
0.2261	0.057	0.3036
Structural Take Indicator Score: 0.587		

Source: Author's calculations based on equations 6.8-6.12

From Table 6.7, the STI score falls from 0.732 to 0.587 as a result of the exclusion of capital. The adjusted weights in this instance are 44% for households, 38% for sectors and 19% for labour. Excluding capital makes a significant difference to Nigeria's overall STI score, as it falls by 20 per cent. Within this context, Nigeria should focus on improving the oil sector's backward linkages as well as the linkage to labour. Improvements in these two impact components should improve the overall STI score and allow fiscal policy to be more investment orientated.

6.2.3.2 Algeria

Algeria's Structural Take Indicator is calculated as 0.666, as illustrated in Table 6.8 below. The capital component has the largest impact and a corresponding weight of 46%. This is followed by households with a weight of 27%, sectors with a weight of 23% and labour with a weight of 4%.

Table 6.8: Structural Take Indicator for Algeria

Sectors	Capital	Labour	Households
0.450	0.9	0.07	0.53
Weight			
23%	46%	4%	27%
Component value			
0.103805	0.415406	0.002513	0.144059
Structural Take Indicator Score: 0.666			

Source: Author's calculations based on equations 6.8-6.12

The overall STI score suggests that Algeria's oil sector has a relatively significant impact. The strongest impact is through capital and households, while the sector impact also makes a significant impact. The smallest impact stems from labour, since the oil sector is mostly capital intensive. Similar to Nigeria, it could be argued that the majority of capital inputs may stem from imported sources and would therefore not have such a significant impact on the domestic economy. For this reason, the STI can also be calculated by excluding capital and this is shown in Table 6.9.

Table 6.9: Structural Take Indicator for Algeria, excluding capital

Sectors	Labour	Households
0.4499	**0.07**	**0.53**
Weight		
43%	**7%**	**50%**
Component value		
0.192789799	**0.004667**	**0.26754929**
Structural Take Indicator Score: 0.465		

Source: Author's calculations based on equations 6.8-6.12

From Table 6.9, the STI score falls from 0.666 to 0.465 as a result of the exclusion of capital. The adjusted weights in this instance are 50% for households, 43% for sectors and 7% for labour. Excluding capital makes a significant difference to Algeria's overall STI score, as it falls by 30 per cent. However, from a comparison to Nigeria's adjusted STI (excluding capital), it is interesting to note that Algeria's sector and household weights show a significant increase over the initial (including capital) STI.

6.2.3.3 Chad

Chad's Structural Take Indicator is calculated as 6.94, as illustrated in Table 6.10 below. The sector component has the largest impact and a corresponding weight of 51%. This is followed by households with a weight of 21%, labour with a weight of 16% and capital with a weight of 12%. The overall STI score suggests that Chad's oil sector has a very significant impact. **However, caution should be taken when interpreting this value**. In comparison to Nigeria and Algeria, this STI value is extremely high. Nonetheless, it is in line with other multipliers derived from the Chadian SAM. Accordingly, the results are interpreted as is, with due consideration that these values seem very high. These results may look like outliers but are less reliable (see section 6.3.1). Readers must take cognisance of these high values and that it is the best data available at present (2015). Furthermore, the Chadian SAM is much more aggregated than the Nigerian and Algerian SAMs, while Chad's economy is much smaller than that of Nigeria and Algeria.

Table 6.10: Structural Take Indicator for Chad

Sectors	Capital	Labour	Households
10.28	**2.41**	**3.2**	**4.21**
Weight			
51%	**12%**	**16%**	**21%**
Component value			
5.25763	**0.28896**	**0.50945**	**0.8818**
Structural Take Indicator Score: 6.94			

Source: Author's calculations based on equations 6.8-6.12

In contrast to Nigeria and Algeria, Chad's nascent oil sector is more dependent on labour than capital. Accordingly, the STI can also be calculated by excluding capital and this is shown in Table 6.11 below.

Table 6.11: Structural Take Indicator for Chad, excluding capital

Sectors	Labour	Households
10.28	**3.2**	**4.21**
Weight		
58%	**18%**	**24%**
Component value		
5.97391	**0.57886**	**1.00193**
Structural Take Indicator Score: 7.55		

Source: Author's calculations based on equations 6.8-6.12

From Table 6.11, the STI score increases from 6.94 to 7.55 as a result of the exclusion of capital. The adjusted weights in this instance are 58% for sectors, 24% for households and 18% for labour. Excluding capital makes a significant difference to Chad's overall STI score, as it increases by nine per cent. However, from a comparison to Nigeria's adjusted STI (excluding capital), it is interesting to note that excluding capital increases the STI value; the contrast here is that Chad's oil sector is more reliant on labour than capital.

6.3 Implications of the STI

The development and application of the STI outlined above fill the research gap outlined in Chapter 1 of this thesis, namely that in terms of the evaluation process for petroleum fiscal systems, there is no measurement instrument that considers the economy-wide impacts of the upstream oil sector's activities, made possible by upstream investment. For this reason, the STI represents a new contribution to the field.

6.3.1 Considerations that affect the STI

There are a number of important considerations that affect the interpretation of the STI. The size of a country's economy and the relative importance of the oil sector will influence the interpretation of the STI. When considering the different SAM base years and the most recent (2013) economic structure, the country GDP ranking has remained relatively stable. The ranking, from the largest to the smallest, is Nigeria, Algeria and Chad. This is illustrated in Table 6.12 below.

Table 6.12: Comparison of relative current GDP in percentage terms

Country	2000 (Chadian SAM base year)	2002 (Algerian SAM base year)	2006 (Nigerian SAM base year)	2013
Nigeria	45.2%	50%	54%	70%
Algeria	53.4%	48%	43%	28%
Chad	1.4%	2%	3%	2%
Combined GDP	100%	100%	100%	100%

Source: Author using data from the World Bank (2015)

Table 6.12 illustrates the countries' current GDP as a percentage of their 'combined' GDP over the SAM base year periods and the most recent (2013) structure. It is clear that the relative size of the economies, as captured by the SAMs, still matches the current ranking. In terms of a comparative interpretation, Table 6.13 summarises the key variables.

Table 6:13: Comparative STI interpretation

Country	GDP Ranking (From a total of 192 countries)	GDP ranking within Africa	Government oil revenue % of GDP (estimates)	Oil sector % of GDP	STI	STI excluding capital
Nigeria	25^{th}	1^{st}	11.1%	14.4%	0.732	0.587
Algeria	49^{th}	4^{th}	26.0%	35.9%	0.666	0.456
Chad	123^{rd}	25^{th}	14.7%	23.9%	6.94	7.55

Source: Author's calculations and author using data from the World Bank (2014b) and Africa Economic Outlook (2014a)

Note: GDP, oil and government revenue for 2013, Algeria's oil as percentage of GDP is for 2012.

From Table 6.13, Nigeria has the largest economy and together with the oil sector's economic linkages (SAM data), Nigeria's oil sector has a larger economy-wide impact than that of Algeria. Furthermore, Chad's economy is much smaller than Nigeria and Algeria's economies. However, according to the Chad SAM, its oil sector has the largest economic multipliers. It follows that a large impact in terms of Chad's economy, relative to Nigeria and Algeria, might not be as large. **Therefore, the results for Chad may possibly be less reliable. For this reason, caution should be taken when interpreting the results for Chad.**

The large multipliers could be a result of the much more aggregated Chadian SAM, since the Chadian SAM is aggregated into 11 sectors, while the Nigerian SAM is aggregated into 61 sectors and the Algerian SAM into 19 sectors. Since each country's SAM/economy has a unique make-up, it is difficult to compare three such different economies with one another. The level of detail captured by each SAM is not identical and such fundamental differences will also have an influence on the results. For these reasons, the STI values for Nigeria and Algeria may be more accurate (comparable) indicators than that of Chad. The availability of a SAM for Angola would also simplify the interpretation of the STI values; it would most likely be in line with the STI for Nigeria and Algeria. The availability of a more recent and more disaggregated SAM for Chad would also provide more certainty to the interpretation.

6.3.2 Interpreting the STI

Host governments face a trade-off between obtaining a fair share of oil revenues and providing sufficient incentive for investors to invest in and develop the country's oil resources. Taking cognisance of the factors outlined in section 6.3.1, the STI provides further clarity on the issues that are at stake. In is not only the government take (taxation) that is important, but also the extent of the oil sector's economy-wide impacts. A large (positive) STI value implies that countries can accept a lower government take, considering the economy-wide impacts derived from the oil sector. When considering these impacts, a more lenient system (lower government take) could attract more investment and with it bring more of the economy-wide impacts.

Therefore, the most important implication of the STI concerns the trade-off between government take and incentives for investment. Host countries with a relatively high STI receive considerable economic benefits from the oil sector through its economy-wide impacts. In such cases, the host government may consider implementing a more lenient fiscal stance in order to promote upstream investment and reap more of the economy-wide benefits. In contrast, host countries with a relatively low STI will have to first consider policies to expand the oil sector's economy-wide impacts before opting for a more lenient fiscal stance. This is especially true for countries with an established oil sector and a long history of oil production. Within such a context (low STI score), the ancillary policy would be to focus more on the extent of government take, by attempting to increase the fiscal (tax) benefits for the host country until such time as the STI could be improved. However, in the case of countries with a nascent oil sector, still to make significant discoveries, the host government should take cognisance of the lack of proven reserves and production when interpreting their STI, since the sector is still in the start-up phase and still needs to be established before any significant sector linkages can form.

The weighted sector linkage and accounting multiplier analysis of Chapter 5 provide a further background for interpreting the STI results. Nigeria's oil sector was shown to be forward orientated, while Algeria's oil sector is a key sector with both forward and backward linkages. Considering more recent sectoral data (Figures 6.1 and 6.2), Nigeria's economy is more diversified than Algeria's economy. In Chapter 5, Chad's oil sector was shown to be weakly backward orientated. Based on the more recent data (Figure 6.3 and Table 6.1), Chad's economy is more diversified and less dependent on oil than Algeria, but less diversified and more oil dependant than Nigeria. Overall, Nigeria's larger, more diversified economy has a larger STI value than Algeria, even though Algeria's oil sector has both forward and backward linkages. As was mentioned, the Chadian SAM produced relatively larger multipliers and accordingly Chad's STI value is higher than both Nigeria and Algeria's STI values. As was noted, the results for Chad may possibly be less reliable.

All three countries analysed in this chapter have an STI greater than 0 (see Table 6.13). The implication for petroleum tax policy in these countries is that the host governments may consider implementing a more lenient fiscal stance in order to promote upstream investment and reap more of the economy-wide benefits. Expanding the oil sector's backward linkages will help to reap more economic benefits for the domestic economy. Importantly, the extent of economic diversification will also have an impact on the extent of the oil sector's economy-wide impacts. However, as was outlined, caution should be taken with the STI results for Chad as these values are likely to be less reliable.

In terms of the adjusted STI (excluding capital), both mature producers' STI values fell. Nigeria's overall STI score falls by 20 per cent. Within this context, Nigeria should focus on improving the oil sector's backward linkages as well as the linkage to labour. Improvements in these two impact components should improve the overall STI score and allow fiscal policy to be more investment orientated. Algeria's overall STI score falls by 30 per cent. However, from a comparison to Nigeria's adjusted STI (excluding capital), it is interesting to note that Algeria's sector and household weights show a significant increase over that in the initial (including capital) STI. In terms of the reduced STI score, Algeria could also focus on improving the oil sector's linkage to both sectors and labour. Furthermore, diversifying Algeria's economy should also help to increase the oil sector's economic impact. In contrast to the mature producers, Chad's adjusted STI increased rather than decreased. Chad's oil sector is more reliant on labour than capital, and the increase in the adjusted STI can be attributed to this, by removing the less important capital component, the more significant labour component has a larger influence on the STI value. Based on the results, Chad's oil sector can produce large multiplier impacts, depending on the multiplicand (size of the expenditure injection). However, in comparison to other sectors in Chad's economy (see Figure 5.5), the oil sector has very weak forward linkages with weak backward linkages. Accordingly, there should also be a focus on expanding the oil sector's linkages to the rest of Chad's economy.

The above considerations must also account for the oil price environment. The oil market is currently (2015) in a global downward price spiral due to oversupply and weakening global demand. The current outlook will have an impact on exploration in the medium to long term. Host countries should incorporate such price fluctuations into their oil sector policy stance. In the current low price environment, the STI is especially important. Focusing on the oil sector's economy-wide impacts (as measured in the STI), host governments can accommodate investors with more favourable regimes that can help to sustain investment during periods of oil price downturns. However, the policy should also allow for upward flexibility during periods of sustained price increases.

Finally, it is important to note that the economy-wide impacts represent an additional benefit that may justify a more lenient fiscal stance. The question of benefits relating to the use (management) of the fiscal (resource) rents falls outside the scope of this thesis and is a separate issue. The STI provides a measure of the oil sector's economy-wide impacts, which up to now have not been considered when evaluating petroleum fiscal systems. Given the availability of the relevant SAM, the STI can be calculated for any specific oil-producing country. The results from this chapter provide a framework, especially for African countries, which can be used to measure the oil sector's economy-wide impacts. Furthermore, by providing an additional instrument to the standard tool of government take, the STI can help to inform the evaluation and formulation of petroleum fiscal systems.

6.4 Conclusion

As custodians of their countries' natural resources, host governments must design, evaluate and implement petroleum fiscal systems that secure a fair share of economic rent for the host country, while still being conducive towards attracting upstream investment. The narrow focus on a fair share of economic rent, in terms of government take, has ignored the economy-wide impacts (benefits) of the upstream oil sector's activities. However, while government take includes most of the revenue accruing to the government, it is plagued by a number of shortcomings. This includes having a too narrow macroeconomic scope that ignores the oil sector's economy-wide impacts.

Although there have been studies estimating economic impacts from the oil sector, none of these studies have attempted to incorporate these results into the evaluation of petroleum fiscal systems. Therefore, this additional and important dimension is not currently part of the process for evaluating petroleum fiscal systems. For this reason, the Structural Take Indicator (STI) that was developed in this chapter fills a research gap and represents a new contribution to the field.

The STI was developed using three components, namely sectors, factors and households. The analysis of these components was built upon the multiplier decomposition and SPA analysis conducted in Chapter 5. In terms of sectors, the majority of the oil sector's backward multipliers were used to calculate a single multiplier, which represents 97% (for Nigeria and Algeria) and 100% (for Chad) of the oil sector's overall sectoral multiplier impact. In terms of factors, the multipliers for capital and labour were aggregated into a single component for factors. The oil sector's household multiplier represents the household component of the indicator. These components were then aggregated and used to calculate the individual component's 'structural weight'. The three components together with their respective structural weights were then combined to calculate the overall STI. For a sensitivity analysis, the STI (adjusted) was also calculated using only sectors, labour and households, thereby excluding capital. This produced a significant reduction to both Nigeria and Algeria's STI values, while increasing it for Chad. The various STI weights are compared between countries in Table 6.14 below.

Table 6.14: Comparison of STI weights

Country	STI: Component weight	Adjusted STI (excluding capital): Component weight
Sectors		
Nigeria	23%	38%
Algeria	23%	43%
Chad	51%	58%
Capital		
Nigeria	38%	Not Applicable
Algeria	46%	Not Applicable
Chad	12%	Not Applicable
Labour		
Nigeria	12%	38%
Algeria	4%	43%
Chad	16%	58%
Households		
Nigeria	27%	44%
Algeria	27%	50%
Chad	21%	24%

Source: Author's calculations

From Table 6.14, the weights for the sector component correspond between Nigeria and Algeria; both have a weight of 23%. There is a slight variation for adjusted STI, with a weight of 38% for Nigeria and 43% for Algeria. Chad's sector component carries a larger weight for both the STI and adjusted STI with 51% and 58%, respectively. Both Nigeria and Algeria are capital intensive with weights of 38% and 46%, respectively. Chad is far less capital intensive with a weight of only 12%. Corresponding to their capital intensities, Nigeria and Algeria's labour weights are 12% and 4%, respectively. Chad is more labour intensive with a weight of 16%. For labour, the adjusted STI weights increase for all three countries. In terms of households, both Nigeria and Algeria have a weight of 27% in the STI and 44% and 50% for the adjusted STI. Chad's household weights are lower with 21% and 24%, respectively.

From these results, Nigeria should focus on improving the oil sector's backward linkages as well as the linkage to labour. In terms of the reduced STI score, Algeria could also focus on improving the oil sector's linkages to both sectors and labour. The oil sector is mostly capital intensive in these countries. Expanding the oil sector's linkages and impact to other sectors may indirectly increase employment through the impact on these sectors. Based on the results, Chad's oil sector can produce large multiplier impacts, depending on the multiplicand (size of the expenditure injection). However, in comparison to other sectors in Chad's economy (see Figure 5.5), the oil sector has very weak forward linkages with weak backward linkages. Accordingly, there should also be a focus on expanding the oil sector's linkages to the rest of Chad's economy.

Based on the STI, Nigeria; Algeria and Chad may consider implementing a more lenient fiscal stance in order to promote upstream investment and reap more of the economy-wide benefits. However, the reader is cautioned that the STI results for Chad may be less reliable. At this stage, the STI results for Nigeria and Algeria may be more accurate (comparable) indicators than that of Chad. The STI results are summarised in Table 6.15.

Table 6:15 Summary of STI results

Country	STI	STI excluding capital
Nigeria	0.732	0.587
Algeria	0.666	0.456
Chad	6.94	7.55

Source: Author's calculations

All three countries analysed in this chapter have STI values greater than 0. With the exception of Chad's potentially less reliable results, Nigeria has the largest STI followed by Algeria. The relative sizes of Nigeria and Algeria's economies have a distinct impact on their multiplier and STI results. Accordingly, these host governments may consider implementing a more lenient fiscal stance in order to promote upstream investment and reap more of the economy-wide benefits. Expanding the oil sector's backward linkages will help to reap more economic benefits for the domestic economy. Importantly, the extent of economic diversification will also have an impact on the extent of the oil sector's economy-wide impacts.

The STI method developed in this chapter can help host governments to evaluate the oil sector's economy-wide impact on their economy. This knowledge can then be used in conjunction with other instruments, such as the government take statistic. The most important implication concerns the trade-off between government take and incentives for investment. Host countries with a relatively high STI receive considerable economic benefits from the oil sector through its economy-wide impacts. In such cases, the host government may consider implementing a more lenient fiscal stance in order to promote upstream investment and reap more of the economy-wide benefits. In contrast, host countries with a relatively low STI will have to first consider policies to expand the oil sector's economy-wide impacts (inter-sector linkages) before opting for a more lenient fiscal stance. However, in such cases, the oil sector's stage of development will play a crucial role in the actual policies that have to be implemented, depending on whether it is an infant or mature sector. Furthermore, the above considerations must also account for the current and future oil price environment.

In the following chapter a summary of the thesis is presented and conclusions and recommendations are made.

Chapter 7: Summary, conclusions and policy recommendations

"If I had six hours to chop down a tree, I'd spend the first four hours sharpening the axe." – Abraham Lincoln.

7.1 Introduction

The aim of this thesis was to conduct a comparative analysis of petroleum fiscal systems between countries and to develop a Structural Take Indicator (STI) to measure the wider spectrum of economy-wide impacts created by oil sector investment in Africa; the use of which will enhance the evaluation of petroleum fiscal systems. The oil sector's economy impacts can most directly be measured by the oil sector's backward linkages, which embody the oil sector's purchases from other sectors to enable production of oil sector output. It is possible to measure forward linkages, but this falls outside the scope of this thesis. The focus of this thesis was the oil sector's economy-wide (upstream) impacts, i.e. backward linkages.

This thesis represents a twofold new contribution to the field of knowledge on petroleum fiscal systems. Firstly, it provides a recent mapping of the various petroleum fiscal systems in a comparative manner, for a representative sample of oil producers. Secondly, it provides a measurement instrument (structure) that can incorporate the oil sector's economy-wide impacts as part of the evaluation of petroleum fiscal systems. From the government policy perspective, the government take statistic is most often used to evaluate and compare petroleum fiscal systems. The government take measures the government's share of economic profits and is normally expressed as a percentage. However, it is often calculated on unrealistic assumptions. More importantly, the macroeconomic scope of government take is too narrow and does not account for the oil sector's economy-wide impacts. Although there have been studies that have estimated the economic impacts from the oil sector, none of these studies have attempted to incorporate these results into the evaluation of petroleum fiscal systems. Therefore, this additional and important dimension is not part of the process of evaluating petroleum fiscal systems. For this reason, the STRUCTURAL TAKE INDICATOR (STI) is developed in this thesis and fills this critical gap in the literature and in policy practice.

Governments can incorporate the STI into the evaluation of their petroleum fiscal system and better address the rent/investment trade-off they face. This trade-off entails the host government's aim of attaining a fair share of economic rent and providing sufficient incentive for investment in upstream exploration and development. The trade-off between government take and investment incentive is particularly important for oil rich African countries. The STI provides a framework by which African countries can evaluate the structure of their petroleum fiscal systems by incorporating the oil sector's economy-wide impacts, based on the structure of the specific oil-producing country's economy. The STI was calculated for Nigeria, Algeria and Chad as an example. The method developed in this thesis can similarly be applied to other African and all other oil producing countries. Apart from the STI developed in this thesis, there is currently no measure incorporating the oil sector's economy-wide impacts into the evaluation of petroleum fiscal systems. Furthermore, although data on individual fiscal systems are publicly available, there are no recent comparative mapping and analysis of petroleum fiscal systems between countries. Therefore, this thesis represents a new contribution to the field of knowledge on evaluating the effectiveness of petroleum fiscal systems in a particular country.

It is important to note that the oil sector's economy-wide impacts, as discussed above, are separate from the question of economic impact and development connected with the allocation and expenditure of the tax revenue received by the host government. The thesis question relates to the trade-off between achieving a 'fair share' for the host government and contractor (IOC), while still being conducive to upstream investment. The thesis research question is an issue of revenue collection and investment attraction as opposed to the question of revenue allocation and management.

7.2 Summary and conclusions

In order to provide a sound theoretical base from which petroleum fiscal systems could be analysed, **Chapter 2** provided a literature and theoretical overview on petroleum taxation.

The basic premise of petroleum taxation is to retrieve for the host government, as owner of the resource, a fair share of the economic rent generated by the extraction of oil resources. Petroleum taxation distributes the rewards of oil production between the host government and the investors/IOCs. From the literature, the oil sector has a number of tax-relevant characteristics that differentiate it from other sectors and that make tax policy both important and challenging. It is particularly the sheer scale of these characteristics that distinguishes the oil sector from other sectors.

The scarcity of non-renewable resources, such as oil, creates economic rent when the resource is extracted. The 'fair' division of this economic rent between the host government and the producer (IOC) is a primary objective of petroleum taxation. The use of a separate fiscal system for the oil sector is largely based upon the special role of economic rent in the production of oil. Although the literature theoretically identifies and describes the issues surrounding resource rents, the identification, measurement and collection of resource rents are more difficult in practice. Once a host government has decided upon the appropriate share of economic rent, it must decide upon the appropriate taxation instruments to collect and capture this rent. A distinction can be made between profit-based taxes and production-based taxes. Profit-based taxes are defined as taxes charged on a specific definition of a company's revenues less specified (qualifying) costs. Production taxes are defined as taxes charged on reserves or production inputs and services. There is an extent of overlap between profit-based taxes and direct taxes and also between production-based taxes and indirect taxes. A third category of instruments are the so-called non-taxation instruments. Companies are assumed to prefer profit-based taxes, while governments have a preference to include at least some production-based tax components in their fiscal regime.

The different 'combinations' of taxation and non-taxation instruments used by host countries are controlled or organised by a country's petroleum fiscal system. This term encompasses all contractual and fiscal elements that define the relationship between a host government and foreign oil company. The two main types of petroleum fiscal systems are royalty/tax (concessionary) systems and contractual (PSC)-based systems. There is no one-size-fits-all fiscal system that is suitable for all countries or projects because countries differ in terms of upstream costs, the size and quality of reserves and the perceptions of commercial and political risk held by potential investors.

Even though the basic concessionary or contractual systems have been in place for a long time, the specific terms of each system have gone through a number of changes in the last few decades. These changes are related to changing political conditions as well as to changes in the international oil market. Today's systems are premised on transnational public-private partnerships, where the nature of the primary partnership varies according to the contract type, i.e. modern concessions or PSCs. Although investor perceptions may regard concessionary systems to be more attractive than PSCs, both systems can be used to achieve similar outcomes depending on how the systems are structured. The difference between concessionary and PSC systems is linked to legal and political issues rather than economic fundamentals. Comparing systems solely in terms of tax rates is misleading. The other issues that must be considered include the host government's objectives, the country- and region-specific influences as well as the trade-off between a fair share for the host government and continued investment attraction.

There are certain desirable features to pursue when designing a petroleum fiscal system. A country's petroleum fiscal system can attract investment by using a framework that is clear and not subject to retroactive changes, provides a stable business environment, deters undue speculation, minimises sovereign risk, provides a balance between risk and reward to provide potential for a fair return to both the host government and investors, minimises complexity and administrative burdens, incorporates flexibility for changing economic conditions and finally promotes competition and market efficiency. Further criteria include economic efficiency, the minimisation of both investor risk and government revenue risk and finally the ease of implementing the system. A 'win-win' petroleum fiscal system will promote exploration activities, encourage the development of both small and large oil reserves, provide incentives for areas that are difficult to explore and difficult to develop and finally provide an equitable distribution of economic benefits between the host government and IOC.

Economic and fiscal measures are used to evaluate and compare petroleum fiscal systems. These metrics stem from two branches, depending on the viewpoint that is used, namely the government viewpoint (the focus of this thesis) and the investor (IOC) viewpoint. Economic measures (indicators) are used by investors (IOCs) to evaluate a potential project's overall return (net worth) in accordance with the associated risks. System (fiscal) measures are used by host governments to evaluate whether they obtain a 'fair share' from oil resources. Although a number of studies have attempted to compare the relative attractiveness of petroleum fiscal systems in terms of government take, it seems the overarching viewpoint is still from an investor perspective. Furthermore, none of these studies consider the oil sector's economy-wide impacts, as is done in this thesis.

Chapter 3 presented an overview of the current systems and taxation instruments that are prevalent in ten oil producing countries, outside Africa. This was done by considering countries from various continents that present a combination of developed, emerging and developing economies. Five of the selected countries have concessionary systems and consist of Russia, Brazil, Norway, the United Kingdom and Australia. The other five countries that were selected have contractual systems and include China, Iraq, Oman, Indonesia and Azerbaijan.

A number of factors influence investors' decision to invest or not. The Fraser Institute's global petroleum survey highlights the following common factors respondents regard as barriers: onerous fiscal regimes, political instability, land claim disputes as well as costly, time-consuming uncertainty surrounding regulations. Competitive tax and regulatory regimes are regarded as positive factors that can attract investment. The effective management of oil rents by host governments influences the benefit host countries derive from the oil sector in terms of taxation. This issue was considered by incorporating the revenue watch resource governance index (RGI) score for each of the countries analysed.

From the analysis of the ten countries listed above, the following points can be highlighted. The concessionary systems mostly rely on CIT as a main instrument and royalties seem to be a secondary instrument based on production. Russia, Brazil and Australia charge royalties, while Norway and the UK do not. However, there are various additional taxes that help to further increase the government's take. In percentage terms, these taxes vary from 0 to 60%. From the ten countries, it appears that the contractual (PSC) system is more prevalent in developing countries. With the exceptions of Russia and Oman, the concessionary system countries have a better PPI score than the contractual system countries. Overall, jurisdictions for developed countries such as Norway, the UK and Australia (South Australia, Northern Territory, the offshore and Tasmania) fall in the second PPI quintile. However, Australia's Victoria, Western Australia and Queensland fall in the third quintile, while New South Wales falls into the fourth PPI quintile. With the exception of Oman (PPI quintile two), jurisdictions from developing countries rank lower. For example, Brazil and China fall in the third quintile, while Azerbaijan falls in the fourth quintile. Russia, Indonesia and Iraq fall into the fifth quintile.

Norway, the UK and Australia (South Australia, Northern Territory, the offshore and Tasmania) have the most favourable jurisdictions in the group of five countries, falling in the second PPI quintile. Jurisdictions in the third PPI quintile include Brazil's offshore and Australia's Victoria, Western Australia and Queensland. China and Azerbaijan fall in the fourth PPI quintile, while Russia, Indonesia and Iraq fall into the fifth PPI quintile.

In general, the contractual system seems to be more complex, and less favoured by IOCs when considering the PPI. There are also many variations of PSCs within countries. The PSC systems mainly collect a share for the government through the production sharing process and secondly through CIT, which ranges from 25 to 55%. In addition, the additional elements such as ring-fencing, bonuses and domestic market obligations place a further weight on IOCs.

In order to gain a better understanding of the current systems and taxation instruments that are prevalent in African countries, **Chapter 4** reviewed the petroleum fiscal systems of Africa's three largest oil producers (Nigeria, Angola and Algeria) as well as an emerging producer, Chad. The mature producers all have some form of mixed systems whereby both concessionary and contractual systems are used. However, in some instances, one of the two systems form part of the 'older' regime as one system is preferred for all newer blocks. For example, Angola's concessionary system only applies to specific partnerships that were set up in the 1960s and 1970s. The more recent agreements are PSCs. In contrast, Algeria's mixed system gravitated towards the concessionary system, as from 2005 only the concessionary system remained in place. In contrast to the mature producers, Chad operates under a single system, namely production sharing.

In terms of concessionary systems, the lower and upper bounds of Algeria's royalty rates (5.5-23%) exceed that of Nigeria (10-20%). In terms of CIT, Algeria has the lowest rate (30%), but there are a number of other taxes levied besides CIT. In terms of contractual (PSC) systems, Nigeria's CIT ranges between 50 and 85%, Angola is at 50%, while under Chad's PSC, companies are exempt from CIT, which is replaced by the profit oil mechanism as part of production sharing. In the case of Algeria's pre- and post-2001 PSC, the NOC (Sonotrach) pays the 38% of profit oil on behalf of the IOC. Accordingly this tax does not enter the company tax flow.

Nigeria's PSCs are based on production values and Angola uses either an IRR or a production-based sliding scale. Both of Algeria's pre- and post-2001 PSCs use a production-based sliding scale, while Chad's PSC used an R-factor split. Angola's concessionary system also charges a petroleum production tax of 20% and a petroleum transaction tax of 70%. In terms of cost recovery, Algeria's PSC allows for 100% of net revenue, Nigeria for 80% of gross revenue, Angola for either 50% (1992 PSC) or 55-65% (2007 PSC) of net revenue, while Chad allows for 70% of revenue after deduction of the royalty. All four countries charge bonus payments and various other taxes. Angola's signature bonuses are among the highest in the world. In terms of jurisdiction rankings, Chad has the best ranking (99), followed by Angola (108), Nigeria (114) and Algeria (124).

Chapter 5 addressed the first part of the petroleum tax question, namely to measure and evaluate the oil sector's inter-sector linkages and impacts by considering the case of Nigeria, Algeria and Chad. The oil sector's economy impacts can most directly be measured by the oil sector's backward linkages, which embody the oil sector's purchases from other sectors to enable production of oil sector output. **It is possible to measure forward linkages, but this falls outside the scope of this thesis. The focus of this thesis is the oil sector's economy-wide (upstream) impacts, i.e. backward linkages.** In order to measure and evaluate these linkages, a SAM-based multiplier decomposition and SPA were used. The applicable data (SAM) are not yet available for Angola, and for this reason, Angola was excluded from the empirical analysis.

In terms of the linkage based sectoral classification, Nigeria's oil sector was found to be mostly forward orientated (a weak classification) and accordingly weaker (less inter-connected) than Algeria's sector, which has both strong forward and backward linkages (a key sector classification). Chad's 'pre-oil' economy has a weak sector classification based on the lack of forward multipliers tied with weak backward multipliers.

From the analysis, Nigeria's oil sector is mostly forward orientated and policies should focus on improving the oil sector's backward linkages with the rest of the economy. The greater use of local content for physical inputs as well as labour could improve the oil sector's backward linkages and inter-connectedness with the rest of the economy. Nigeria's largest backward multipliers create demand for intermediate inputs from the following sectors: wholesale and retail trade; cassava; yams; goat and sheep meat; rice; road transport; electricity and water; maize; real estate; vegetables; and financial and business services. Considering Nigeria's matrix of technical coefficients (derived from the SAM), the oil sector is highly capital intensive with capital accounting for 92% of total production cost (factor usage), while labour accounts for only 0.25%. From the SPA results, in terms of factors, the majority of capital flows directly between the oil sector and capital (98.77%). For labour, the most common nodes through which the flows travel are from the oil sector to capital to enterprises to households, households purchase other commodities, which then flow to labour. In terms of household institutions, the majority of the addition to household income (94.65%) flows from the oil sector to capital to enterprises and finally to households.

Algeria's oil sector is more inter-connected with the rest of Algeria's economy (key sector), as opposed to Nigeria's oil sector that is mostly forward orientated. Algeria's largest backward multipliers create demand for intermediate inputs from the following sectors: transport and communications, food processing, agriculture, trade, services and construction for petroleum, water and energy, other private services, public services, hotels and restaurants, the metal sector and textiles. Considering Algeria's matrix of technical coefficients (derived from the SAM), the oil sector is relatively capital intensive with capital accounting for 54% of total production cost (factor usage), while labour accounts for only 2%. However, in comparison with Nigeria's oil sector, Algeria's oil sector is significantly less capital intensive and slightly more labour intensive. From the SPA results, in terms of factors, the majority of capital flows directly between the oil sector and capital (89.86%). For labour, the most common nodes through which the flows travel are from the oil sector to capital to households, households purchase other commodities, which then flow to labour. In terms of household institutions, the majority of the addition to household income (81.88%) flows from the oil sector to capital to households.

Considering Chad's 'pre-oil' matrix of technical coefficients, in terms of oil sector costs, capital accounts for 9% of total production cost (factor usage), while labour accounts for only 3%. Notably, Chad's nascent oil sector has relatively larger activity multipliers in comparison to Nigeria and Algeria. In terms of a relative comparison, Chad's capital and labour multipliers are significantly larger than that of the mature producers, Nigeria and Algeria. However, Chad's oil sector impact could be smaller since the multiplicand (injection from the sector) will most likely be smaller than that of the mature producers. In terms of household institutions, the majority (84.08%) of the addition to household income is explained by the path from the oil sector through informal manufacturing, capital, enterprises, services, labour and finally to households. In terms of enterprises, the majority (77.25%) of the addition to the income received by enterprises is explained by the path through services, labour, households, construction and public works, capital and finally to enterprises.

Chapter 6 addressed the second part of the petroleum tax question, namely to develop a measurement instrument of the oil sector's economy-wide impacts, i.e. the Structural Take Indicator (STI). The development and application of the STI outlined in Chapter 6 fills the research gap outlined in Chapter 1 of this thesis, namely that in terms of the evaluation of petroleum fiscal systems, there is no measurement instrument that considers the economy-wide impacts (benefits) of the upstream oil sector's activities, made possible by upstream investment.

The STI was developed using three components, namely sectors, factors and households. The analysis of these components was built upon the multiplier decomposition and SPA conducted in Chapter 5. In terms of sectors, the majority oil sectors' backward multipliers were used to calculate a single multiplier, which represents 97% (Nigeria and Algeria) and 100% (for Chad) of the oil sector's overall sectoral multiplier impact. In terms of factors, the multipliers for capital and labour were aggregated into a single component for factors. The oil sector's household multiplier represents the household component of the indicator. These components were then aggregated and used to calculate the individual component's 'structural weight'. The three components together with their respective structural weights were then combined to calculate the overall STI. For a sensitivity analysis, the STI (adjusted) was also calculated using only sectors, labour and households, thereby excluding capital.

There are a number of important considerations that affect the interpretation of the STI, for example the size of a country's economy and the relative importance of the oil sector. According to the Chadian SAM, its oil sector has the largest economic multipliers and STI. However, Chad's economy is much smaller than Nigeria and Algeria's economies. It follows that a large impact in terms of Chad's economy, relative to Nigeria and Algeria, might not be as large. Therefore, the results for Chad may possibly be less reliable. The large multipliers could be a result of the much more aggregated Chadian SAM, since the Chadian SAM is aggregated into 11 sectors, while the Nigerian SAM is aggregated into 61 sectors and the Algerian SAM into 19 sectors. Since each country's SAM/economy has a unique make-up, it is difficult to compare three such different economies with one another. The level of detail captured by each SAM is not identical and such fundamental differences will also have an influence on the results. For these reasons, the STI values for Nigeria and Algeria may be more accurate and comparable indicators than that of Chad. The availability of a SAM for Angola would also simplify the interpretation of the STI values; it would most likely be in line with the STI for Nigeria and Algeria. The availability of a more recent and more disaggregated SAM for Chad would also give more certainty to the interpretation.

There are distinct structural and size differences between the three countries analysed. Nigeria and Algeria both have a relatively positive STI score. Although Chad's oil sector exhibits very weak forward linkages with weak backward linkages, the individual multipliers are very high and result in a particularly high STI score. From the adjusted STI (excluding capital), the mature producers showed a significant reduction in their STI values, while Chad's STI value increased. This reflects the difference in capital intensity between the mature and emerging producers. The various STI weights are compared between countries in Table 7.1.

Table 7.1: Comparison of STI weights

Country	STI: Component weight	Adjusted STI (excluding capital): Component weight
Sectors		
Nigeria	23%	38%
Algeria	23%	43%
Chad	51%	58%
Capital		
Nigeria	38%	Not Applicable
Algeria	46%	Not Applicable
Chad	12%	Not Applicable
Labour		
Nigeria	12%	38%
Algeria	4%	43%
Chad	16%	58%
Households		
Nigeria	27%	44%
Algeria	27%	50%
Chad	21%	24%

Source: Author's calculations

From the above, the weights for the sector component correspond between Nigeria and Algeria; both have a weight of 23%. There is a slight variation for adjusted STI, with a weight of 38% for Nigeria and 43% for Algeria. Chad's sector component carries a larger weight for both the STI and adjusted STI with 51% and 58%, respectively. Both Nigeria and Algeria are capital intensive with weights of 38% and 46%, respectively. Chad is far less capital intensive with a weight of only 12%. Corresponding to their capital intensities, Nigeria and Algeria's labour weights are 12% and 4%, respectively. Chad is more labour intensive with a weight of 16%. For labour, the adjusted STI weights increase for all three countries. In terms of households, both Nigeria and Algeria have a weight of 27% in the STI and 44% and 50% for the adjusted STI. Chad's household weights are lower with 21% and 24%, respectively.

From these results, Nigeria should focus on improving the oil sector's backward linkages as well as the linkage to labour. In terms of the reduced STI score, Algeria could also focus on improving the oil sector's linkages to both sectors and labour. The oil sector is mostly capital intensive in these countries. Expanding the oil sector's linkages and impact to other sectors may indirectly increase employment through the impact on these sectors. Based on the results, Chad's oil sector can produce large multiplier impacts, depending on the multiplicand (size of the expenditure injection). However, in comparison to other sectors in Chad's economy (see Figure 5.5), the oil sector has very weak forward linkages with weak backward linkages. Accordingly, there should also be a focus on expanding the oil sector's linkages to the rest of Chad's economy.

Based on the STI, Nigeria, Algeria and Chad may consider implementing a more lenient fiscal stance in order to promote upstream investment and reap more of the economy-wide benefits. However, the reader is cautioned that the STI results for Chad may be less reliable. At this stage, the STI results for Nigeria and Algeria may be more accurate (comparable) indicators than that of Chad. The STI results are summarised in Table 7.2.

Table 7.2: Summary of STI results

Country	STI	STI excluding capital
Nigeria	0.732	0.587
Algeria	0.666	0.456
Chad	6.94	7.55

Source: Author's calculations

From Table 7.2, all three countries analysed in this thesis have an STI value greater than 0. With the exception of Chad's potentially less reliable results, Nigeria has the largest STI followed by Algeria. The relative sizes of Nigeria and Algeria's economies have a distinct impact on their multiplier and STI results. Accordingly, these host governments may consider implementing a more lenient fiscal stance in order to promote upstream investment and reap more of the economy-wide benefits. Expanding the oil sector's backward linkages will help to reap more economic benefits for the domestic economy. Importantly, the extent of economic diversification will also have an impact on the extent of the oil sector's economy-wide impacts.

7.3 Policy recommendations

The critical underlying theme of this thesis is the trade-off faced by host governments in terms of attaining a fair share of economic rent and providing sufficient incentive for investment in upstream exploration and development. The STI method developed in this thesis can help host governments to evaluate the oil sector's economy-wide impact on their economy. This knowledge can then be used in conjunction with other instruments, such as the government take statistic. Specifically, the STI will better address the trade-off that oil-producing countries (or nascent producers) face in terms of attaining a fair share of economic rent and providing sufficient incentive for investment in upstream exploration and development. Accordingly, the STI provides further clarity on the issues that are at stake. It is not only the government take (taxation) that is important, but also the extent of the oil sector's economy-wide impacts.

Countries with a large (positive) STI score receive significant economic benefits from the oil sector's activities. In such cases, a slightly lower government take could be acceptable, assuming this will promote further investment and with it further economic benefits in terms of the STI. Therefore, such a host government may consider implementing a more lenient fiscal stance in order to promote upstream investment and reap more of the economy-wide benefits.

In contrast, host countries with a relatively low (close to 0) STI will have to first consider policies to expand the oil sector's economy-wide impacts before opting for a more lenient fiscal stance. This is especially true for countries with an established oil sector and a long history of oil production. Within such a context (low STI score), the ancillary policy would be to focus more on the extent of government take, by attempting to increase the fiscal (tax) benefits for the host country until such time as the STI could be improved. However, in the case of countries with a nascent oil sector, still to make significant discoveries, the host government should take cognisance of the lack of proven reserves and production when interpreting their STI, since the sector is still in the start-up phase and still needs to be established before any significant sector linkages can form. Within this context, favourable tax policies tied to policies that stimulate the development of local supply networks (promoting backward-linkages) may be conducive to developing the oil sector and the potential for future economic benefits.

The above considerations must also account for the oil price environment. The oil market is currently (2015) in a global downward price spiral due to oversupply and weakening global demand. The current outlook will have an impact on exploration in the medium to long term. Host countries should incorporate such price fluctuations into their oil sector policy stance. In the current low price environment, the STI is especially important. Focusing on the oil sector's economy-wide impacts (as measured in the STI), host governments can accommodate investors with more favourable regimes that can help to sustain investment during periods of oil price downturns. However, the policy should also allow for upward flexibility during periods of sustained price increases.

7.4 Vision for further and future development

This thesis has shown that the oil sector's economy-wide impacts can be measured and meaningfully incorporated into the evaluation of petroleum fiscal systems. It must be emphasised that the STI is not an attempt to replace all other fiscal evaluation instruments, but rather to serve a specific purpose in the overall toolkit that host governments use when evaluating their petroleum fiscal system. The oil sector's economy-wide impacts no longer have to be ignored, but can form an integral part of the evaluation of petroleum fiscal systems. One of the major constraints on this thesis has been the limited data available on African economies, specifically in terms of Angola. As soon as a SAM for Angola becomes available, the next step will be to calculate the STI for Angola. Over time, the author intends to expand (follow-up research) the countries included in the STI. The goal is to calculate STI scores for all of Africa's oil producers and monitor the evolution of the oil sector's STI scores and the associated economy-wide impacts. The foreign based nature of Africa's oil sector can produce "leakages". The development literature, on sectors which exists in "vacuums", can be linked to how a lack of linkages could impact on the STI. The literature on the political economy of oil in Africa can provide further context.

The construction of SAMs for African countries is critical to gain a better understanding, also over time, of the structural changes that the development of the oil industry can bring about in Africa. Considering the data limitations associated with the analysis of African economies, the collective SAM analysis performed in this thesis is an example of what can be done. Future research should also incorporate the SAM and STI analysis with the allocation and expenditure of the tax revenue received by the host government. Such research could link the issues of revenue collection, investment attraction, revenue allocation and revenue management. The key question to incorporate is whether this tax revenue is distributed to the wide population or captured by politicians and bureaucrats.

Future research should also examine how resource fiscal windfalls can affect economic development and the role of the state and state owned enterprises in this regard, which impacts on the nature of the petroleum fiscal system adopted. Chapter 3 provided a comparative analysis of selected global petroleum fiscal systems, whilst Chapter 4 is a continuation of the discussion of petroleum fiscal systems presented in Chapters 2 and 3, but with a specific focus on the current petroleum fiscal systems of the African countries that were used for the empirical analysis. The analysis in Chapter 3 and 4 focused on comparing the differences and trends in terms of the current systems. However, the following issues were not considered, the evolution of these systems over time, whether the systems have been contested, the debates at the time of formulation, as well as the link to economic theory. Future research should examine these dynamic issues in order to provide more clarity on the processes that guide the evolution of petroleum fiscal systems.

Furhtermore, the use and role of sovereign wealth funds must also be considered, especially the case of Norway. The literature on sovereign wealth funds can be used to deal with both the macro-economic and rent-seeking effects of oil revenues, but which in itself is driving investments in the upstream and downstream industry. For example, Azerbaijan's State Oil Funds' investment in trans-European pipelines. It will also be useful to expand the STI analysis to other nascent and mature oil-producing regions. The issue of local content and the shortage of technical skills is a further aspect that can be included.

7.5 Concluding remarks

Although data on individual fiscal systems are publicly available, there is no recent comparative analysis of petroleum fiscal systems between countries. Furthermore, from the government policy perspective, government take is one of the main instruments used to evaluate petroleum fiscal systems in the upstream sector. However, it is often calculated on unrealistic assumptions. More importantly, the macroeconomic scope of government take is too narrow and does not account for the oil sector's economy-wide impacts. Considering the government's trade-off between collecting a 'fair' share and attracting investment, the oil sector's economy-wide impacts represent an important policy factor. Should a country consider these impacts, it may be able to provide a more attractive investment destination. In such a case, the economy could benefit in terms of not only government revenue, but also increased investment as well as realising the economy-wide impacts that accompany such investment.

For these reasons, the aim of this thesis was twofold. Firstly, it provided a recent mapping of the various petroleum fiscal systems in a comparative manner, for a representative sample of oil producers. These producers included: Russia, Brazil, Norway, the United Kingdom, Australia, China, Iraq, Oman, Indonesia and Azerbaijan. Secondly, it provided a measurement instrument (structure) that can incorporate the oil sector's economy-wide impacts as part of the evaluation process. The focus was specifically on petroleum fiscal systems in Africa, considering Nigeria, Angola, Algeria and Chad. The development of the measurement instrument (structure) involved two components. Firstly, the country- and sector-specific linkages were identified and evaluated by means of multiplier decomposition and SPA. The focus was specifically on the oil sector's backward linkages, which embody the oil sector's purchases from other sectors to enable the production of oil sector output. Secondly, the knowledge of these linkages was used to develop a measurement instrument, the STI, based on the structure of the specific African economies evaluated in this thesis. Using the STI, these three African oil producers will now be able to incorporate the oil sector's economy-wide impacts when they evaluate their petroleum fiscal systems. Over time, the changes in the STI can be monitored and policies adjusted accordingly.

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Appendix I: Nigeria

This appendix lays the foundation for the analysis in Chapter 5. Tables I.1 summarises the macro structure of the Nigeria SAM used for the multiplier and SPA analysis in Chapter 5. Table I.2 and I.3 give the SAM account (activities and commodities) abbreviations and their corresponding names. Table I.4 provides the detailed results from the SPA performed in Chapter 5. Figure I.1 to I.16 are a graphical representation of the SPA results from Chapter 5.

Table I.1: Macro Social Accounting Matrix for Nigeria (2006)

Receipts \ Payments	Activities	Commodities	Labour	Capital	Land	Enterprises	Households	Government	Capital account	Rest of the world	Total
Activities		26 868 389.7						26 730.6			**26 895 120.3**
Commodities	6 814 769.5		677 153.9				12 788 014.2	3 716 689.7	976 109.0	7 836 670.9	**32 809 407.2**
Labour	9 099 655.2	677 153.9									**9 776 809.1**
Capital	8 618 833.3										**8 618 833.3**
Land	2 190 044.0										**2 190 044.0**
Enterprises				4 865 843.7							**4 865 843.7**
Households			9 099 655.2		2 190 044.0	2 632 477.6		171 781.1		1 359 241.7	**15 453 199.6**
Government	171 818.2	296 800.0		2 760 884.3		2 233 366.1	125 405.2	2 800 658.9		206 333.8	**8 595 266.5**
Capital account							2 539 780.2	1 879 406.2			**4 419 186.4**
Rest of the world		4 967 063.6		992 105.4					3 443 077.5		**9 402 246.4**
Total	**26 895 120.3**	**32 809 407.2**	**9 776 809.1**	**8 618 833.3**	**2 190 044.0**	**4 865 843.7**	**15 453 199.6**	**8 595 266.5**	**4 419 186.4**	**9 402 246.4**	**123 025 956.5**

Note: *Trade costs (TRC) where incorporated into the labour account for the macro SAM, Household subgroups have been aggregated.*

Table I.2: Nigeria SAM accounts: Activities

Account Number	Code	Description	Account Number	Code	Description
1	arice	Rice	31	aoliv	Other live animals
2	awhet	Wheat	32	afish	Fish and fish meat
3	amaze	Maize	33	afore	Forestry
4	asorg	Sorghum	34	abeef	Beef
5	amilt	Millet	35	agsmt	Goat and sheep meat
6	acass	Cassava	36	apmet	Poultry meat
7	ayams	Yams	37	aeggs	Eggs
8	acyam	Cocoyams	38	amilk	Milk and dairy products
9	apota	Irish potato	39	aomet	Other livestock meat
10	aspot	Sweet potato	40	abevg	Beverages and tobacco products
11	aplan	Banana and plantain	41	aofod	Processed food products (excluding beverages)
12	abean	Beans	42	atext	Textiles and leather products
13	agnut	Groundnuts	43	awood	Wood, wood products, furniture
14	asoys	Soyabeans	44	aemfc	Transportation and other equipment
15	aosed	Beniseed	45	aomfc	Other manufactured products
16	aveg	Vegetables	46	acoil	Crude petroleum and natural gas
17	afrt	Fruits	47	aroil	Refined oil
18	acoco	Cocoa	48	aomin	Other mining
19	acoff	Coffee	49	acons	Building and construction
20	acott	Cotton	50	autil	Electricity and water
21	apalm	Oil palm	51	artra	Road transport
22	asuga	Sugar and sugar cane	52	aotra	Other transportation
23	atoba	Unprocessed tobacco	53	atrad	Wholesale and retail trade
24	anuts	Nuts	54	ahotl	Hotel and restaurants
25	acash	Cashew	55	acomm	Telecommunications, Post, broadcasting
26	arube	Rubber	56	abser	Financial institutions, Insurance, Business services (not health or education)
27	aocrp	Other crops not specified	57	arest	Real estate
28	acatl	Cattle	58	aeduc	Education

Table I.2: Continued

29	agshp	Live goats and sheep	59	aheal	Health
30	apoul	Live poultry	60	apser	Public administration
			61	aoser	Private non profit organisations, Other services

Table I.3: Nigeria SAM accounts: Commodities

Account Number	Code	Description	Account Number	Code	Description
1	crice	Rice	31	coliv	Other live animals
2	cwhet	Wheat	32	cfish	Fish and fish meat
3	cmaze	Maize	33	cfore	Forestry
4	csorg	Sorghum	34	cbeef	Beef
5	cmilt	Millet	35	cgsmt	Goat and sheep meat
6	ccass	Cassava	36	cpmet	Poultry meat
7	cyams	Yams	37	ceggs	Eggs
8	ccyam	Cocoyams	38	cmilk	Milk and dairy products
9	cpota	Irish potato	39	comet	Other livestock meat
10	cspot	Sweet potato	40	cbevg	Beverages and tobacco products
11	cplan	Banana and plantain	41	cofod	Processed food products (excluding beverages)
12	cbean	Beans	42	ctext	Textiles and leather products
13	cgnut	Groundnuts	43	cwood	Wood, wood products, furniture
14	csoys	Soyabeans	44	cemfc	Transportation and other equipment
15	cosed	Beniseed	45	comfc	Other manufactured products
16	cveg	Vegetables	46	cfert	Fertilizer
17	cfrt	Fruits	47	ccoil	Crude petroleum and natural gas
18	ccoco	Cocoa	48	croil	Refined oil
19	ccoff	Coffee	49	comin	Other mining
20	ccott	Cotton	50	ccons	Building and construction
21	cpalm	Oil palm	51	cutil	Electricity and water
22	csuga	Sugar and sugar cane	52	crtra	Road transport

Table I.3: Continued

Account Number	Code	Description	Account Number	Code	Description
23	ctoba	Unprocessed tobacco	53	cotra	Other transportation
24	cnuts	Nuts	54	ctrad	Wholesale and retail trade
25	ccash	Cashew	55	chotl	Hotel and restaurants
26	crube	Rubber	56	ccomm	Telecommunications, Post, broadcasting
27	cocrp	Other crops not specified	57	cbser	Financial institutions, Insurance, Business services (not health or education)
28	ccatl	Cattle	58	crest	Real estate
29	cgshp	Live goats and sheep	59	ceduc	Education
30	cpoul	Live poultry	60	cheal	Health
			61	cpser	Public administration
			62	coser	Private non profit organisations, Other services

Table I.4: SPA for selected activities: Nigeria (CASE I TO XI)

Case	Origin	Dest.	Global infl.	Path	Direct infl.	Path mult.	Total infl.	Prop. (in %)	Accum. Prop.
I	acoil	atrad	0.06	acoil / fcap / ent / Households / cgsmt / agsmt / ctrad / atrad	0.002	2.53	0.005	8.4	8.4
				acoil / fcap / ent / Households / cyams / trc / ctrad / atrad	0.002	2.61	0.004	7.2	15.7
				acoil / fcap / ent / Households / ccass / trc / ctrad / atrad	0.001	2.61	0.003	5.6	21.3
				acoil / fcap / ent / Households / crice / trc / ctrad / atrad	0.001	2.54	0.003	4.7	26.1
				acoil / fcap / ent / Households / ctrad / atrad	0.001	2.53	0.003	4.4	30.5
				acoil / fcap / ent / Households / cbeef / abeef / ctrad / atrad	0.001	2.53	0.002	3.7	34.1
				acoil / fcap / ent / Households / ccass / acass / ctrad / atrad	0.001	2.61	0.002	3.4	37.5
				acoil / fcap / ent / Households / cyams / ayams / ctrad / atrad	0.001	2.61	0.001	2.4	39.9
				acoil / fcap / ent / Households / cfish / trc / ctrad / atrad	0.001	2.54	0.001	2.3	42.2
				acoil / fcap / ent / Households / cmilt / trc / ctrad / atrad	0.001	2.53	0.001	2.2	44.4
				acoil / fcap / ent / Households / cbean / trc / ctrad / atrad	0.000	2.56	0.001	1.8	46.1
				acoil / fcap / ent / Households / cmaze / trc / ctrad / atrad	0.000	2.54	0.001	1.7	47.8
				acoil / fcap / ent / Households / crice / arice / ctrad / atrad	0.000	2.54	0.001	1.6	49.4

Table I.4: Continued

Case	Origin	Dest.	Global infl.	Path	Direct infl.	Path mult.	Total infl.	Prop. (in %)	Accum. Prop.
II	acoil	acass	0.04	acoil / fcap / ent / Households / ccass / acass	0.017	2.42	0.041	94.1	94.1
				acoil / crtra / artra / flab / Households / ccass / acass	0.000	2.43	0.001	1.7	95.8
				acoil / flab / Households / ccass / acass	0.000	2.42	0.000	0.8	96.6
				acoil / crtra / artra / fcap / ent / Households / ccass / acass	0.000	2.43	0.000	0.3	96.9
				acoil / cbser / abser / flab / Households / ccass / acass	0.000	2.53	0.000	0.3	97.3
				acoil / fcap / ent / Households / chotl / ahotl / ccass / acass	0.000	2.44	0.000	0.3	97.5
				acoil / fcap / ent / Households / cofod / aofod / ccass / acass	0.000	2.43	0.000	0.2	97.8
				acoil / comfc / aomfc / fcap / ent / Households / ccass / acass	0.000	2.50	0.000	0.2	98.0
				acoil / cemfc / aemfc / fcap / ent / Households / ccass / acass	0.000	2.50	0.000	0.2	98.2
				acoil / cemfc / trc / ctrad / atrad / flab / Households / ccass / acass	0.000	2.69	0.000	0.2	98.3
III	acoil	ayams	0.04	acoil / fcap / ent / Households / cyams / ayams	0.015	2.41	0.037	94.3	94.3
				acoil / crtra / artra / flab / Households / cyams / ayams	0.000	2.43	0.001	1.7	96.0
				acoil / flab / Households / cyams / ayams	0.000	2.41	0.000	0.8	96.8
				acoil / crtra / artra / fcap / ent / Households / cyams / ayams	0.000	2.43	0.000	0.3	97.2
				acoil / cbser / abser / flab / Households / cyams / ayams	0.000	2.52	0.000	0.3	97.5
				acoil / fcap / ent / Households / cofod / aofod / cyams / ayams	0.000	2.43	0.000	0.3	97.8
				acoil / comfc / aomfc / fcap / ent / Households / cyams / ayams	0.000	2.50	0.000	0.2	98.0
				acoil / cemfc / aemfc / fcap / ent / Households / cyams / ayams	0.000	2.49	0.000	0.2	98.2
				acoil / cemfc / trc / ctrad / atrad / flab / Households / cyams / ayams	0.000	2.69	0.000	0.2	98.4
				acoil / cemfc / aemfc / flab / Households / cyams / ayams	0.000	2.49	0.000	0.2	98.5

Table I.4: Continued

Case	Origin	Dest.	Global infl.	Path	Direct infl.	Path mult.	Total infl.	Prop. (in %)	Accum. Prop.
IV	acoil	agsmt	0.03	acoil / fcap / ent / Households / cgsmt / agsmt	0.014	2.34	0.032	94.6	94.6
				acoil / crtra / artra / flab / Households / cgsmt / agsmt	0.000	2.36	0.001	1.7	96.3
				acoil / flab / Households / cgsmt / agsmt	0.000	2.34	0.000	0.8	97.1
				acoil / crtra / artra / fcap / ent / Households / cgsmt / agsmt	0.000	2.36	0.000	0.3	97.5
				acoil / cbser / abser / flab / Households / cgsmt / agsmt	0.000	2.45	0.000	0.3	97.8
				acoil / comfc / aomfc / fcap / ent / Households / cgsmt / agsmt	0.000	2.42	0.000	0.2	98.0
				acoil / cemfc / aemfc / fcap / ent / Households / cgsmt / agsmt	0.000	2.42	0.000	0.2	98.2
				acoil / cemfc / trc / ctrad / atrad / flab / Households / cgsmt / agsmt	0.000	2.61	0.000	0.2	98.4
				acoil / cemfc / aemfc / flab / Households / cgsmt / agsmt	0.000	2.42	0.000	0.2	98.5
				acoil / comfc / aomfc / flab / Households / cgsmt / agsmt	0.000	2.42	0.000	0.2	98.7
V	acoil	arice	0.03	acoil / fcap / ent / Households / crice / arice	0.010	2.35	0.024	94.6	94.6
				acoil / crtra / artra / flab / Households / crice / arice	0.000	2.36	0.000	1.7	96.3
				acoil / flab / Households / crice / arice	0.000	2.35	0.000	0.8	97.2
				acoil / crtra / artra / fcap / ent / Households / crice / arice	0.000	2.36	0.000	0.3	97.5
				acoil / cbser / abser / flab / Households / crice / arice	0.000	2.46	0.000	0.3	97.8
				acoil / comfc / aomfc / fcap / ent / Households / crice / arice	0.000	2.43	0.000	0.2	98.0
				acoil / cemfc / aemfc / fcap / ent / Households / crice / arice	0.000	2.43	0.000	0.2	98.2
				acoil / cemfc / trc / ctrad / atrad / flab / Households / crice / arice	0.000	2.62	0.000	0.2	98.4
				acoil / cemfc / aemfc / flab / Households / crice / arice	0.000	2.43	0.000	0.2	98.6
				acoil / comfc / aomfc / flab / Households / crice / arice	0.000	2.43	0.000	0.2	98.7
VI	acoil	artra	0.02	acoil / crtra / artra	0.014	1.03	0.014	59.0	59.0
				acoil / fcap / ent / Households / crtra / artra	0.002	2.36	0.005	22.2	81.1
				acoil / fcap / ent / Households / cgsmt / agsmt / crtra / artra	0.000	2.36	0.000	1.0	82.2
				acoil / fcap / ent / Households / coser / aoser / crtra / artra	0.000	2.36	0.000	0.9	83.1
				acoil / fcap / ent / Households / cbser / abser / crtra / artra	0.000	2.46	0.000	0.9	84.0
				acoil / fcap / ent / Households / cgsmt / agsmt / ctrad / atrad / crtra / artra	0.000	2.54	0.000	0.8	84.8
				acoil / fcap / ent / Households / cfish / afish / crtra / artra	0.000	2.37	0.000	0.7	85.5

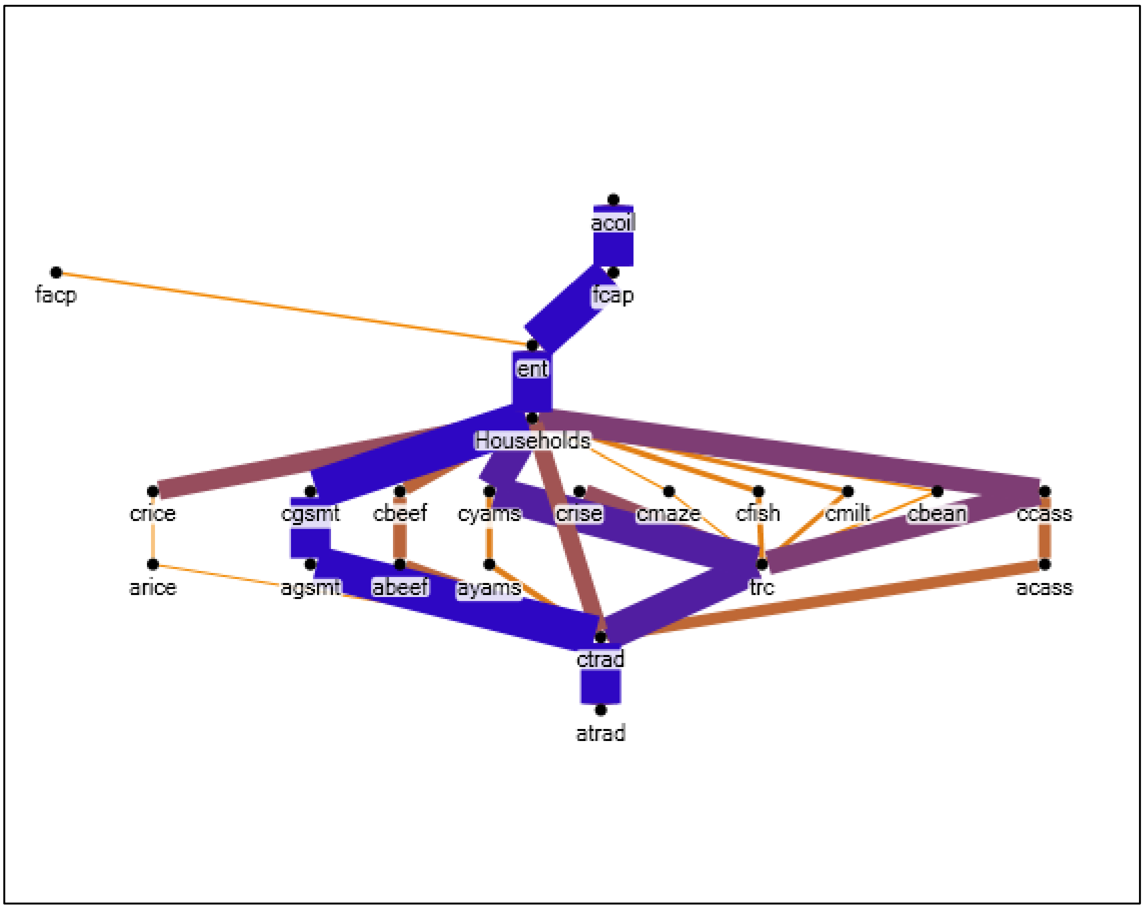
Table I.4: Continued

Case	Origin	Dest.	Global infl.	Path	Direct infl.	Path mult.	Total infl.	Prop. (in %)	Accum. Prop.
				acoil / fcap / ent / Households / cyams / trc / ctrad / atrad / crtra / artra	0.000	2.62	0.000	0.7	86.2
				acoil / fcap / ent / Households / cbeef / abeef / crtra / artra	0.000	2.36	0.000	0.5	86.7
				acoil / fcap / ent / Households / ccass / trc / ctrad / atrad / crtra / artra	0.000	2.62	0.000	0.5	87.3
VII	acoil	autil	0.02	acoil / fcap / ent / Households / cutil / autil	0.008	2.35	0.018	80.1	80.1
				acoil / fcap / ent / Households / chotl / ahotl / cutil / autil	0.000	2.37	0.001	3.0	83.1
				acoil / fcap / ent / Households / ceduc / aeduc / cutil / autil	0.000	2.35	0.000	2.1	85.1
				acoil / fcap / ent / Households / cheal / aheal / cutil / autil	0.000	2.35	0.000	2.0	87.2
				acoil / crtra / artra / flab / Households / cutil / autil	0.000	2.37	0.000	1.4	88.6
				acoil / fcap / ent / Households / coser / aoser / cutil / autil	0.000	2.35	0.000	1.4	90.1
				acoil / fcap / ent / Households / cbser / abser / cutil / autil	0.000	2.46	0.000	1.3	91.3
				acoil / fcap / ent / Households / cmaze / amaze / cutil / autil	0.000	2.36	0.000	0.8	92.2
				acoil / flab / Households / cutil / autil	0.000	2.35	0.000	0.7	92.9
				acoil / croil / aroil / cutil / autil	0.000	1.07	0.000	0.7	93.5
VIII	acoil	amaze	0.02	acoil / fcap / ent / Households / cmaze / amaze	0.009	2.35	0.020	94.4	94.4
				acoil / crtra / artra / flab / Households / cmaze / amaze	0.000	2.36	0.000	1.7	96.1
				acoil / flab / Households / cmaze / amaze	0.000	2.35	0.000	0.8	97.0
				acoil / crtra / artra / fcap / ent / Households / cmaze / amaze	0.000	2.36	0.000	0.3	97.3
				acoil / cbser / abser / flab / Households / cmaze / amaze	0.000	2.45	0.000	0.3	97.6
				acoil / comfc / aomfc / fcap / ent / Households / cmaze / amaze	0.000	2.43	0.000	0.2	97.8
				acoil / cemfc / aemfc / fcap / ent / Households / cmaze / amaze	0.000	2.42	0.000	0.2	98.0
				acoil / cemfc / trc / ctrad / atrad / flab / Households / cmaze / amaze	0.000	2.61	0.000	0.2	98.2
				acoil / cemfc / aemfc / flab / Households / cmaze / amaze	0.000	2.42	0.000	0.2	98.4
				acoil / comfc / aomfc / flab / Households / cmaze / amaze	0.000	2.43	0.000	0.2	98.5
IX	acoil	arest	0.02	acoil / fcap / ent / Households / crest / arest	0.008	2.34	0.018	92.8	92.8
				acoil / crtra / artra / flab / Households / crest / arest	0.000	2.36	0.000	1.7	94.4
				acoil / fcap / ent / Households / cbser / abser / crest / arest	0.000	2.45	0.000	1.5	95.9
				acoil / flab / Households / crest / arest	0.000	2.34	0.000	0.8	96.7

Table I.4: Continued

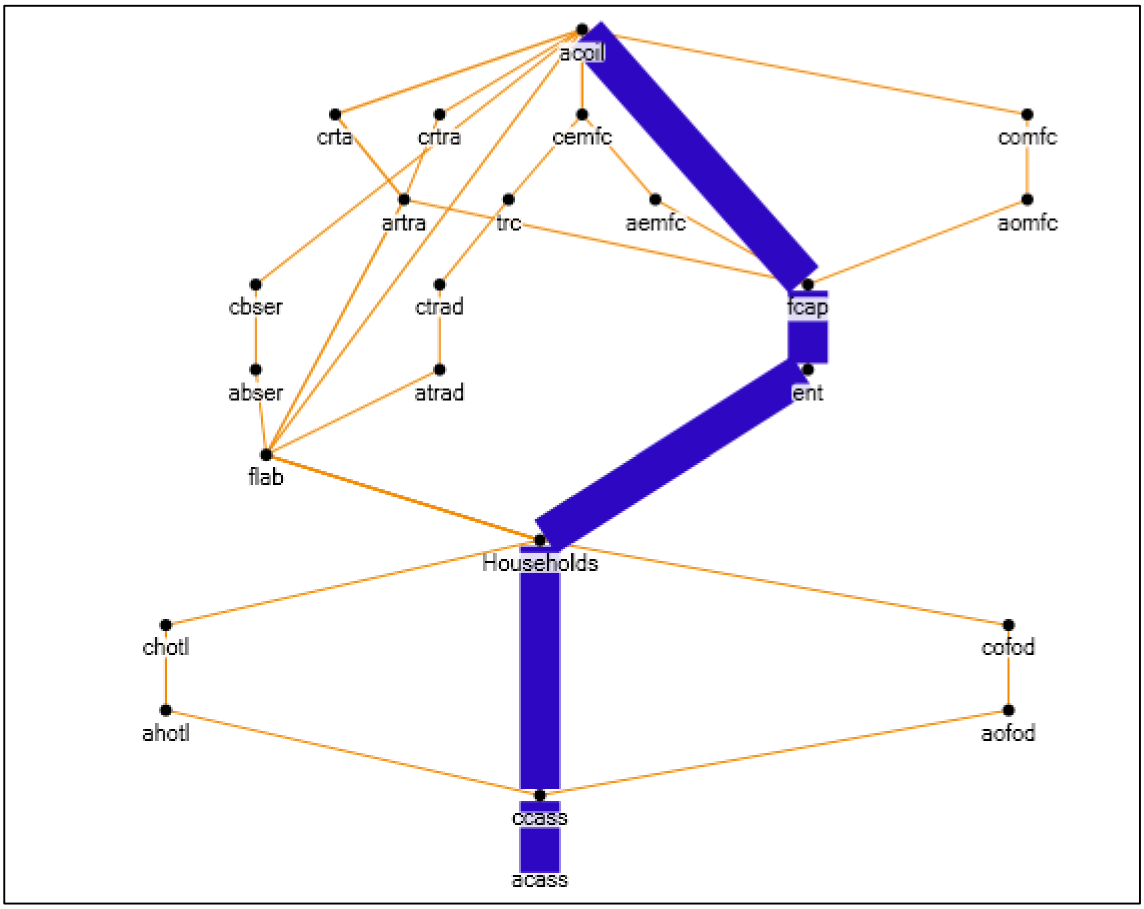
Case	Origin	Dest.	Global infl.	Path	Direct infl.	Path mult.	Total infl.	Prop. (in %)	Accum. Prop.
				acoil / crtra / artra / fcap / ent / Households / crest / arest	0.000	2.36	0.000	0.3	97.1
				acoil / cbser / abser / flab / Households / crest / arest	0.000	2.45	0.000	0.3	97.4
				acoil / cbser / abser / crest / arest	0.000	1.14	0.000	0.2	97.6
				acoil / comfc / aomfc / fcap / ent / Households / crest / arest	0.000	2.42	0.000	0.2	97.8
				acoil / cemfc / aemfc / fcap / ent / Households / crest / arest	0.000	2.42	0.000	0.2	98.0
				acoil / cemfc / trc / ctrad / atrad / flab / Households / crest / arest	0.000	2.61	0.000	0.2	98.2
X	acoil	aveg	0.02	acoil / fcap / ent / Households / cveg / aveg	0.008	2.35	0.018	94.6	94.6
				acoil / crtra / artra / flab / Households / cveg / aveg	0.000	2.36	0.000	1.7	96.3
				acoil / flab / Households / cveg / aveg	0.000	2.35	0.000	0.8	97.1
				acoil / crtra / artra / fcap / ent / Households / cveg / aveg	0.000	2.36	0.000	0.3	97.5
				acoil / cbser / abser / flab / Households / cveg / aveg	0.000	2.45	0.000	0.3	97.8
				acoil / comfc / aomfc / fcap / ent / Households / cveg / aveg	0.000	2.42	0.000	0.2	98.0
				acoil / cemfc / aemfc / fcap / ent / Households / cveg / aveg	0.000	2.42	0.000	0.2	98.2
				acoil / cemfc / trc / ctrad / atrad / flab / Households / cveg / aveg	0.000	2.61	0.000	0.2	98.4
				acoil / cemfc / aemfc / flab / Households / cveg / aveg	0.000	2.42	0.000	0.2	98.5
				acoil / comfc / aomfc / flab / Households / cveg / aveg	0.000	2.42	0.000	0.2	98.7
XI	acoil	abser	0.02	acoil / fcap / ent / Households / cbser / abser	0.005	2.45	0.012	73.3	73.3
				acoil / cbser / abser	0.002	1.08	0.002	11.2	84.5
				acoil / fcap / ent / Households / crest / arest / cbser / abser	0.000	2.45	0.000	2.0	86.6
				acoil / crtra / artra / flab / Households / cbser / abser	0.000	2.46	0.000	1.3	87.9
				acoil / fcap / ent / Households / ccomm / acomm / cbser / abser	0.000	2.58	0.000	1.1	88.9
				acoil / fcap / ent / Households / cutil / autil / cbser / abser	0.000	2.46	0.000	0.8	89.7
				acoil / fcap / ent / Households / chotl / ahotl / cbser / abser	0.000	2.47	0.000	0.7	90.4
				acoil / flab / Households / cbser / abser	0.000	2.45	0.000	0.7	91.1
				acoil / fcap / ent / Households / cfore / afore / cbser / abser	0.000	2.47	0.000	0.6	91.7
				acoil / crtra / artra / cbser / abser	0.000	1.11	0.000	0.5	92.1

Figure I.1: Production activities – Case I



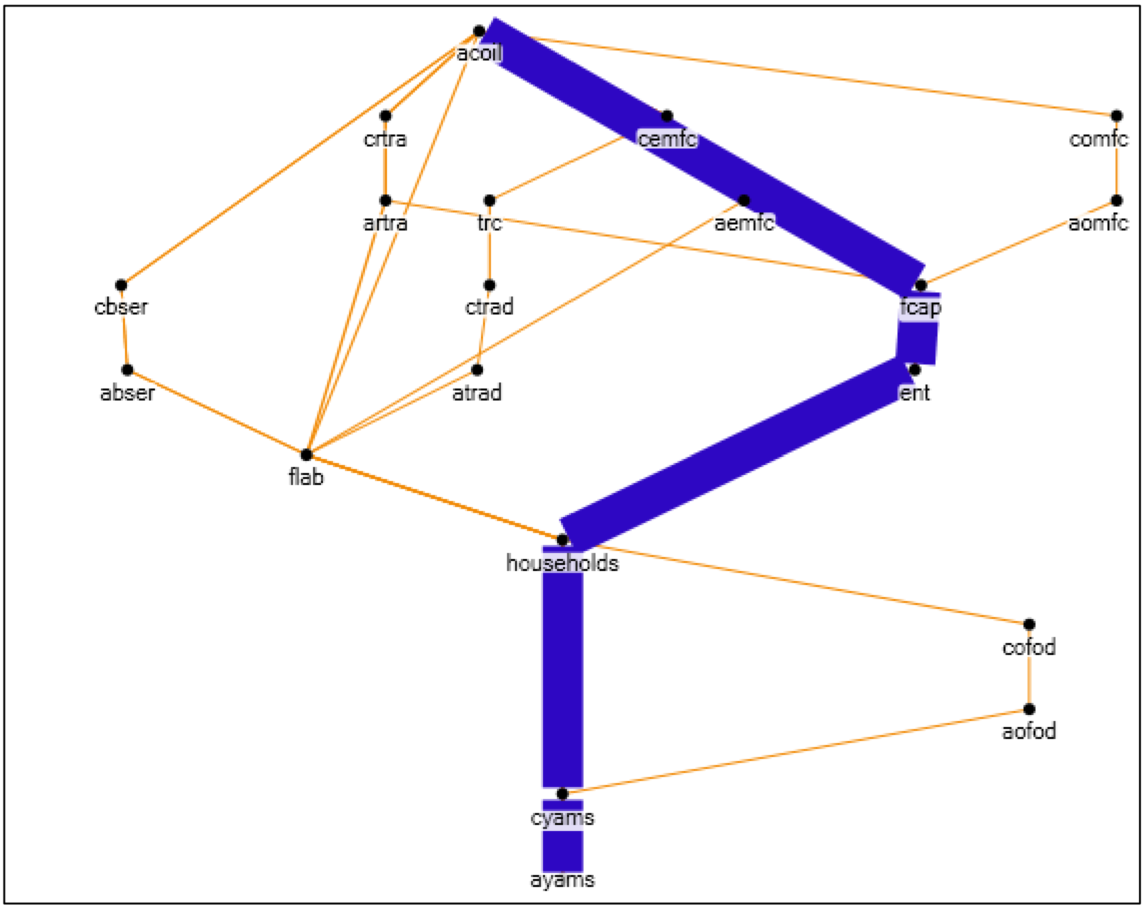
Note: Figure created using the weighted graph scheme of NodeXL. Paths depicted explain 49% of the accounting multiplier.

Figure I.2: Production activities – Case II



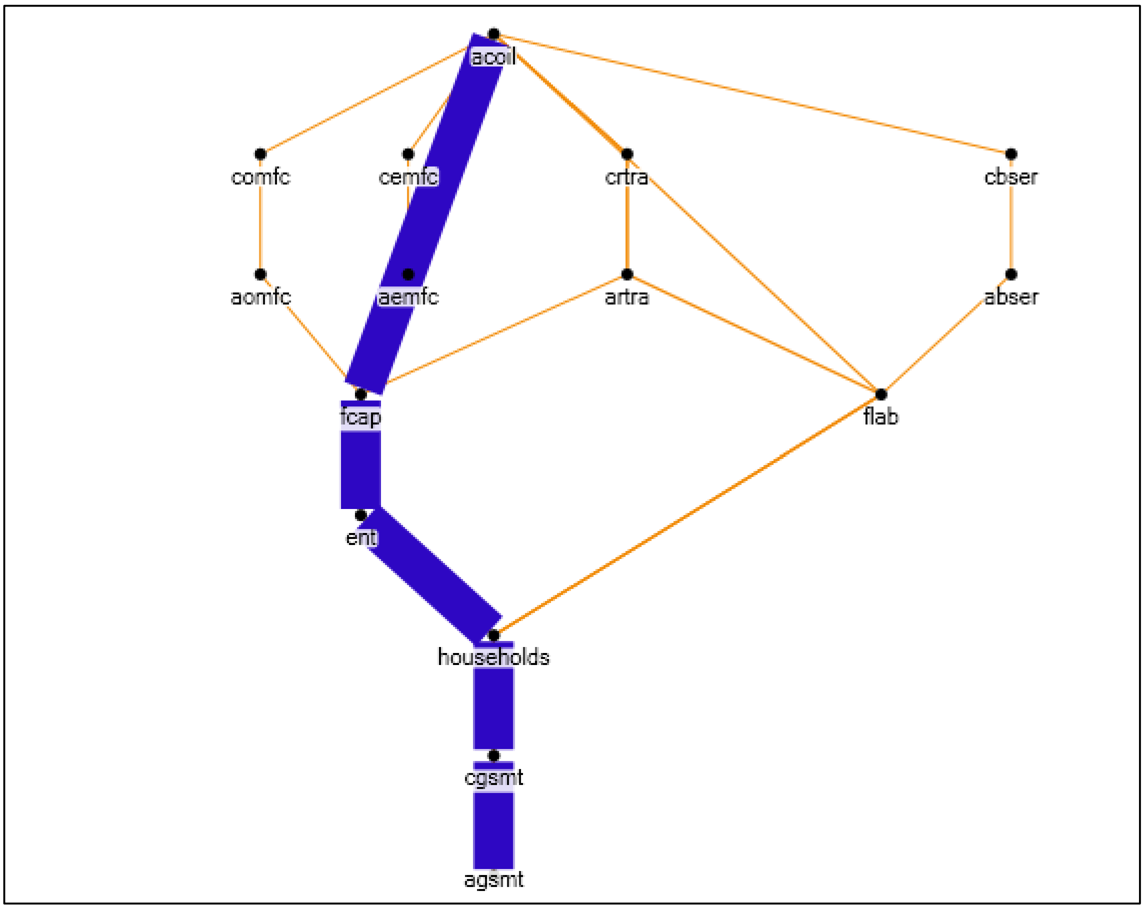
Note: Figure created using the weighted graph scheme of NodeXL. Paths depicted explain 98% of the accounting multiplier.

Figure I.3: Production activities – Case III



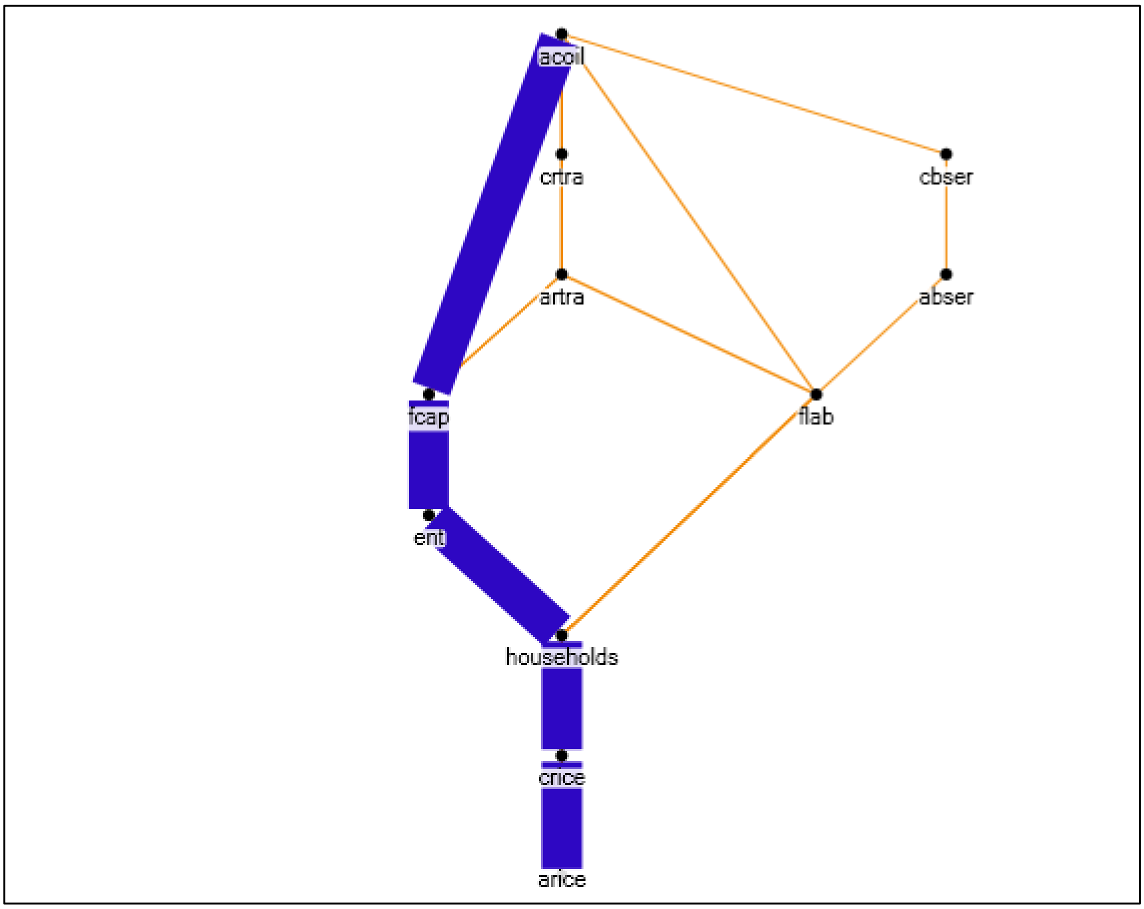
Note: Figure created using the weighted graph scheme of NodeXL. Paths depicted explain 99% of the accounting multiplier.

Figure I.4: Production activities – Case IV



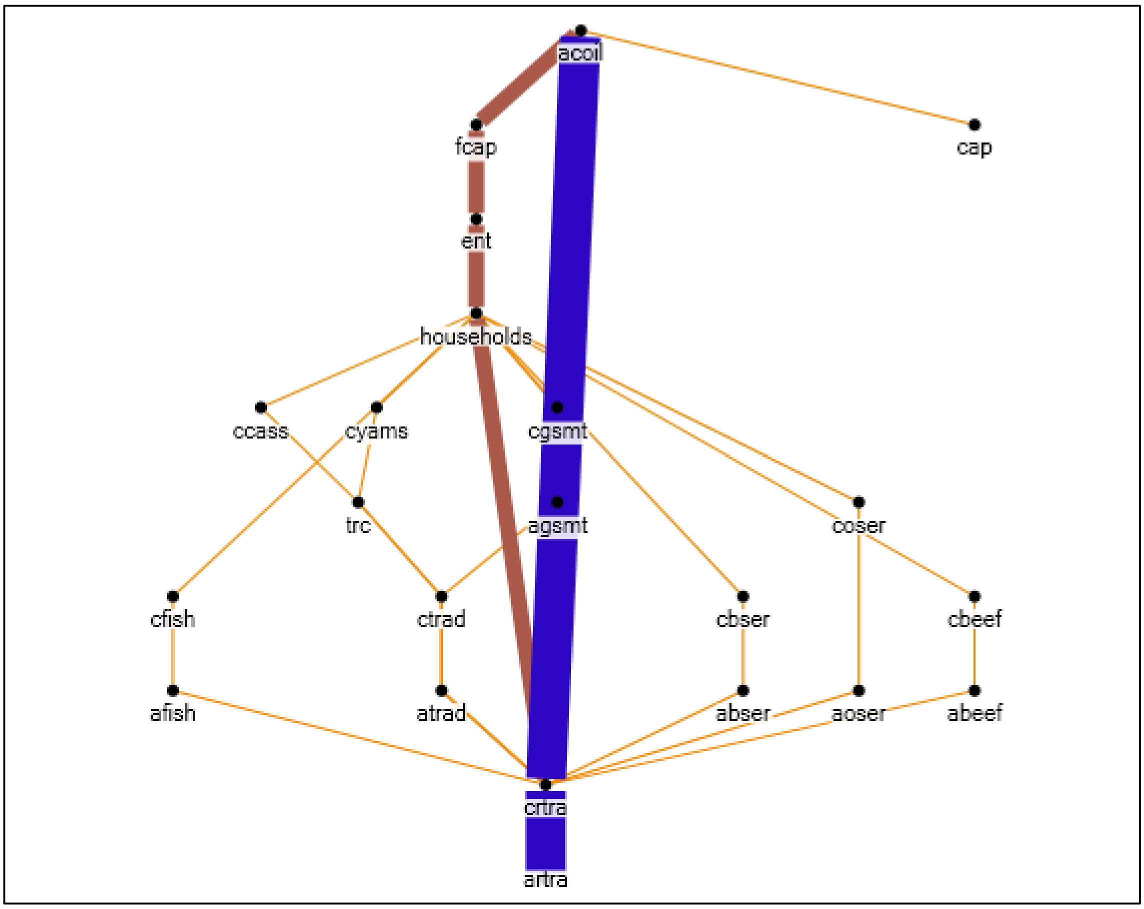
Note: Figure created using the weighted graph scheme of NodeXL. Paths depicted explain 98% of the accounting multiplier.

Figure I.5: Production activities – Case V



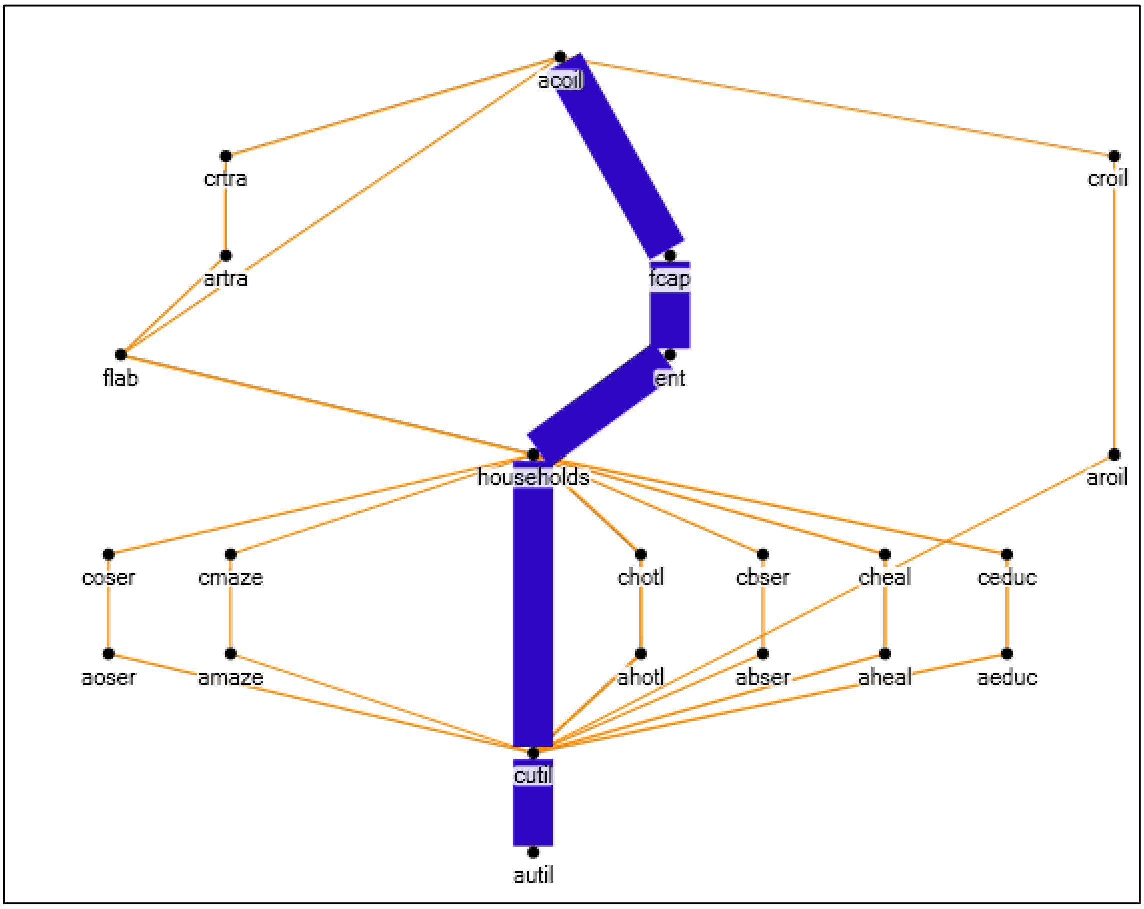
Note: Figure created using the weighted graph scheme of NodeXL. Paths depicted explain 98% of the accounting multiplier.

Figure I.6: Production activities – Case VI



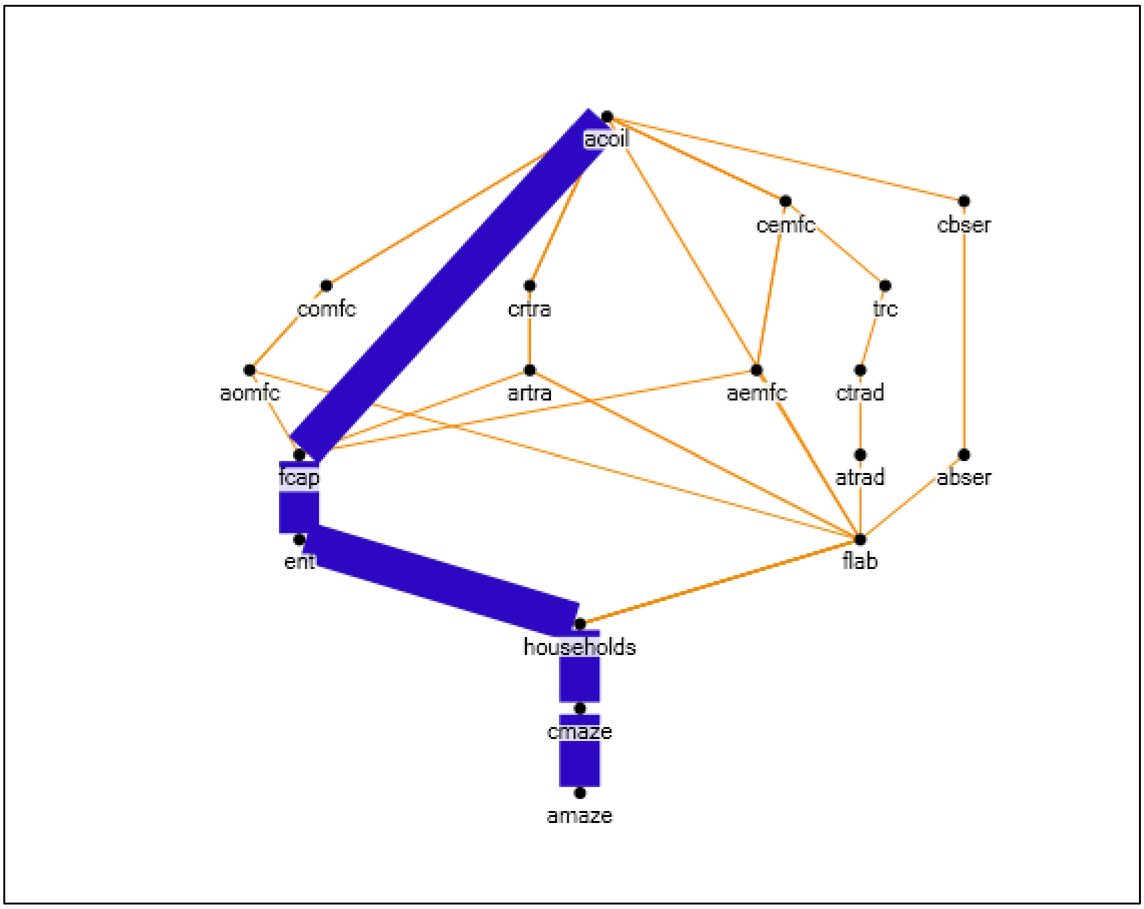
Note: Figure created using the weighted graph scheme of NodeXL. Paths depicted explain 87% of the accounting multiplier.

Figure I.7: Production activities – Case VII



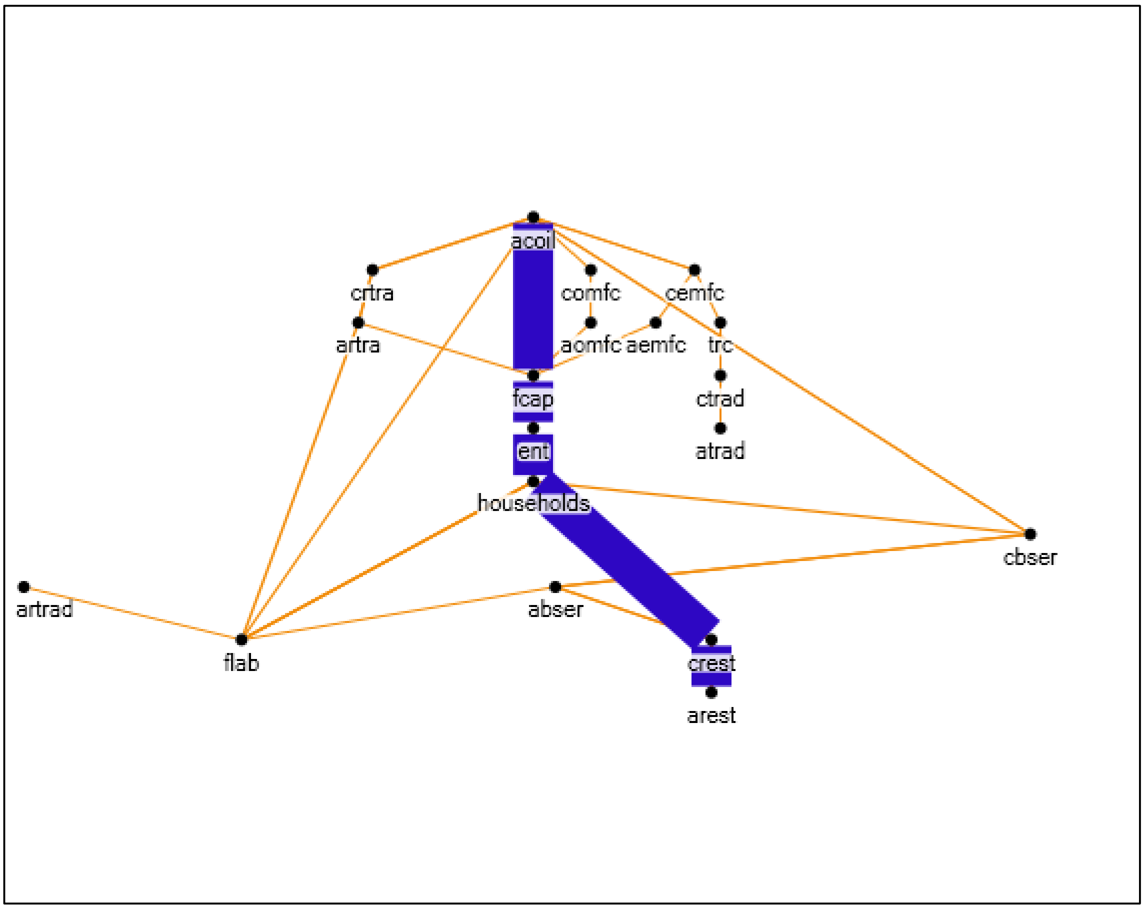
Note: Figure created using the weighted graph scheme of NodeXL. Paths depicted explain 94% of the accounting multiplier.

Figure I.8: Production activities – Case VIII



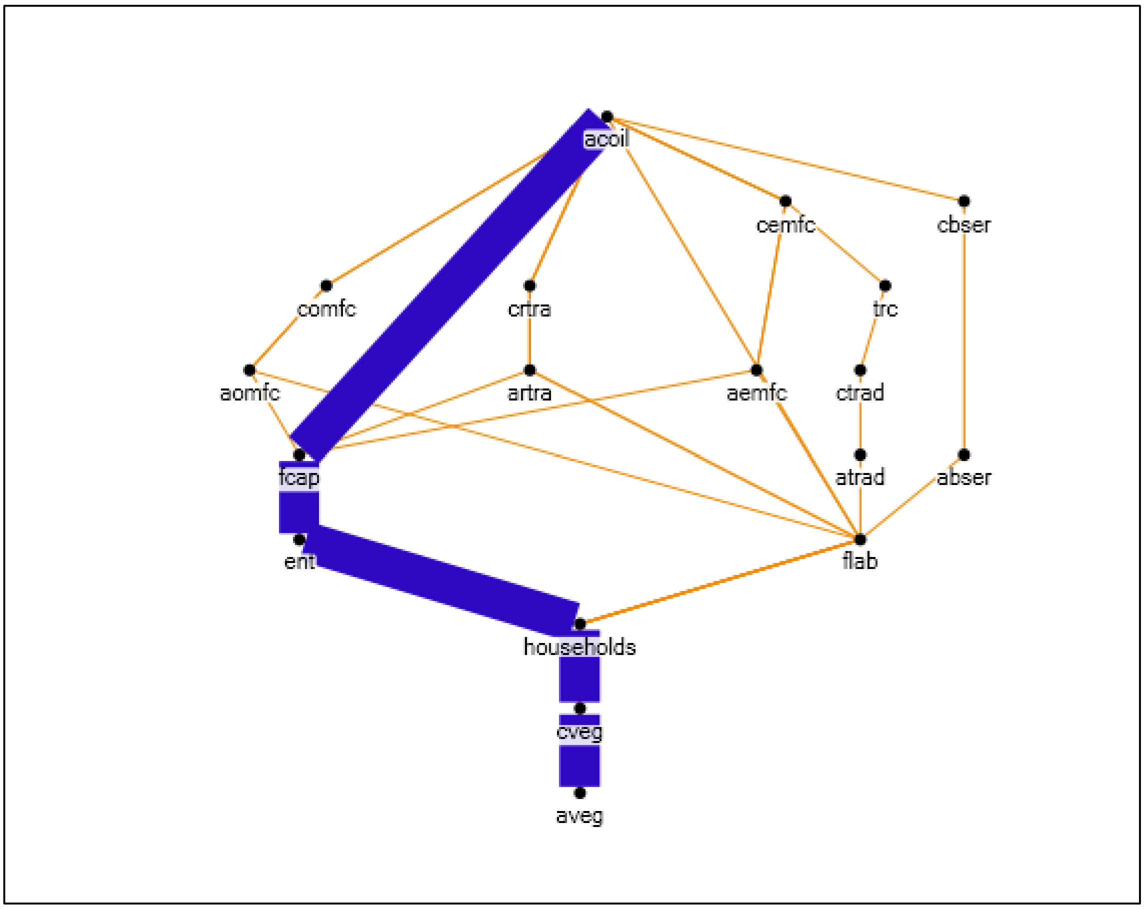
Note: Figure created using the weighted graph scheme of NodeXL. Paths depicted explain 99% of the accounting multiplier.

Figure I.9: Production activities – Case IX



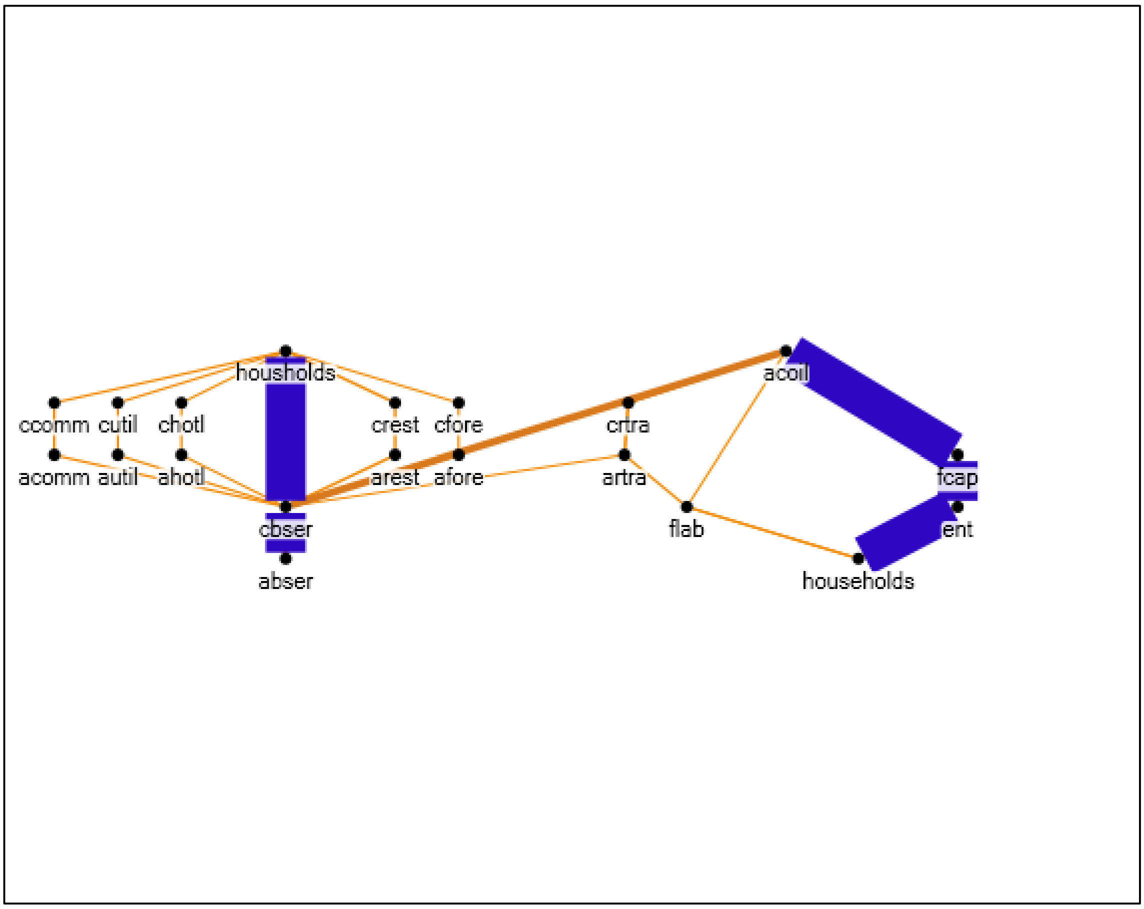
Note: Figure created using the weighted graph scheme of NodeXL. Paths depicted explain 98% of the accounting multiplier.

Figure I.10: Production activities – Case X



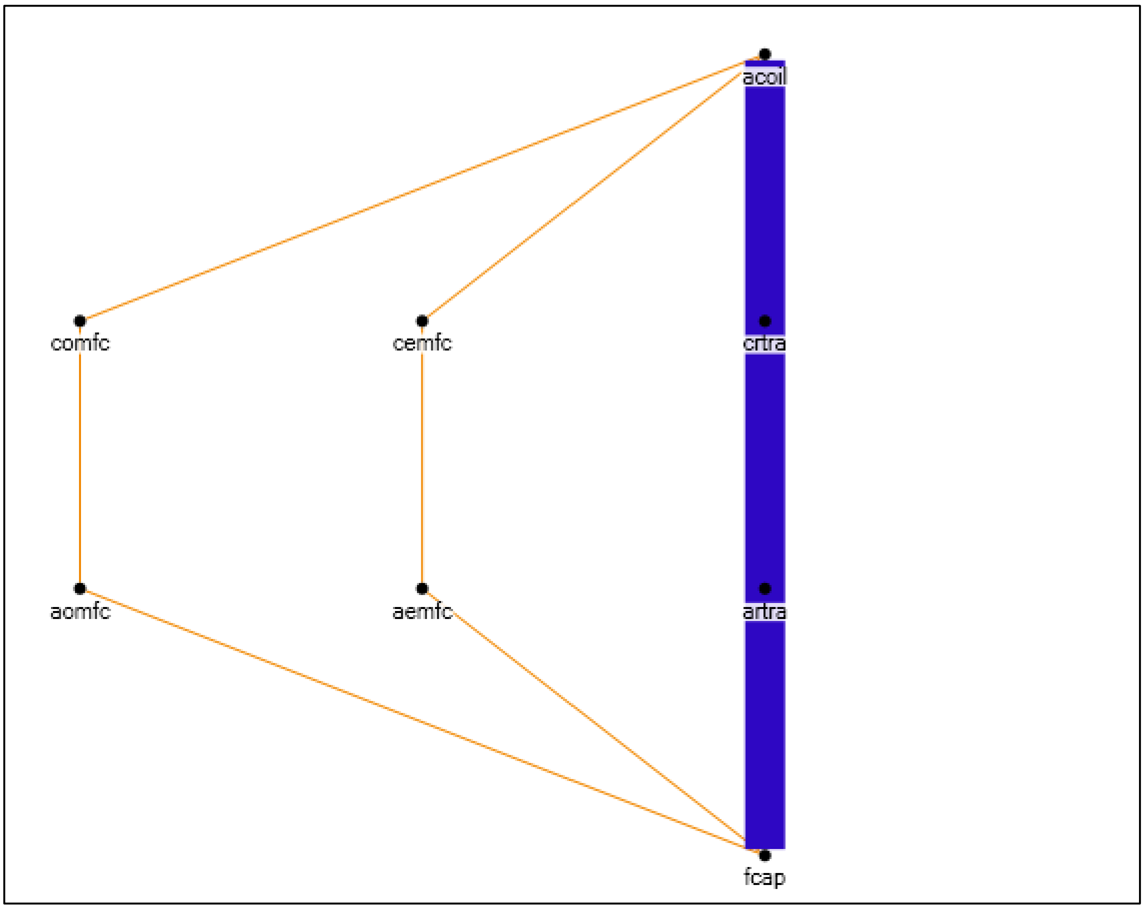
Note: Figure created using the weighted graph scheme of NodeXL. Paths depicted explain 99% of the accounting multiplier.

Figure I.11: Production activities – Case XI



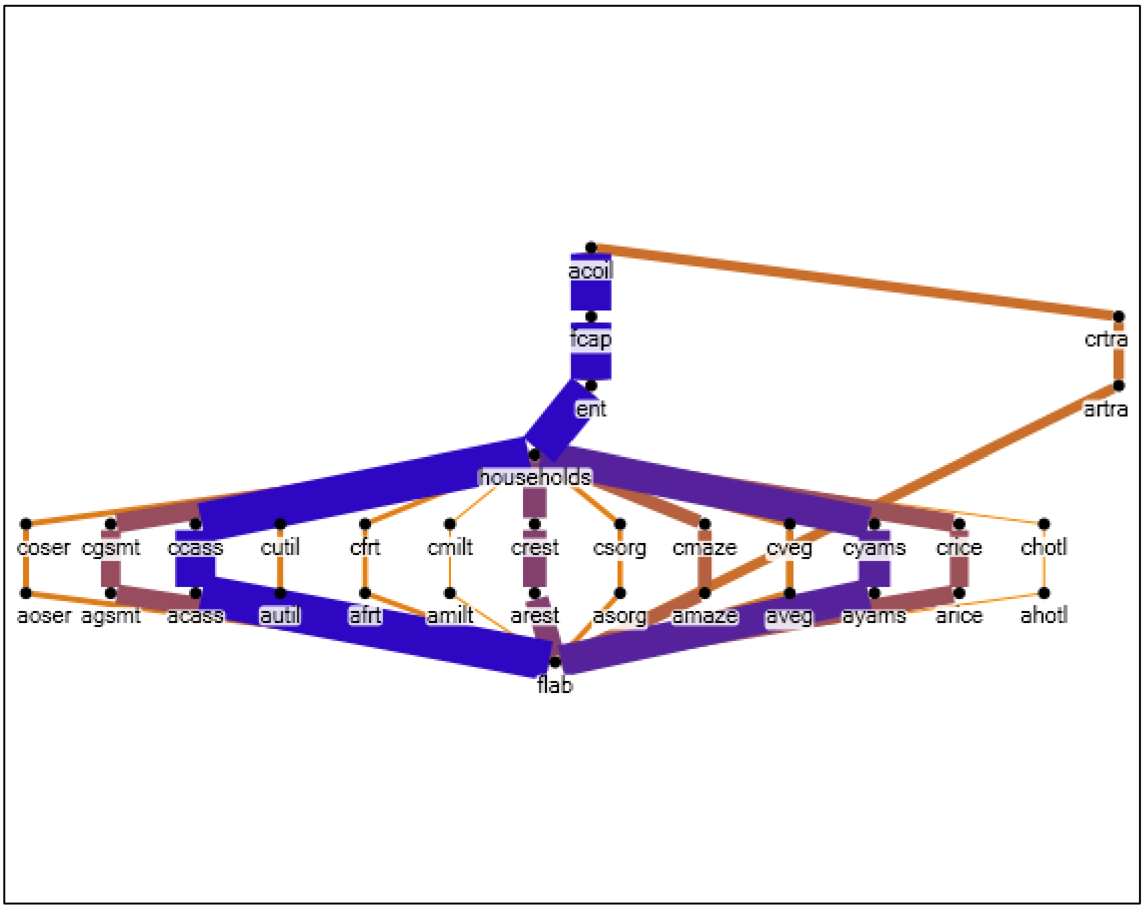
Note: Figure created using the weighted graph scheme of NodeXL. Paths depicted explain 92% of the accounting multiplier.

Figure I.12: Factors – Case I (Capital)



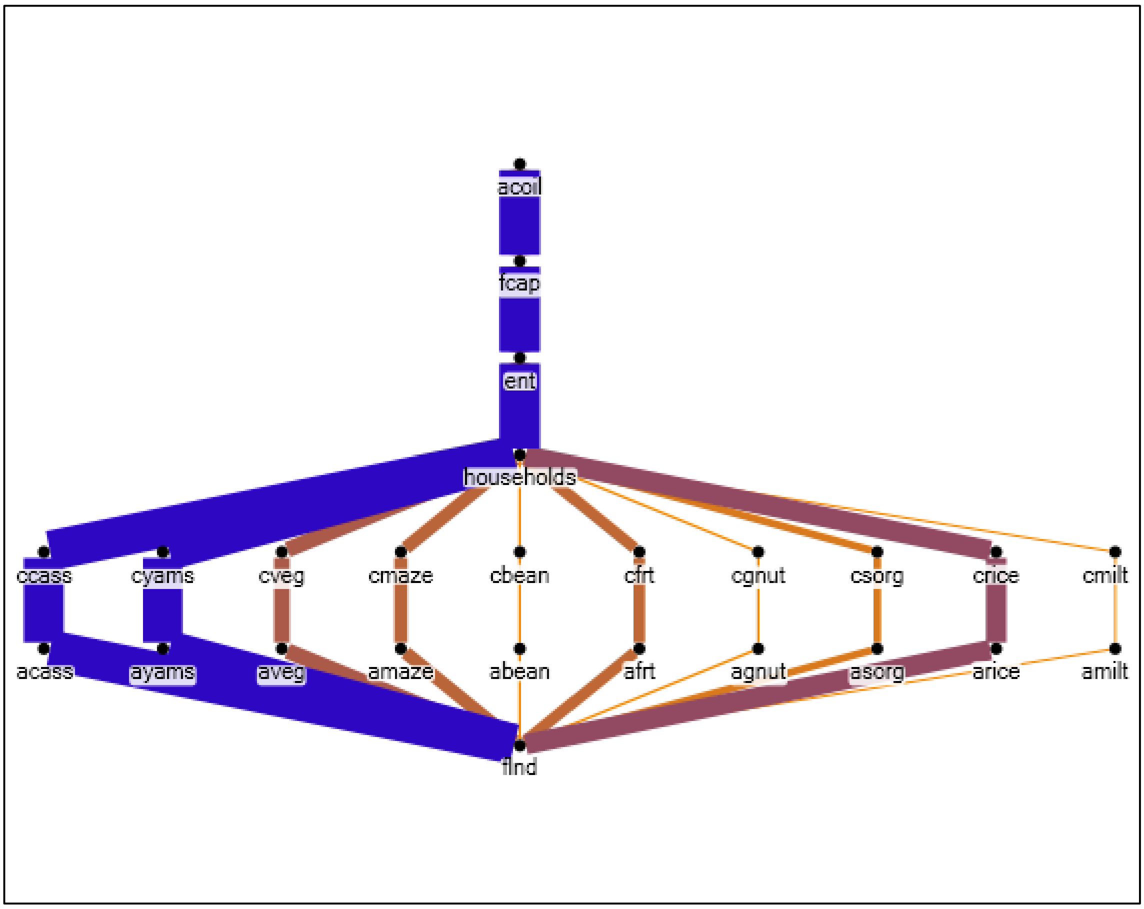
Note: Figure created using the weighted graph scheme of NodeXL. Paths depicted explain 100% of the accounting multiplier.

Figure I.13: Factors – Case II (Labour)



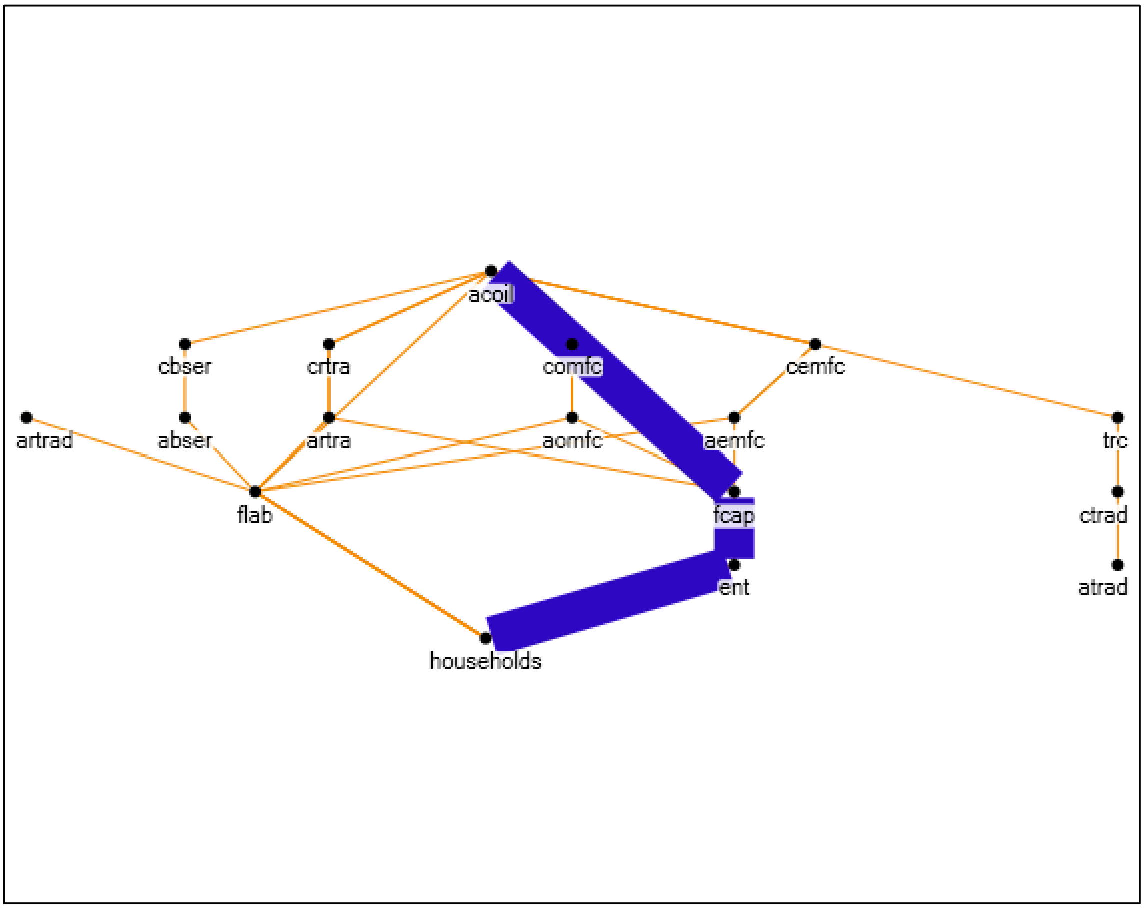
Note: Figure created using the weighted graph scheme of NodeXL. Paths depicted explain 53% of the accounting multiplier.

Figure I.14: Factors – Case III (Land)



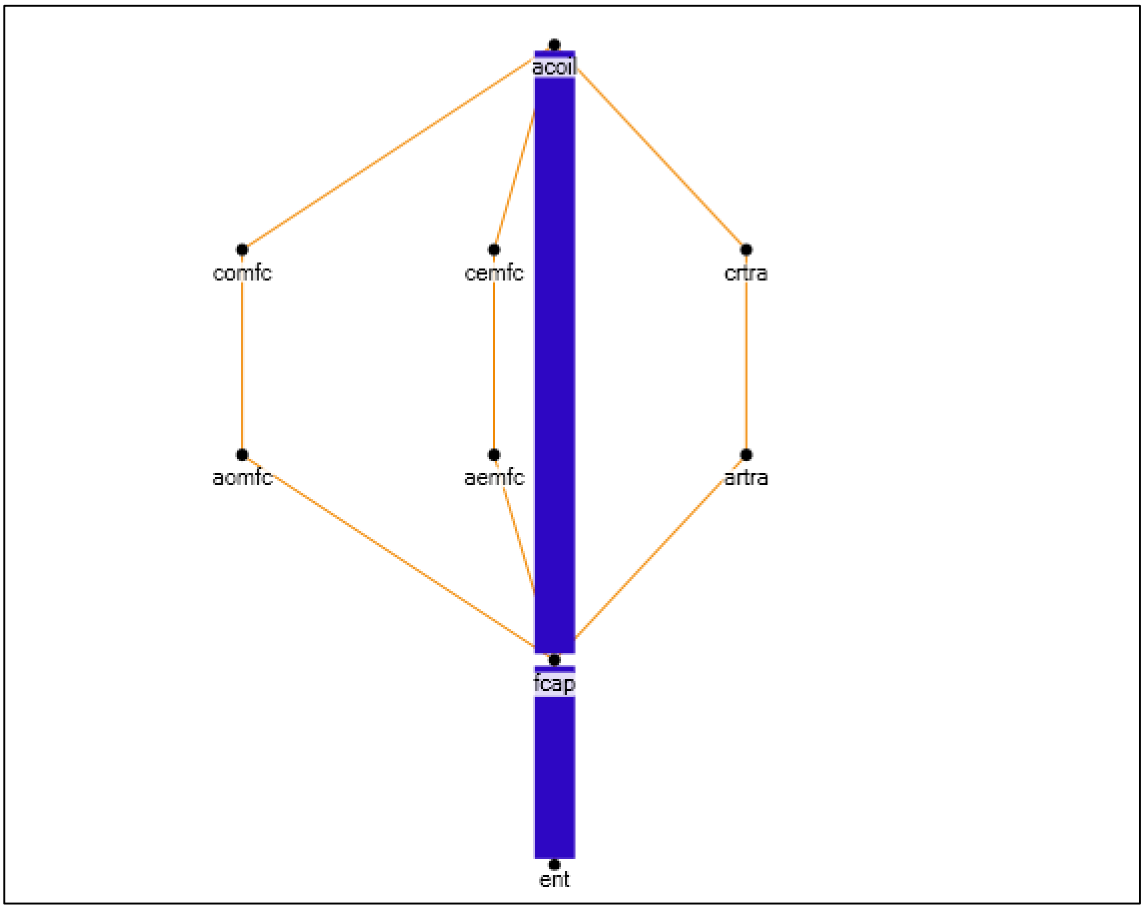
Note: Figure created using the weighted graph scheme of NodeXL. Paths depicted explain 79% of the accounting multiplier.

Figure I.15: Institutions – Case I (Households)



Note: Figure created using the weighted graph scheme of NodeXL. Paths depicted explain 99% of the accounting multiplier.

Figure I.16: Institutions – Case II (Enterprises)



Note: Figure created using the weighted graph scheme of NodeXL. Paths depicted explain 100% of the accounting multiplier.

Appendix II: Algeria

This appendix lays the foundation for the analysis in Chapter 5. Tables II.1 summarises the macro structure of the Algeria SAM used for the multiplier and SPA analysis in Chapter 5. Table II.2 and II.3 give the SAM account (activities and commodities) abbreviations and their corresponding names. Table II.4 provides the detailed results from the SPA performed in Chapter 5. Figure II.1 to II.15 are a graphical representation of the SPA results from Chapter 5.

Table II.1: Macro Social Accounting Matrix for Algeria (2002)

Receipts \ Payments	Activities	Commodities	Labour	Capital	Households	Enterprises	Government	Rest of the world	Residual	Total
Activities		5 555 791.6							0.0	5 555 791.6
Commodities	1 915 205.5				1 988 263.3		240 331.8	1 538 803.6	1 414 405.4	7 097 009.6
Labour	505 930.9						523 023.8		0.0	1 028 954.7
Capital	2 679 893.2								0.0	2 679 893.2
Households		3 227.3	1 028 954.7	1 338 786.5	27 026.5	6 936.6	528 755.2	13 460.8	0.0	2 947 147.6
Enterprises				1 341 106.7	218.2	2 458.7	202 195.8	4 243.0	0.0	1 550 222.4
Government	454 762.0	355 783.2			421 405.6	823 476.8	227 790.9	208 080.0	0.0	2 491 298.6
Rest of the world		1 182 207.5			21.7	160 217.2	162 122.1			1 504 568.5
Residual					510 212.3	557 133.1	607 078.9	-260 018.9	0.0	1 414 405.4
Total	5 555 791.6	7 097 009.6	1 028 954.7	2 679 893.2	2 947 147.6	1 550 222.4	2 491 298.6	1 504 568.5	1 414 405.4	26 269 291.7

Table II.2: Algeria SAM accounts: Activities

Account Number	Code	Description	Account Number	Code	Description
1	aAgri	Agriculture	11	aTextiles	Textiles
2	aW&Ener	Water and Energy	12	aLeather&Shoes	Leather and footwear
3	aHydrocarbons	Hydrocarbons (petroleum)	13	aWoodcorkpaper	Wood, cork and paper
4	aPW&PetroServ	Services and construction for petroleum	14	aVarious industries	Other manufacturing
5	aMines&Quar	Mining and quarrying	15	aTrans&comms	Transport and communications
6	aMetalSteelMecelectric	Metal sector (Metal steel industries, mechanical and electrical)	16	aShops	Trade
7	aBuildingM	Construction materials	17	aHotels&Restaur	Hotels and restaurants
8	aBuild&civil	Building and construction	18	aServicestoCo	Other private services (Services Provided to companies)
9	aChemRubberPlastic	Chemicals, Rubber and Plastic	19	aServicestoHH	Public services (Services provided to households)
10	aAgroFood	Food processing			

Table II.3: Algeria SAM accounts: Commodities

Account Number	Code	Description	Account Number	Code	Description
1	cAgri	Agriculture	11	cTextiles	Textiles
2	cW&Ener	Water and Energy	12	cLeather&Shoes	Leather and footwear
3	cHydrocarbons	Hydrocarbons (petroleum)	13	cWoodcorkpaper	Wood, cork and paper
4	cPW&PetroServ	Services and construction for petroleum	14	cVarious industries	Other manufacturing
5	cMines&Quar	Mining and quarrying	15	cTrans&comms	Transport and communications
6	cMetalSteelMecelectric	Metal sector (Metal steel industries, mechanical and electrical)	16	cShops	Trade
7	cBuildingM	Construction materials	17	cHotels&Restaur	Hotels and restaurants
8	cBuild&civil	Building and construction	18	cServicestoCo	Other private services (Services Provided to companies)
9	cChemRubberPlastic	Chemicals, Rubber and Plastic	19	cServicestoHH	Public services (Services provided to households)
10	cAgroFood	Food processing			

Table II.4: SPA for selected activites: Algeria (CASE I TO XI)

Case	Origin	Dest.	Global infl.	Path	Direct infl.	Path mult.	Total infl.	Prop. (in %)	Accum. Prop.
I	aHydrocarbons	aTrans&comms	0.12	aHydrocarbons / cTrans&comms / aTrans&comms	0.037	1.44	0.054	46.4	46.4
				aHydrocarbons / Cap / HH / cTrans&comms / aTrans&comms	0.025	1.77	0.044	38.2	84.6
				aHydrocarbons / Cap / HH / cShops / aShops / cTrans&comms / aTrans&comms	0.003	1.78	0.005	3.9	88.6
				aHydrocarbons / Lab / HH / cTrans&comms / aTrans&comms	0.002	1.77	0.003	2.6	91.2
				aHydrocarbons / cPW&PetroServ / aPW&PetroServ / cTrans&comms / aTrans&comms	0.001	1.51	0.002	1.4	92.6
				aHydrocarbons / cShops / aShops / cTrans&comms / aTrans&comms	0.001	1.54	0.002	1.3	93.9
				aHydrocarbons / cShops / aShops / Cap / HH / cTrans&comms / aTrans&comms	0.000	1.78	0.001	0.6	94.5
				aHydrocarbons / cServicestoCo / aServicestoCo / Lab / HH / cTrans&comms / aTrans&comms	0.000	1.78	0.001	0.4	94.9
				aHydrocarbons / Cap / HH / cAgroFood / aAgroFood / cTrans&comms / aTrans&comms	0.000	2.00	0.000	0.4	95.2
				aHydrocarbons / cServicestoCo / aServicestoCo / Cap / HH / cTrans&comms / aTrans&comms	0.000	1.78	0.000	0.3	95.6
				aHydrocarbons / cPW&PetroServ / aPW&PetroServ / Lab / HH / cTrans&comms / aTrans&comms	0.000	1.85	0.000	0.3	95.9
				aHydrocarbons / Lab / HH / cShops / aShops / cTrans&comms / aTrans&comms	0.000	1.78	0.000	0.3	96.2
				aHydrocarbons / cPW&PetroServ / aPW&PetroServ / Cap / HH / cTrans&comms / aTrans&comms	0.000	1.85	0.000	0.2	96.4
				aHydrocarbons / Cap / HH / cAgroFood / aAgroFood / cShops / aShops / cTrans&comms / aTrans&comms	0.000	2.01	0.000	0.2	96.6
				aHydrocarbons / Cap / Ent / HH / cTrans&comms / aTrans&comms	0.000	1.77	0.000	0.2	96.8
				aHydrocarbons / Cap / HH / cHotels&Restaur / aHotels&Restaur / cTrans&comms / aTrans&comms	0.000	1.77	0.000	0.2	97.0
				aHydrocarbons / cServicestoCo / aServicestoCo / cTrans&comms / aTrans&comms	0.000	1.45	0.000	0.2	97.1
				aHydrocarbons / cShops / aShops / Lab / HH / cTrans&comms / aTrans&comms	0.000	1.78	0.000	0.2	97.3
				aHydrocarbons / cBuildingM / aBuildingM / cTrans&comms / aTrans&comms	0.000	1.45	0.000	0.1	97.4
				aHydrocarbons / cAgroFood / aAgroFood / Cap / HH / cTrans&comms / aTrans&comms	0.000	2.00	0.000	0.1	97.5
				aHydrocarbons / Cap / HH / cServicestoHH / aServicestoHH / cTrans&comms / aTrans&comms	0.000	1.77	0.000	0.1	97.6
				aHydrocarbons / cW&Ener / aW&Ener / Cap / HH / cTrans&comms / aTrans&comms	0.000	1.80	0.000	0.1	97.7

Table II.4: Continued

Case	Origin	Dest.	Global infl.	Path	Direct infl.	Path mult.	Total infl.	Prop. (in %)	Accum. Prop.
II	aHydrocarbons	aAgroFood	0.09	aHydrocarbons / Cap / HH / cAgroFood / aAgroFood	0.036	1.82	0.065	72.8	72.8
				aHydrocarbons / cAgroFood / aAgroFood	0.005	1.49	0.008	8.8	81.6
				aHydrocarbons / Lab / HH / cAgroFood / aAgroFood	0.003	1.82	0.005	5.0	86.6
				aHydrocarbons / cTrans&comms / aTrans&comms / Cap / HH / cAgroFood / aAgroFood	0.001	2.00	0.003	2.8	89.5
				aHydrocarbons / cTrans&comms / aTrans&comms / Lab / HH / cAgroFood / aAgroFood	0.001	2.00	0.001	1.3	90.7
				aHydrocarbons / Cap / HH / cAgri / aAgri / cAgroFood / aAgroFood	0.001	1.95	0.001	1.2	91.9
				aHydrocarbons / cShops / aShops / Cap / HH / cAgroFood / aAgroFood	0.001	1.83	0.001	1.1	93.0
				aHydrocarbons / cServicestoCo / aServicestoCo / Lab / HH / cAgroFood / aAgroFood	0.000	1.84	0.001	0.7	93.7
				aHydrocarbons / cServicestoCo / aServicestoCo / Cap / HH / cAgroFood / aAgroFood	0.000	1.84	0.001	0.7	94.4
				aHydrocarbons / cPW&PetroServ / aPW&PetroServ / Lab / HH / cAgroFood / aAgroFood	0.000	1.90	0.001	0.7	95.0
				aHydrocarbons / cPW&PetroServ / aPW&PetroServ / Cap / HH / cAgroFood / aAgroFood	0.000	1.90	0.000	0.4	95.5
				aHydrocarbons / cPW&PetroServ / aPW&PetroServ / cAgroFood / aAgroFood	0.000	1.56	0.000	0.4	95.9
				aHydrocarbons / Cap / Ent / HH / cAgroFood / aAgroFood	0.000	1.82	0.000	0.3	96.2
				aHydrocarbons / Cap / HH / cHotels&Restaur / aHotels&Restaur / cAgroFood / aAgroFood	0.000	1.82	0.000	0.3	96.5
				aHydrocarbons / cShops / aShops / Lab / HH / cAgroFood / aAgroFood	0.000	1.83	0.000	0.3	96.8
				aHydrocarbons / cW&Ener / aW&Ener / Cap / HH / cAgroFood / aAgroFood	0.000	1.85	0.000	0.2	97.0
				aHydrocarbons / cBuild&civil / aBuild&civil / Lab / HH / cAgroFood / aAgroFood	0.000	1.82	0.000	0.1	97.1
				aHydrocarbons / cBuildingM / aBuildingM / Lab / HH / cAgroFood / aAgroFood	0.000	1.83	0.000	0.1	97.2
				aHydrocarbons / cW&Ener / aW&Ener / Lab / HH / cAgroFood / aAgroFood	0.000	1.85	0.000	0.1	97.4
				aHydrocarbons / Cap / HH / cChemRubberPlastic / aChemRubberPlastic / cAgroFood / aAgroFood	0.000	1.90	0.000	0.1	97.5

Table II.4: Continued

Case	Origin	Dest.	Global infl.	Path	Direct infl.	Path mult.	Total infl.	Prop. (in %)	Accum. Prop.
III	aHydrocarbons	aAgri	0.09	aHydrocarbons / Cap / HH / cAgri / aAgri	0.025	1.74	0.044	51.3	51.3
				aHydrocarbons / Cap / HH / cAgroFood / aAgroFood / cAgri / aAgri	0.010	1.95	0.020	23.7	75.0
				aHydrocarbons / Lab / HH / cAgri / aAgri	0.002	1.74	0.003	3.6	78.6
				aHydrocarbons / cAgroFood / aAgroFood / cAgri / aAgri	0.002	1.69	0.003	3.0	81.6
				aHydrocarbons / cTrans&comms / aTrans&comms / Cap / HH / cAgri / aAgri	0.001	1.91	0.002	2.0	83.6
				aHydrocarbons / Lab / HH / cAgroFood / aAgroFood / cAgri / aAgri	0.001	1.95	0.001	1.6	85.3
				aHydrocarbons / cTrans&comms / aTrans&comms / cAgri / aAgri	0.001	1.69	0.001	1.5	86.8
				aHydrocarbons / Cap / HH / cTrans&comms / aTrans&comms / cAgri / aAgri	0.001	1.91	0.001	1.1	87.9
				aHydrocarbons / cTrans&comms / aTrans&comms / Cap / HH / cAgroFood / aAgroFood / cAgri / aAgri	0.000	2.15	0.001	0.9	88.8
				aHydrocarbons / cTrans&comms / aTrans&comms / Lab / HH / cAgri / aAgri	0.000	1.91	0.001	0.9	89.7
				aHydrocarbons / cShops / aShops / Cap / HH / cAgri / aAgri	0.000	1.75	0.001	0.8	90.5
				aHydrocarbons / Cap / HH / cHotels&Restaur / aHotels&Restaur / cAgri / aAgri	0.000	1.74	0.001	0.6	91.1
				aHydrocarbons / cServicestoCo / aServicestoCo / Lab / HH / cAgri / aAgri	0.000	1.76	0.000	0.5	91.6
				aHydrocarbons / cServicestoCo / aServicestoCo / Cap / HH / cAgri / aAgri	0.000	1.76	0.000	0.5	92.1
				aHydrocarbons / cPW&PetroServ / aPW&PetroServ / Lab / HH / cAgri / aAgri	0.000	1.82	0.000	0.5	92.6
				aHydrocarbons / cTrans&comms / aTrans&comms / Lab / HH / cAgroFood / aAgroFood / cAgri / aAgri	0.000	2.15	0.000	0.4	93.0
				aHydrocarbons / Cap / HH / cShops / aShops / cAgri / aAgri	0.000	1.75	0.000	0.4	93.4
				aHydrocarbons / cPW&PetroServ / aPW&PetroServ / cAgri / aAgri	0.000	1.52	0.000	0.4	93.7
				aHydrocarbons / cShops / aShops / Cap / HH / cAgroFood / aAgroFood / cAgri / aAgri	0.000	1.97	0.000	0.4	94.1
				aHydrocarbons / cPW&PetroServ / aPW&PetroServ / Cap / HH / cAgri / aAgri	0.000	1.82	0.000	0.3	94.4
				aHydrocarbons / cServicestoCo / aServicestoCo / Lab / HH / cAgroFood / aAgroFood / cAgri / aAgri	0.000	1.97	0.000	0.2	94.6
				aHydrocarbons / Cap / Ent / HH / cAgri / aAgri	0.000	1.74	0.000	0.2305	94.869

Table II.4: Continued

Case	Origin	Dest.	Global infl.	Path	Direct infl.	Path mult.	Total infl.	Prop. (in %)	Accum. Prop.
				aHydrocarbons / cServicestoCo / aServicestoCo / Cap / HH / cAgroFood / aAgroFood / cAgri / aAgri	0.000	1.97	0.000	0.2	95.1
				aHydrocarbons / cPW&PetroServ / aPW&PetroServ / Lab / HH / cAgroFood / aAgroFood / cAgri / aAgri	0.000	2.05	0.000	0.2	95.3
				aHydrocarbons / cShops / aShops / Lab / HH / cAgri / aAgri	0.000	1.75	0.000	0.2	95.5
				aHydrocarbons / cAgroFood / aAgroFood / Cap / HH / cAgri / aAgri	0.000	1.95	0.000	0.2	95.7
				aHydrocarbons / cShops / aShops / cAgri / aAgri	0.000	1.57	0.000	0.1	95.8
				aHydrocarbons / cPW&PetroServ / aPW&PetroServ / cAgroFood / aAgroFood / cAgri / aAgri	0.000	1.77	0.000	0.1	95.9
				aHydrocarbons / cPW&PetroServ / aPW&PetroServ / Cap / HH / cAgroFood / aAgroFood / cAgri / aAgri	0.000	2.05	0.000	0.1	96.1
				aHydrocarbons / cW&Ener / aW&Ener / Cap / HH / cAgri / aAgri	0.000	1.78	0.000	0.1	96.2
				aHydrocarbons / Cap / HH / cShops / aShops / cTrans&comms / aTrans&comms / cAgri / aAgri	0.000	1.92	0.000	0.1	96.3
				aHydrocarbons / Cap / Ent / HH / cAgroFood / aAgroFood / cAgri / aAgri	0.000	1.96	0.000	0.1	96.4
IV	aHydrocarbons	aShops	0.08	aHydrocarbons / Cap / HH / cShops / aShops	0.030	1.62	0.049	58.7	95.1
				aHydrocarbons / cShops / aShops	0.012	1.34	0.016	19.1	95.3
				aHydrocarbons / Lab / HH / cShops / aShops	0.002	1.62	0.003	4.1	95.5
				aHydrocarbons / Cap / HH / cAgroFood / aAgroFood / cShops / aShops	0.001	1.83	0.002	2.8	95.7
				aHydrocarbons / cTrans&comms / aTrans&comms / Cap / HH / cShops / aShops	0.001	1.78	0.002	2.3	95.8
				aHydrocarbons / cTrans&comms / aTrans&comms / cShops / aShops	0.001	1.54	0.001	1.2	95.9
				aHydrocarbons / cTrans&comms / aTrans&comms / Lab / HH / cShops / aShops	0.001	1.78	0.001	1.0	96.1
				aHydrocarbons / Cap / HH / cTrans&comms / aTrans&comms / cShops / aShops	0.000	1.78	0.001	0.9	96.2
				aHydrocarbons / cPW&PetroServ / aPW&PetroServ / cShops / aShops	0.000	1.40	0.001	0.7	96.3
				aHydrocarbons / cServicestoCo / aServicestoCo / Lab / HH / cShops / aShops	0.000	1.63	0.001	0.6	96.4
				aHydrocarbons / cServicestoCo / aServicestoCo / Cap / HH / cShops / aShops	0.000	1.63	0.000	0.5	95.1
				aHydrocarbons / cPW&PetroServ / aPW&PetroServ / Lab / HH / cShops / aShops	0.000	1.70	0.000	0.5	95.3
				aHydrocarbons / Cap / HH / cTextiles / aTextiles / cShops / aShops	0.000	1.91	0.000	0.5	95.5

Table II.4: Continued

Case	Origin	Dest.	Global infl.	Path	Direct infl.	Path mult.	Total infl.	Prop. (in %)	Accum. Prop.
				aHydrocarbons / Cap / HH / cAgri / aAgri / cShops / aShops	0.000	1.75	0.000	0.4	93.3
				aHydrocarbons / cAgroFood / aAgroFood / cShops / aShops	0.000	1.60	0.000	0.4	93.6
				aHydrocarbons / cPW&PetroServ / aPW&PetroServ / Cap / HH / cShops / aShops	0.000	1.70	0.000	0.3	94.0
				aHydrocarbons / cBuild&civil / aBuild&civil / cShops / aShops	0.000	1.34	0.000	0.3	94.3
				aHydrocarbons / Cap / Ent / HH / cShops / aShops	0.000	1.62	0.000	0.3	94.5
				aHydrocarbons / Cap / HH / cMetalSteelMecelectric / aMetalSteelMecelectric / cShops / aShops	0.000	1.66	0.000	0.2	94.8
				aHydrocarbons / Lab / HH / cAgroFood / aAgroFood / cShops / aShops	0.000	1.83	0.000	0.2	95.0
				aHydrocarbons / Cap / HH / cAgroFood / aAgroFood / cAgri / aAgri / cShops / aShops	0.000	1.97	0.000	0.2	95.1
				aHydrocarbons / Cap / HH / cChemRubberPlastic / aChemRubberPlastic / cShops / aShops	0.000	1.69	0.000	0.2	95.3
				aHydrocarbons / cMetalSteelMecelectric / aMetalSteelMecelectric / cShops / aShops	0.000	1.38	0.000	0.2	95.5
				aHydrocarbons / cServicestoCo / aServicestoCo / cShops / aShops	0.000	1.35	0.000	0.2	95.7
				aHydrocarbons / cAgroFood / aAgroFood / Cap / HH / cShops / aShops	0.000	1.83	0.000	0.2	95.9
				aHydrocarbons / cW&Ener / aW&Ener / Cap / HH / cShops / aShops	0.000	1.65	0.000	0.2	96.0
				aHydrocarbons / Cap / HH / cServicestoHH / aServicestoHH / cShops / aShops	0.000	1.62	0.000	0.1	96.2
				aHydrocarbons / Cap / HH / cW&Ener / aW&Ener / cShops / aShops	0.000	1.65	0.000	0.1	96.3
				aHydrocarbons / cAgroFood / aAgroFood / cAgri / aAgri / Cap / HH / cShops / aShops	0.000	1.97	0.000	0.1	96.4
				aHydrocarbons / cBuildingM / aBuildingM / cShops / aShops	0.000	1.35	0.000	0.1	96.6
				aHydrocarbons / cBuild&civil / aBuild&civil / Lab / HH / cShops / aShops	0.000	1.62	0.000	0.1	96.7
				aHydrocarbons / cTrans&comms / aTrans&comms / Cap / HH / cAgroFood / aAgroFood / cShops / aShops	0.000	2.01	0.000	0.1	96.8
				aHydrocarbons / cBuildingM / aBuildingM / Lab / HH / cShops / aShops	0.000	1.63	0.000	0.1	96.9
V	aHydrocarbons	aPW&PetroServ	0.02	aHydrocarbons / cPW&PetroServ / aPW&PetroServ	0.012	1.291	0.015	100	100

Table II.4: Continued

Case	Origin	Dest.	Global infl.	Path	Direct infl.	Path mult.	Total infl.	Prop. (in %)	Accum. Prop.
VI	aHydrocarbons	aW&Ener	0.01	aHydrocarbons / Cap / HH / cW&Ener / aW&Ener	0.004	1.64	0.006	42.4	42.4
				aHydrocarbons / cW&Ener / aW&Ener	0.003	1.27	0.004	27.3	69.7
				aHydrocarbons / cServicestoCo / aServicestoCo / cW&Ener / aW&Ener	0.001	1.28	0.001	4.0	73.7
				aHydrocarbons / Lab / HH / cW&Ener / aW&Ener	0.000	1.64	0.000	2.9	76.7
				aHydrocarbons / cTrans&comms / aTrans&comms / cW&Ener / aW&Ener	0.000	1.48	0.000	1.8	78.5
				aHydrocarbons / Cap / HH / cShops / aShops / cW&Ener / aW&Ener	0.000	1.65	0.000	1.7	80.2
				aHydrocarbons / cTrans&comms / aTrans&comms / Cap / HH / cW&Ener / aW&Ener	0.000	1.80	0.000	1.7	81.9
				aHydrocarbons / Cap / HH / cAgroFood / aAgroFood / cW&Ener / aW&Ener	0.000	1.85	0.000	1.6	83.5
				aHydrocarbons / Cap / HH / cTrans&comms / aTrans&comms / cW&Ener / aW&Ener	0.000	1.80	0.000	1.5	85.0
				aHydrocarbons / Cap / HH / cServicestoHH / aServicestoHH / cW&Ener / aW&Ener	0.000	1.64	0.000	1.3	86.2
				aHydrocarbons / Cap / HH / cAgri / aAgri / cW&Ener / aW&Ener	0.000	1.78	0.000	0.8	87.1
				aHydrocarbons / Cap / HH / cHotels&Restaur / aHotels&Restaur / cW&Ener / aW&Ener	0.000	1.64	0.000	0.8	87.9
				aHydrocarbons / cTrans&comms / aTrans&comms / Lab / HH / cW&Ener / aW&Ener	0.000	1.80	0.000	0.7	88.6
				aHydrocarbons / cShops / aShops / Cap / HH / cW&Ener / aW&Ener	0.000	1.65	0.000	0.6	89.2
				aHydrocarbons / cShops / aShops / cW&Ener / aW&Ener	0.000	1.38	0.000	0.6	89.8
				aHydrocarbons / Cap / HH / cTextiles / aTextiles / cW&Ener / aW&Ener	0	1.93	0.000	0.5	90.4
				aHydrocarbons / cServicestoCo / aServicestoCo / Lab / HH / cW&Ener / aW&Ener	0	1.66	0.000	0.4	90.8
				aHydrocarbons / cPW&PetroServ / aPW&PetroServ / cW&Ener / aW&Ener	0	1.33	0.000	0.4	91.2
				aHydrocarbons / Cap / HH / cAgroFood / aAgroFood / cAgri / aAgri / cW&Ener / aW&Ener	0	1.99	0.000	0.4	91.6
				aHydrocarbons / cServicestoCo / aServicestoCo / Cap / HH / cW&Ener / aW&Ener	0	1.66	0.000	0.4	92.0
				aHydrocarbons / cPW&PetroServ / aPW&PetroServ / Lab / HH / cW&Ener / aW&Ener	0	1.72	0.000	0.4	92.4
				aHydrocarbons / Cap / HH / cMetalSteelMecelectric / aMetalSteelMecelectric / cW&Ener / aW&Ener	0	1.68	0	0.3	92.7
				aHydrocarbons / cPW&PetroServ / aPW&PetroServ / Cap / HH / cW&Ener / aW&Ener	0	1.72	0	0.2	92.9
				aHydrocarbons / cMetalSteelMecelectric / aMetalSteelMecelectric / cW&Ener / aW&Ener	0	1.31	0	0.2	93.1

Table II.4: Continued

Case	Origin	Dest.	Global infl.	Path	Direct infl.	Path mult.	Total infl.	Prop. (in %)	Accum. Prop.
				aHydrocarbons / cTrans&comms / aTrans&comms / cServicestoCo / aServicestoCo / cW&Ener / aW&Ener	0	1.50	0	0.2	93.4
				aHydrocarbons / cAgroFood / aAgroFood / cW&Ener / aW&Ener	0	1.53	0	0.2	93.6
				aHydrocarbons / Cap / Ent / HH / cW&Ener / aW&Ener	0	1.64	0	0.2	93.8
				aHydrocarbons / Cap / HH / cTrans&comms / aTrans&comms / cServicestoCo / aServicestoCo / cW&Ener / aW&Ener	0	1.82	0	0.2	93.9
				aHydrocarbons / cShops / aShops / Lab / HH / cW&Ener / aW&Ener	0	1.65	0	0.2	94.1
				aHydrocarbons / Cap / HH / cShops / aShops / cTrans&comms / aTrans&comms / cW&Ener / aW&Ener	0	1.81	0	0.2	94.3
				aHydrocarbons / cBuild&civil / aBuild&civil / cW&Ener / aW&Ener	0	1.27	0	0.1	94.4
				aHydrocarbons / Cap / HH / cChemRubberPlastic / aChemRubberPlastic / cW&Ener / aW&Ener	0	1.71	0	0.1	94.6
				aHydrocarbons / cAgroFood / aAgroFood / Cap / HH / cW&Ener / aW&Ener	0	1.85	0	0.1	94.7
				aHydrocarbons / cPW&PetroServ / aPW&PetroServ / cServicestoCo / aServicestoCo / cW&Ener / aW&Ener	0	1.34	0	0.1	94.8
				aHydrocarbons / Lab / HH / cShops / aShops / cW&Ener / aW&Ener	0	1.65	0	0.1	94.9
				aHydrocarbons / cBuildingM / aBuildingM / cW&Ener / aW&Ener	0	1.28	0	0.1	95.0
				aHydrocarbons / Lab / HH / cAgroFood / aAgroFood / cW&Ener / aW&Ener	0	1.85	0	0.1	95.2
				aHydrocarbons / Lab / HH / cTrans&comms / aTrans&comms / cW&Ener / aW&Ener	0	1.80	0	0.1	95.3
VII	aHydrocarbons	aServicestoCo	0.01	aHydrocarbons / cServicestoCo / aServicestoCo	0.010	1.25	0.012	84.8	84.8
				aHydrocarbons / cTrans&comms / aTrans&comms / cServicestoCo / aServicestoCo	0.001	1.45	0.001	4.7	89.6
				aHydrocarbons / Cap / HH / cTrans&comms / aTrans&comms / cServicestoCo / aServicestoCo	0.000	1.78	0.001	3.9	93.5
				aHydrocarbons / cPW&PetroServ / aPW&PetroServ / cServicestoCo / aServicestoCo	0.000	1.31	0.000	2.6	96.1
				aHydrocarbons / Cap / HH / cShops / aShops / cServicestoCo / aServicestoCo	0.000	1.63	0.000	0.8	96.9
				aHydrocarbons / Cap / HH / cShops / aShops / cTrans&comms / aTrans&comms / cServicestoCo / aServicestoCo	0	1.79	0.000	0.4	97.3
				aHydrocarbons / Lab / HH / cTrans&comms / aTrans&comms / cServicestoCo / aServicestoCo	0	1.78	0	0.3	97.6
				aHydrocarbons / cShops / aShops / cServicestoCo / aServicestoCo	0	1.35	0	0.3	97.8
				aHydrocarbons / Cap / HH / cAgri / aAgri / cServicestoCo / aServicestoCo	0	1.76	0	0.2	98.0
				aHydrocarbons / cPW&PetroServ / aPW&PetroServ / cTrans&comms / aTrans&comms / cServicestoCo / aServicestoCo	0	1.52	0	0.1	98.2

Table II.4: Continued

Case	Origin	Dest.	Global infl.	Path	Direct infl.	Path mult.	Total infl.	Prop. (in %)	Accum. Prop.
				aHydrocarbons / cShops / aShops / cTrans&comms / aTrans&comms / cServicestoCo / aServicestoCo	0	1.56	0	0.1	98.3
				aHydrocarbons / Cap / HH / cAgroFood / aAgroFood / cServicestoCo / aServicestoCo	0	1.84	0	0.1	98.4
				aHydrocarbons / Cap / HH / cHotels&Restaur / aHotels&Restaur / cServicestoCo / aServicestoCo	0	1.63	0	0.1	98.6
				aHydrocarbons / Cap / HH / cAgroFood / aAgroFood / cAgri / aAgri / cServicestoCo / aServicestoCo	0	1.97	0	0.1	98.7
				aHydrocarbons / Lab / HH / cTrans&comms / aTrans&comms / cServicestoCo / aServicestoCo	0	1.78	0	0.3	98.9
				aHydrocarbons / cShops / aShops / cServicestoCo / aServicestoCo	0	1.35	0	0.3	99.2
				aHydrocarbons / Cap / HH / cAgri / aAgri / cServicestoCo / aServicestoCo	0	1.76	0	0.2	99.4
				aHydrocarbons / cPW&PetroServ / aPW&PetroServ / cTrans&comms / aTrans&comms / cServicestoCo / aServicestoCo	0	1.52	0	0.1	99.6
				aHydrocarbons / cShops / aShops / cTrans&comms / aTrans&comms / cServicestoCo / aServicestoCo	0	1.56	0	0.1	99.7
				aHydrocarbons / Cap / HH / cAgroFood / aAgroFood / cServicestoCo / aServicestoCo	0	1.84	0	0.1	99.8
				aHydrocarbons / Cap / HH / cHotels&Restaur / aHotels&Restaur / cServicestoCo / aServicestoCo	0	1.63	0	0.1	99.9
				aHydrocarbons / Cap / HH / cAgroFood / aAgroFood / cAgri / aAgri / cServicestoCo / aServicestoCo	0	1.97	0	0.1	100.0
VIII	aHydrocarbons	aServicestoHH	0.01	aHydrocarbons / Cap / HH / cServicestoHH / aServicestoHH	0.005	1.61	0.009	74.3	74.3
				aHydrocarbons / Lab / HH / cServicestoHH / aServicestoHH	0.000	1.61	0.001	5.1	79.5
				aHydrocarbons / cTrans&comms / aTrans&comms / cServicestoHH / aServicestoHH	0.000	1.46	0.001	4.1	83.6
				aHydrocarbons / Cap / HH / cTrans&comms / aTrans&comms / cServicestoHH / aServicestoHH	0.000	1.77	0.000	3.3	86.9
				aHydrocarbons / cTrans&comms / aTrans&comms / Cap / HH / cServicestoHH / aServicestoHH	0.000	1.77	0.000	2.9	89.8
				aHydrocarbons / cTrans&comms / aTrans&comms / Lab / HH / cServicestoHH / aServicestoHH	0.000	1.77	0.000	1.3	91.1
				aHydrocarbons / cShops / aShops / Cap / HH / cServicestoHH / aServicestoHH	0.000	1.62	0.000	1.1	92.2
				aHydrocarbons / cServicestoCo / aServicestoCo / Lab / HH / cServicestoHH / aServicestoHH	0.000	1.62	0.000	0.8	93.0
				aHydrocarbons / cServicestoCo / aServicestoCo / Cap / HH / cServicestoHH / aServicestoHH	0	1.62	0.000	0.7	93.7
				aHydrocarbons / cPW&PetroServ / aPW&PetroServ / Lab / HH / cServicestoHH / aServicestoHH	0	1.68	0.000	0.7	94.3
				aHydrocarbons / cPW&PetroServ / aPW&PetroServ / Cap / HH / cServicestoHH / aServicestoHH	0	1.68	0.000	0.4	94.8

Table II.4: Continued

Case	Origin	Dest.	Global infl.	Path	Direct infl.	Path mult.	Total infl.	Prop. (in %)	Accum. Prop.
				aHydrocarbons / Cap / HH / cShops / aShops / cTrans&comms / aTrans&comms / cServicestoHH / aServicestoHH	0	1.78	0	0.3	95.1
				aHydrocarbons / Cap / Ent / HH / cServicestoHH / aServicestoHH	0	1.61	0	0.3	95.4
				aHydrocarbons / cShops / aShops / Lab / HH / cServicestoHH / aServicestoHH	0	1.62	0	0.3	95.7
				aHydrocarbons / Lab / HH / cTrans&comms / aTrans&comms / cServicestoHH / aServicestoHH	0	1.77	0	0.2	96.0
				aHydrocarbons / Cap / HH / cAgri / aAgri / cServicestoHH / aServicestoHH	0	1.74	0	0.2	96.2
				aHydrocarbons / cAgroFood / aAgroFood / Cap / HH / cServicestoHH / aServicestoHH	0	1.82	0	0.2	96.4
				aHydrocarbons / cW&Ener / aW&Ener / Cap / HH / cServicestoHH / aServicestoHH	0	1.64	0	0.2	96.6
				aHydrocarbons / cAgroFood / aAgroFood / cAgri / aAgri / Cap / HH / cServicestoHH / aServicestoHH	0	1.95	0	0.2	96.8
				aHydrocarbons / cBuild&civil / aBuild&civil / Lab / HH / cServicestoHH / aServicestoHH	0	1.61	0	0.1	96.9
				aHydrocarbons / cBuildingM / aBuildingM / Lab / HH / cServicestoHH / aServicestoHH	0	1.62	0	0.1	97.1
				aHydrocarbons / cW&Ener / aW&Ener / Lab / HH / cServicestoHH / aServicestoHH	0	1.64	0	0.1	97.2
				aHydrocarbons / cPW&PetroServ / aPW&PetroServ / cTrans&comms / aTrans&comms / cServicestoHH / aServicestoHH	0	1.53	0	0.1	97.3
				aHydrocarbons / cShops / aShops / cTrans&comms / aTrans&comms / cServicestoHH / aServicestoHH	0	1.56	0	0.1	97.4
				aHydrocarbons / Cap / HH / cAgroFood / aAgroFood / cAgri / aAgri / cServicestoHH / aServicestoHH	0	1.95	0	0.1	97.5
IX	aHydrocarbons	aHotels&Restaur	0.01	aHydrocarbons / Cap / HH / cHotels&Restaur / aHotels&Restaur	0.004	1.61	0.006	63.0	63.0
				aHydrocarbons / cTrans&comms / aTrans&comms / cHotels&Restaur / aHotels&Restaur	0.000	1.45	0.001	5.8	68.8
				aHydrocarbons / Cap / HH / cTrans&comms / aTrans&comms / cHotels&Restaur / aHotels&Restaur	0.000	1.77	0.000	4.8	73.6
				aHydrocarbons / cHotels&Restaur / aHotels&Restaur	0.000	1.25	0.000	4.5	78.1
				aHydrocarbons / Lab / HH / cHotels&Restaur / aHotels&Restaur	0.000	1.61	0.000	4.4	82.4
				aHydrocarbons / cTrans&comms / aTrans&comms / Cap / HH / cHotels&Restaur / aHotels&Restaur	0.000	1.77	0.000	2.5	84.9
				aHydrocarbons / Cap / HH / cShops / aShops / cHotels&Restaur / aHotels&Restaur	0.000	1.62	0.000	1.7	86.6
				aHydrocarbons / cTrans&comms / aTrans&comms / Lab / HH / cHotels&Restaur / aHotels&Restaur	0.000	1.77	0.000	1.1	87.7
				aHydrocarbons / cPW&PetroServ / aPW&PetroServ / cHotels&Restaur / aHotels&Restaur	0.000	1.31	0.000	1.0	88.6

Table II.4: Continued

Case	Origin	Dest.	Global infl.	Path	Direct infl.	Path mult.	Total infl.	Prop. (in %)	Accum. Prop.
				aHydrocarbons / cShops / aShops / Cap / HH / cHotels&Restaur / aHotels&Restaur	0.000	1.62	0.000	0.9	89.6
				aHydrocarbons / cServicestoCo / aServicestoCo / cHotels&Restaur / aHotels&Restaur	0	1.26	0.000	0.7	90.3
				aHydrocarbons / cServicestoCo / aServicestoCo / Lab / HH / cHotels&Restaur / aHotels&Restaur	0	1.63	0.000	0.6	90.9
				aHydrocarbons / cServicestoCo / aServicestoCo / Cap / HH / cHotels&Restaur / aHotels&Restaur	0	1.63	0.000	0.6	91.5
				aHydrocarbons / cPW&PetroServ / aPW&PetroServ / Lab / HH / cHotels&Restaur / aHotels&Restaur	0	1.69	0.000	0.6	92.0
				aHydrocarbons / cShops / aShops / cHotels&Restaur / aHotels&Restaur	0	1.35	0.000	0.6	92.6
				aHydrocarbons / Cap / HH / cAgri / aAgri / cHotels&Restaur / aHotels&Restaur	0	1.74	0.000	0.6	93.1
				aHydrocarbons / Cap / HH / cShops / aShops / cTrans&comms / aTrans&comms / cHotels&Restaur / aHotels&Restaur	0	1.78	0	0.5	93.6
				aHydrocarbons / cPW&PetroServ / aPW&PetroServ / Cap / HH / cHotels&Restaur / aHotels&Restaur	0	1.69	0	0.4	94.0
				aHydrocarbons / Lab / HH / cTrans&comms / aTrans&comms / cHotels&Restaur / aHotels&Restaur	0	1.77	0	0.3	94.3
				aHydrocarbons / Cap / Ent / HH / cHotels&Restaur / aHotels&Restaur	0	1.61	0	0.3	94.6
				aHydrocarbons / Cap / HH / cAgroFood / aAgroFood / cAgri / aAgri / cHotels&Restaur / aHotels&Restaur	0	1.96	0	0.3	94.9
				aHydrocarbons / cShops / aShops / Lab / HH / cHotels&Restaur / aHotels&Restaur	0	1.62	0	0.3	95.1
				aHydrocarbons / cAgroFood / aAgroFood / Cap / HH / cHotels&Restaur / aHotels&Restaur	0	1.82	0	0.2	95.3
				aHydrocarbons / cPW&PetroServ / aPW&PetroServ / cTrans&comms / aTrans&comms / cHotels&Restaur / aHotels&Restaur	0	1.52	0	0.2	95.5
				aHydrocarbons / cShops / aShops / cTrans&comms / aTrans&comms / cHotels&Restaur / aHotels&Restaur	0	1.56	0	0.2	95.6
				aHydrocarbons / cW&Ener / aW&Ener / Cap / HH / cHotels&Restaur / aHotels&Restaur	0	1.64	0	0.2	95.8
				aHydrocarbons / Cap / HH / cAgroFood / aAgroFood / cHotels&Restaur / aHotels&Restaur	0	1.82	0	0.2	96.0
				aHydrocarbons / cAgroFood / aAgroFood / cAgri / aAgri / Cap / HH / cHotels&Restaur / aHotels&Restaur	0	1.96	0	0.1	96.1

Table II.4: Continued

Case	Origin	Dest.	Global infl.	Path	Direct infl.	Path mult.	Total infl.	Prop. (in %)	Accum.. Prop.
				aHydrocarbons / Lab / HH / cShops / aShops / cHotels&Restaur / aHotels&Restaur	0	1.62	0	0.1	96.2
				aHydrocarbons / cBuild&civil / aBuild&civil / Lab / HH / cHotels&Restaur / aHotels&Restaur	0	1.61	0	0.1	96.3
				aHydrocarbons / cBuildingM / aBuildingM / Lab / HH / cHotels&Restaur / aHotels&Restaur	0	1.62	0	0.1	96.4
				aHydrocarbons / cW&Ener / aW&Ener / Lab / HH / cHotels&Restaur / aHotels&Restaur	0	1.64	0	0.1	96.5
X	aHydrocarbons	aMetalSteelMecelectric	0.01	aHydrocarbons / Cap / HH / cMetalSteelMecelectric / aMetalSteelMecelectric	0.002	1.65	0.003	39.8	39.8
				aHydrocarbons / cMetalSteelMecelectric / aMetalSteelMecelectric	0.002	1.27	0.002	30.4	70.2
				aHydrocarbons / cTrans&comms / aTrans&comms / cMetalSteelMecelectric / aMetalSteelMecelectric	0.000	1.48	0.000	4.9	75.1
				aHydrocarbons / Cap / HH / cTrans&comms / aTrans&comms / cMetalSteelMecelectric / aMetalSteelMecelectric	0.000	1.82	0.000	4.0	79.1
				aHydrocarbons / Lab / HH / cMetalSteelMecelectric / aMetalSteelMecelectric	0.000	1.65	0.000	2.8	81.9
				aHydrocarbons / cPW&PetroServ / aPW&PetroServ / cMetalSteelMecelectric / aMetalSteelMecelectric	0.000	1.33	0.000	2.4	84.2
				aHydrocarbons / cTrans&comms / aTrans&comms / Cap / HH / cMetalSteelMecelectric / aMetalSteelMecelectric	0.000	1.82	0.000	1.6	85.8
				aHydrocarbons / cBuild&civil / aBuild&civil / cMetalSteelMecelectric / aMetalSteelMecelectric	0.000	1.27	0.000	1.1	86.9
				aHydrocarbons / Cap / HH / cShops / aShops / cMetalSteelMecelectric / aMetalSteelMecelectric	0	1.66	0.000	1.1	88.0
				aHydrocarbons / Cap / HH / cServicestoHH / aServicestoHH / cMetalSteelMecelectric / aMetalSteelMecelectric	0	1.65	0.000	0.8	88.7
				aHydrocarbons / cTrans&comms / aTrans&comms / Lab / HH / cMetalSteelMecelectric / aMetalSteelMecelectric	0	1.82	0	0.7	89.4
				aHydrocarbons / cServicestoCo / aServicestoCo / cMetalSteelMecelectric / aMetalSteelMecelectric	0	1.28	0	0.7	90.1
				aHydrocarbons / cShops / aShops / Cap / HH / cMetalSteelMecelectric / aMetalSteelMecelectric	0	1.66	0	0.6	90.7
				aHydrocarbons / Cap / HH / cShops / aShops / cTrans&comms / aTrans&comms / cMetalSteelMecelectric / aMetalSteelMecelectric	0	1.82	0	0.4	91.1
				aHydrocarbons / cServicestoCo / aServicestoCo / Lab / HH / cMetalSteelMecelectric / aMetalSteelMecelectric	0	1.67	0	0.4	91.5
				aHydrocarbons / Cap / HH / cAgroFood / aAgroFood / cMetalSteelMecelectric / aMetalSteelMecelectric	0	1.87	0	0.4	91.9

Table II.4: Continued

Case	Origin	Dest.	Global infl.	Path	Direct infl.	Path mult.	Total infl.	Prop. (in %)	Accum. Prop.
				aHydrocarbons / cBuildingM / aBuildingM / cMetalSteelMecelectric / aMetalSteelMecelectric	0	1.28	0	0.4	92.3
				aHydrocarbons / cServicestoCo / aServicestoCo / Cap / HH / cMetalSteelMecelectric / aMetalSteelMecelectric	0	1.67	0	0.4	92.7
				aHydrocarbons / cPW&PetroServ / aPW&PetroServ / Lab / HH / cMetalSteelMecelectric / aMetalSteelMecelectric	0	1.73	0	0.4	93.0
				aHydrocarbons / cShops / aShops / cMetalSteelMecelectric / aMetalSteelMecelectric	0	1.38	0	0.4	93.4
				aHydrocarbons / Cap / HH / cW&Ener / aW&Ener / cMetalSteelMecelectric / aMetalSteelMecelectric	0	1.68	0	0.3	93.7
				aHydrocarbons / Lab / HH / cTrans&comms / aTrans&comms / cMetalSteelMecelectric / aMetalSteelMecelectric	0	1.82	0	0.3	94.0
				aHydrocarbons / Cap / HH / cBuild&civil / aBuild&civil / cMetalSteelMecelectric / aMetalSteelMecelectric	0	1.65	0	0.3	94.2
				aHydrocarbons / cPW&PetroServ / aPW&PetroServ / Cap / HH / cMetalSteelMecelectric / aMetalSteelMecelectric	0	1.73	0	0.2	94.5
				aHydrocarbons / Cap / HH / cAgri / aAgri / cMetalSteelMecelectric / aMetalSteelMecelectric	0	1.79	0	0.2	94.7
				aHydrocarbons / cW&Ener / aW&Ener / cMetalSteelMecelectric / aMetalSteelMecelectric	0	1.31	0	0.2	94.9
				aHydrocarbons / Cap / HH / cChemRubberPlastic / aChemRubberPlastic / cMetalSteelMecelectric / aMetalSteelMecelectric	0	1.72	0	0.2	95.1
				aHydrocarbons / Cap / Ent / HH / cMetalSteelMecelectric / aMetalSteelMecelectric	0	1.65	0	0.2	95.2
				aHydrocarbons / cShops / aShops / Lab / HH / cMetalSteelMecelectric / aMetalSteelMecelectric	0	1.66	0	0.2	95.4
				aHydrocarbons / cPW&PetroServ / aPW&PetroServ / cTrans&comms / aTrans&comms / cMetalSteelMecelectric / aMetalSteelMecelectric	0	1.55	0	0.1	95.5
				aHydrocarbons / cShops / aShops / cTrans&comms / aTrans&comms / cMetalSteelMecelectric / aMetalSteelMecelectric	0	1.59	0	0.1	95.7
				aHydrocarbons / cAgroFood / aAgroFood / Cap / HH / cMetalSteelMecelectric / aMetalSteelMecelectric	0	1.87	0	0.1	95.8
				aHydrocarbons / cW&Ener / aW&Ener / Cap / HH / cMetalSteelMecelectric / aMetalSteelMecelectric	0	1.68	0	0.1	95.9
				aHydrocarbons / Cap / HH / cAgroFood / aAgroFood / cAgri / aAgri / cMetalSteelMecelectric / aMetalSteelMecelectric	0	2.0054	0	0.1	96.0

Table II.4: Continued

Case	Origin	Dest.	Global infl.	Path	Direct infl.	Path mult.	Total infl.	Prop. (in %)	Accum. Prop.
XI	aHydrocarbons	aTextiles	0.018	aHydrocarbons / Cap / HH / cTextiles / aTextiles	0.003	1.89	0.005	77.9	77.9
				aHydrocarbons / Lab / HH / cTextiles / aTextiles	0.000	1.89	0.000	5.4	83.3
				aHydrocarbons / cTrans&comms / aTrans&comms / Cap / HH / cTextiles / aTextiles	0.000	2.08	0.000	3.0	86.4
				aHydrocarbons / cTextiles / aTextiles	0.000	1.46	0.000	2.9	89.3
				aHydrocarbons / cTrans&comms / aTrans&comms / Lab / HH / cTextiles / aTextiles	0.000	2.08	8.59E-05	1.4	90.6
				aHydrocarbons / cShops / aShops / Cap / HH / cTextiles / aTextiles	0.000	1.91	7.38E-05	1.2	91.8
				aHydrocarbons / cServicestoCo / aServicestoCo / Lab / HH / cTextiles / aTextiles	0.000	1.91	5.03E-05	0.8	92.6
				aHydrocarbons / cServicestoCo / aServicestoCo / Cap / HH / cTextiles / aTextiles	0.000	1.91	4.41E-05	0.7	93.3
				aHydrocarbons / cPW&PetroServ / aPW&PetroServ / Lab / HH / cTextiles / aTextiles	0.000	1.98	4.41E-05	0.7	94.0
				aHydrocarbons / cPW&PetroServ / aPW&PetroServ / Cap / HH / cTextiles / aTextiles	0.000	1.98	2.84E-05	0.4	94.5
				aHydrocarbons / Cap / Ent / HH / cTextiles / aTextiles	0.000	1.90	2.21E-05	0.3	94.8
				aHydrocarbons / cShops / aShops / Lab / HH / cTextiles / aTextiles	0.000	1.91	1.96E-05	0.3	95.1
				aHydrocarbons / cTrans&comms / aTrans&comms / cTextiles / aTextiles	0.000	1.70	1.51E-05	0.2	95.4
				aHydrocarbons / cAgroFood / aAgroFood / Cap / HH / cTextiles / aTextiles	0.000	2.14	1.47E-05	0.2	95.6
				aHydrocarbons / cPW&PetroServ / aPW&PetroServ / cTextiles / aTextiles	0.000	1.53	1.38E-05	0.2	95.8
				aHydrocarbons / cW&Ener / aW&Ener / Cap / HH / cTextiles / aTextiles	0.000	1.93	1.29E-05	0.2	96.0
				aHydrocarbons / Cap / HH / cTrans&comms / aTrans&comms / cTextiles / aTextiles	0.000	2.08	1.24E-05	0.2	96.2
				aHydrocarbons / cAgroFood / aAgroFood / cAgri / aAgri / Cap / HH / cTextiles / aTextiles	0.000	2.30	1.12E-05	0.2	96.4
				aHydrocarbons / cBuild&civil / aBuild&civil / Lab / HH / cTextiles / aTextiles	0.000	1.90	9.10E-06	0.1	96.5
				aHydrocarbons / cBuildingM / aBuildingM / Lab / HH / cTextiles / aTextiles	0.000	1.91	8.92E-06	0.1	96.7
				aHydrocarbons / cW&Ener / aW&Ener / Lab / HH / cTextiles / aTextiles	0.000	1.93	8.16E-06	0.1	96.8
				aHydrocarbons / Cap / HH / cServicestoHH / aServicestoHH / cTextiles / aTextiles	0.000	1.89	7.97E-06	0.1	96.9

Table II.4: Continued

Case	Origin	Dest.	Global infl.	Path	Direct infl.	Path mult.	Total infl.	Prop. (in %)	Accum. Prop.
				aHydrocarbons / Cap / HH / cShops / aShops / cTextiles / aTextiles	3.88E-06	1.91	7.41E-06	0.1	97.0
				aHydrocarbons / Cap / HH / cWoodcorkpaper / aWoodcorkpaper / cTextiles / aTextiles	3.37E-06	2.01	6.77E-06	0.1	97.2
				aHydrocarbons / cPW&PetroServ / aPW&PetroServ / cTrans&comms / aTrans&comms / Cap / HH / cTextiles / aTextiles	2.60E-06	2.18	5.68E-06	0.1	97.2
				aHydrocarbons / cBuildingM / aBuildingM / Cap / HH / cTextiles / aTextiles	2.96E-06	1.91	5.65E-06	0.1	97.3
				aHydrocarbons / cTrans&comms / aTrans&comms / cAgri / aAgri / Cap / HH / cTextiles / aTextiles	2.40E-06	2.26	5.42E-06	0.1	97.4
				aHydrocarbons / cBuild&civil / aBuild&civil / cTextiles / aTextiles	3.66E-06	1.46	5.35E-06	0.1	97.5
				aHydrocarbons / cBuild&civil / aBuild&civil / Cap / HH / cTextiles / aTextiles	2.81E-06	1.90	5.33E-06	0.1	97.6
				aHydrocarbons / cShops / aShops / cTrans&comms / aTrans&comms / Cap / HH / cTextiles / aTextiles	2.50E-06	2.09	5.23E-06	0.1	97.7
				aHydrocarbons / cHydrocarbons / HH / cTextiles / aTextiles	2.57E-06	1.89	4.87E-06	0.1	97.7
				aHydrocarbons / cMetalSteelMecelectric / aMetalSteelMecelectric / Lab / HH / cTextiles / aTextiles	2.41E-06	1.95	4.68E-06	0.1	97.8
				aHydrocarbons / Cap / HH / cLeather&Shoes / aLeather&Shoes / cTextiles / aTextiles	2.08E-06	2.24	4.64E-06	0.1	97.9
				aHydrocarbons / Cap / HH / cChemRubberPlastic / aChemRubberPlastic / cTextiles / aTextiles	2.28E-06	1.98	4.51E-06	0.1	98.0
				aHydrocarbons / cAgroFood / aAgroFood / Lab / HH / cTextiles / aTextiles	2.10E-06	2.14	4.50E-06	0.1	98.0
				aHydrocarbons / cTrans&comms / aTrans&comms / cShops / aShops / Cap / HH / cTextiles / aTextiles	2.12E-06	2.09	4.44E-06	0.1	98.1
				aHydrocarbons / cAgroFood / aAgroFood / cAgri / aAgri / Lab / HH / cTextiles / aTextiles	1.48E-06	2.30	3.40E-06	0.1	98.2
				aHydrocarbons / Cap / HH / cAgroFood / aAgroFood / cWoodcorkpaper / aWoodcorkpaper / cTextiles / aTextiles	1.44E-06	2.27	3.26E-06	0.1	98.2
				aHydrocarbons / cWoodcorkpaper / aWoodcorkpaper / cTextiles / aTextiles	2.01E-06	1.55	3.11E-06	0.0	98.3
				aHydrocarbons / cTrans&comms / aTrans&comms / cServicestoCo / aServicestoCo / Lab / HH / cTextiles / aTextiles	1.26E-06	2.10	2.65E-06	0.0	98.3
				aHydrocarbons / cPW&PetroServ / aPW&PetroServ / cShops / aShops / Cap / HH / cTextiles / aTextiles	1.27E-06	2.00	2.55E-06	0.0	98.3
				aHydrocarbons / cPW&PetroServ / aPW&PetroServ / cTrans&comms / aTrans&comms / Lab / HH / cTextiles / aTextiles	1.16E-06	2.18	2.54E-06	0.0	98.4

Table II.4: Continued

Case	Origin	Dest.	Global infl.	Path	Direct infl.	Path mult.	Total infl.	Prop. (in %)	Accum. Prop.
				aHydrocarbons / cShops / aShops / cTextiles / aTextiles	1.53E-06	1.58	2.42E-06	0.0	98.4
				aHydrocarbons / cShops / aShops / cTrans&comms / aTrans&comms / Lab / HH / cTextiles / aTextiles	1.12E-06	2.09	2.34E-06	0.0	98.5
				aHydrocarbons / cTrans&comms / aTrans&comms / cServicestoCo / aServicestoCo / Cap / HH / cTextiles / aTextiles	1.10E-06	2.10	2.32E-06	0.0	98.5
				aHydrocarbons / cTrans&comms / aTrans&comms / cServicestoHH / aServicestoHH / Cap / HH / cTextiles / aTextiles	1.08E-06	2.08	2.26E-06	0.0	98.5
				aHydrocarbons / cMetalSteelMecelectric / aMetalSteelMecelectric / Cap / HH / cTextiles / aTextiles	1.06E-06	1.95	2.06E-06	0.0	98.6
				aHydrocarbons / cTrans&comms / aTrans&comms / cHotels&Restaur / aHotels&Restaur / Cap / HH / cTextiles / aTextiles	9.54E-07	2.09	1.99E-06	0.0	98.6
				aHydrocarbons / cServicestoCo / aServicestoCo / cW&Ener / aW&Ener / Cap / HH / cTextiles / aTextiles	9.77E-07	1.95	1.91E-06	0.0	98.6
				aHydrocarbons / cTrans&comms / aTrans&comms / cAgri / aAgri / Lab / HH / cTextiles / aTextiles	7.33E-07	2.26	1.65E-06	0.0	98.7
				aHydrocarbons / cHotels&Restaur / aHotels&Restaur / Cap / HH / cTextiles / aTextiles	8.61E-07	1.90	1.63E-06	0.0	98.7
				aHydrocarbons / Cap / HH / cAgroFood / aAgroFood / cTextiles / aTextiles	7.23E-07	2.14	1.55E-06	0.0	98.7
				aHydrocarbons / cPW&PetroServ / aPW&PetroServ / cServicestoCo / aServicestoCo / Lab / HH / cTextiles / aTextiles	7.60E-07	2.00	1.52E-06	0.0	98.7
				aHydrocarbons / cPW&PetroServ / aPW&PetroServ / cAgri / aAgri / Cap / HH / cTextiles / aTextiles	6.85E-07	2.15	1.47E-06	0.0	98.8
				aHydrocarbons / cServicestoCo / aServicestoCo / cTextiles / aTextiles	9.63E-07	1.48	1.42E-06	0.0	98.8
				aHydrocarbons / cPW&PetroServ / aPW&PetroServ / cServicestoCo / aServicestoCo / Cap / HH / cTextiles / aTextiles	6.66E-07	2.00	1.34E-06	0.0	98.8
				aHydrocarbons / cAgroFood / aAgroFood / cShops / aShops / Cap / HH / cTextiles / aTextiles	5.99E-07	2.16	1.29E-06	0.0	98.8
				aHydrocarbons / Cap / HH / cShops / aShops / cTrans&comms / aTrans&comms / cTextiles / aTextiles	6.07E-07	2.09	1.27E-06	0.0	98.8
				aHydrocarbons / Cap / HH / cBuild&civil / aBuild&civil / cTextiles / aTextiles	6.66E-07	1.90	1.26E-06	0.0	98.9
				aHydrocarbons / cServicestoCo / aServicestoCo / cW&Ener / aW&Ener / Lab / HH / cTextiles / aTextiles	6.18E-07	1.95	1.21E-06	0.0	98.9
				aHydrocarbons / cTrans&comms / aTrans&comms / cShops / aShops / Lab / HH / cTextiles / aTextiles	5.63E-07	2.09	1.18E-06	0.0	98.9

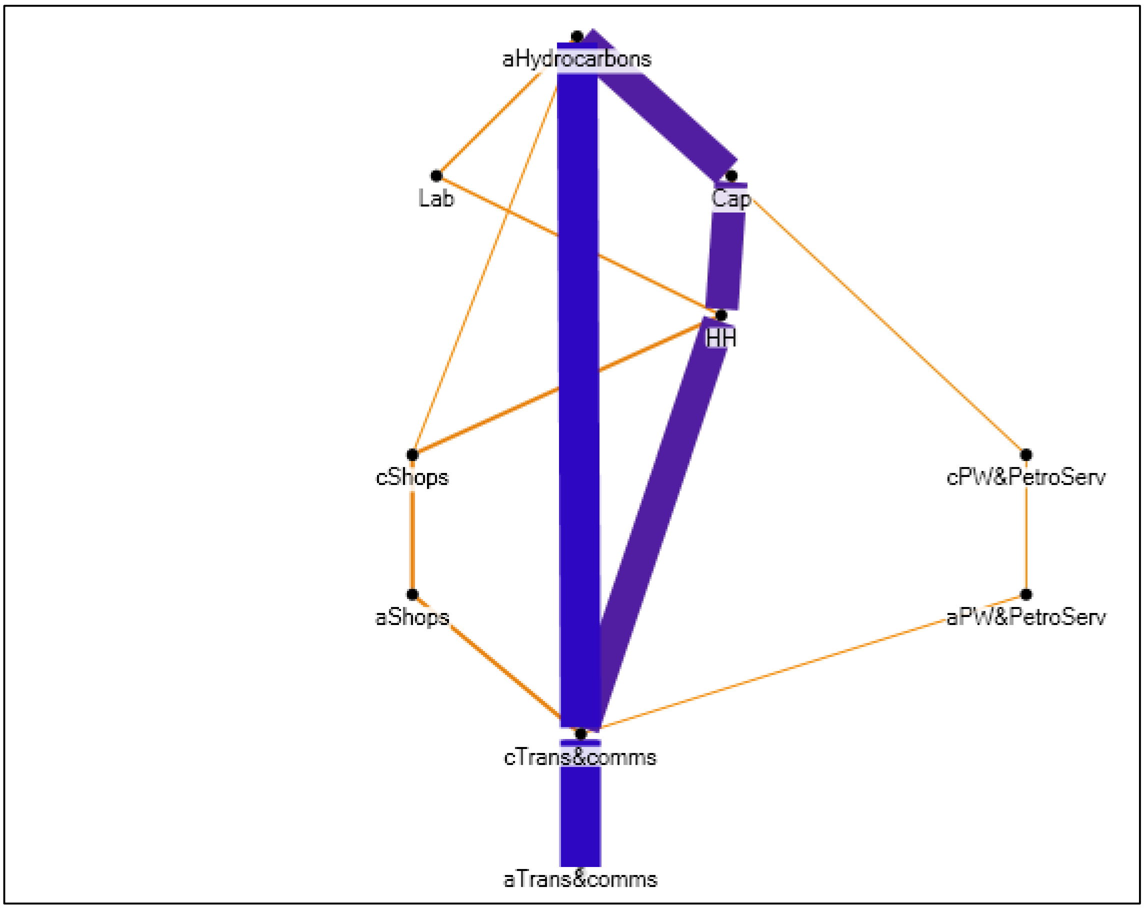
Table II.4: Continued

Case	Origin	Dest.	Global infl.	Path	Direct infl.	Path mult.	Total infl.	Prop. (in %)	Accum. Prop.
				aHydrocarbons / cBuild&civil / aBuild&civil / cShops / aShops / Cap / HH / cTextiles / aTextiles	6.00E-07	1.91	1.15E-06	0.0	98.9
				aHydrocarbons / cTrans&comms / aTrans&comms / cWoodcorkpaper / aWoodcorkpaper / cTextiles / aTextiles	6.08E-07	1.81	1.10E-06	0.0	98.9
				aHydrocarbons / cChemRubberPlastic / aChemRubberPlastic / Lab / HH / cTextiles / aTextiles	5.35E-07	1.98	1.06E-06	0.0	98.9
				aHydrocarbons / cTrans&comms / aTrans&comms / cHotels&Restaur / aHotels&Restaur / Lab / HH / cTextiles / aTextiles	5.06E-07	2.09	1.06E-06	0.0	99.0
				aHydrocarbons / cTrans&comms / aTrans&comms / cServicestoHH / aServicestoHH / Lab / HH / cTextiles / aTextiles	4.90E-07	2.08	1.02E-06	0.0	99.0
				aHydrocarbons / cWoodcorkpaper / aWoodcorkpaper / Lab / HH / cTextiles / aTextiles	5.07E-07	2.01	1.02E-06	0.0	99.0
				aHydrocarbons / Cap / HH / cAgri / aAgri / cTextiles / aTextiles	4.40E-07	2.05	9.03E-07	0.0	99.0
				aHydrocarbons / Cap / HH / cTrans&comms / aTrans&comms / cWoodcorkpaper / aWoodcorkpaper / cTextiles / aTextiles	4.08E-07	2.21	9.00E-07	0.0	99.0
				aHydrocarbons / cHotels&Restaur / aHotels&Restaur / Lab / HH / cTextiles / aTextiles	4.57E-07	1.90	8.67E-07	0.0	99.0
				aHydrocarbons / cTrans&comms / aTrans&comms / Cap / Ent / HH / cTextiles / aTextiles	4.14E-07	2.09	8.64E-07	0.0	99.1
				aHydrocarbons / Lab / HH / cTrans&comms / aTrans&comms / cTextiles / aTextiles	4.11E-07	2.08	8.57E-07	0.0	99.1
				aHydrocarbons / cChemRubberPlastic / aChemRubberPlastic / cTextiles / aTextiles	5.39E-07	1.53	8.24E-07	0.0	99.1
				aHydrocarbons / cTrans&comms / aTrans&comms / cW&Ener / aW&Ener / Cap / HH / cTextiles / aTextiles	3.79E-07	2.13	8.07E-07	0.0	99.1
				aHydrocarbons / Cap / HH / cShops / aShops / cWoodcorkpaper / aWoodcorkpaper / cTextiles / aTextiles	3.80E-07	2.02	7.68E-07	0.0	99.1
				aHydrocarbons / cServicestoCo / aServicestoCo / cWoodcorkpaper / aWoodcorkpaper / cTextiles / aTextiles	4.76E-07	1.56	7.45E-07	0.0	99.1

Table II.4: Continued

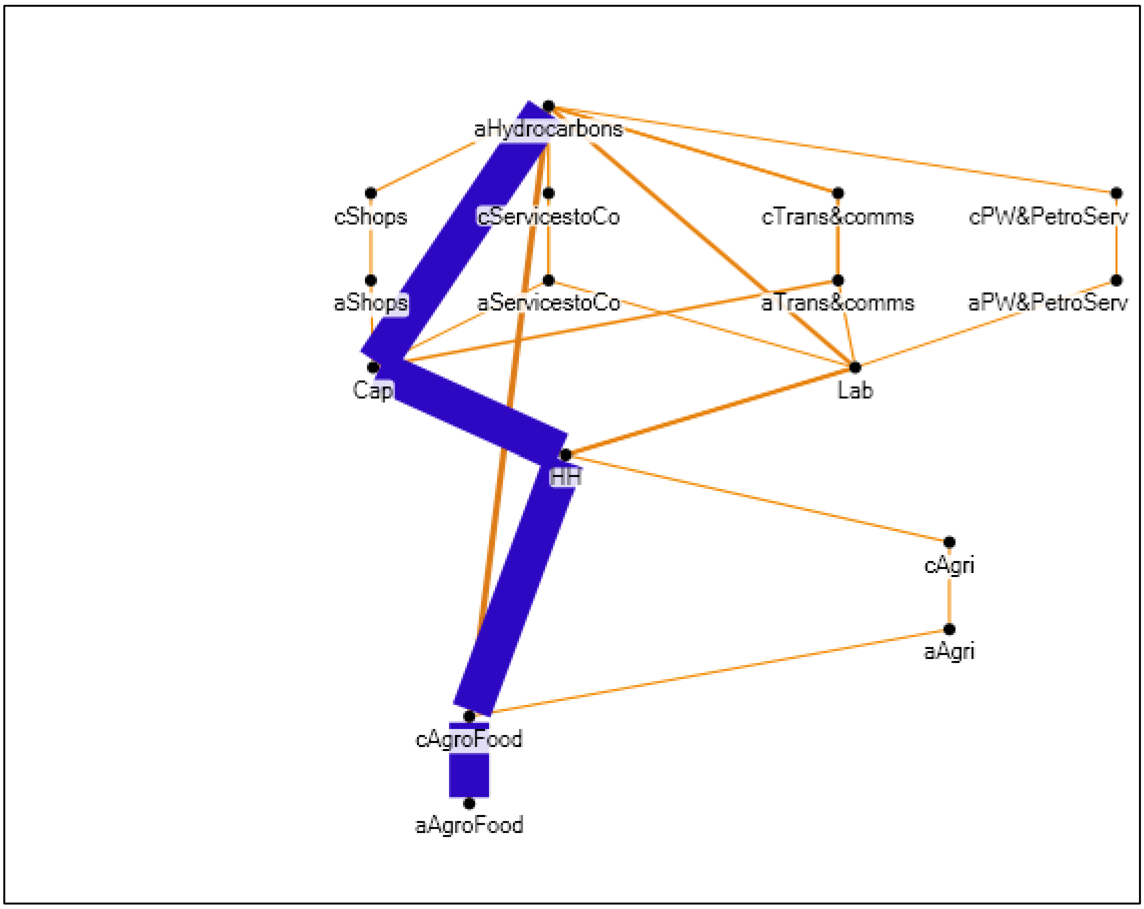
Case	Origin	Dest.	Global infl.	Path	Direct infl.	Path mult.	Total infl.	Prop. (in %)	Accum. Prop.
				aHydrocarbons / cChemRubberPlastic / aChemRubberPlastic / Cap / HH / cTextiles / aTextiles	3.73E-07	1.98	7.38E-07	0.0	99.1
				aHydrocarbons / cTrans&comms / aTrans&comms / cMetalSteelMecelectric / aMetalSteelMecelectric / Lab / HH / cTextiles / aTextiles	3.31E-07	2.14	7.08E-07	0.0	99.1
				aHydrocarbons / cMetalSteelMecelectric / aMetalSteelMecelectric / cShops / aShops / Cap / HH / cTextiles / aTextiles	3.55E-07	1.96	6.97E-07	0.0	99.1
				aHydrocarbons / Cap / HH / cMetalSteelMecelectric / aMetalSteelMecelectric / cTextiles / aTextiles	3.52E-07	1.95	6.85E-07	0.0	99.2
				aHydrocarbons / cServicestoCo / aServicestoCo / cShops / aShops / Cap / HH / cTextiles / aTextiles	3.54E-07	1.93	6.82E-07	0.0	99.2
				aHydrocarbons / cPW&PetroServ / aPW&PetroServ / cAgroFood / aAgroFood / Cap / HH / cTextiles / aTextiles	3.02E-07	2.24	6.77E-07	0.0	99.2
				aHydrocarbons / cPW&PetroServ / aPW&PetroServ / cShops / aShops / Lab / HH / cTextiles / aTextiles	3.38E-07	2.00	6.76E-07	0.0	99.2
				aHydrocarbons / cServicestoCo / aServicestoCo / cTrans&comms / aTrans&comms / Cap / HH / cTextiles / aTextiles	3.15E-07	2.10	6.63E-07	0.0	99.2
				aHydrocarbons / cBuildingM / aBuildingM / cTextiles / aTextiles	4.50E-07	1.47	6.63E-07	0.0	99.2

Figure II.1: Production Activities – Case I



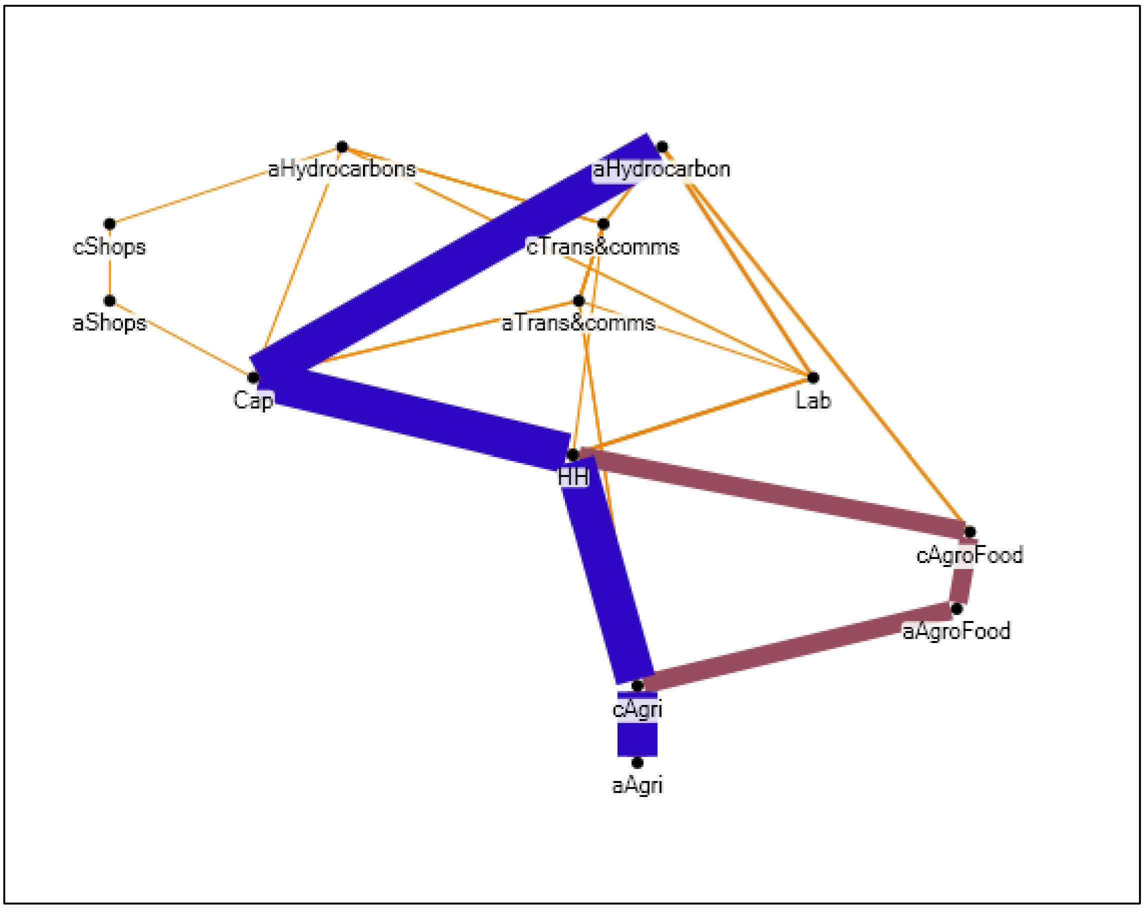
Note: Figure created using the weighted graph scheme of NodeXL. Paths depicted explain 93% of the accounting multiplier.

Figure II.2: Production Activities – Case II



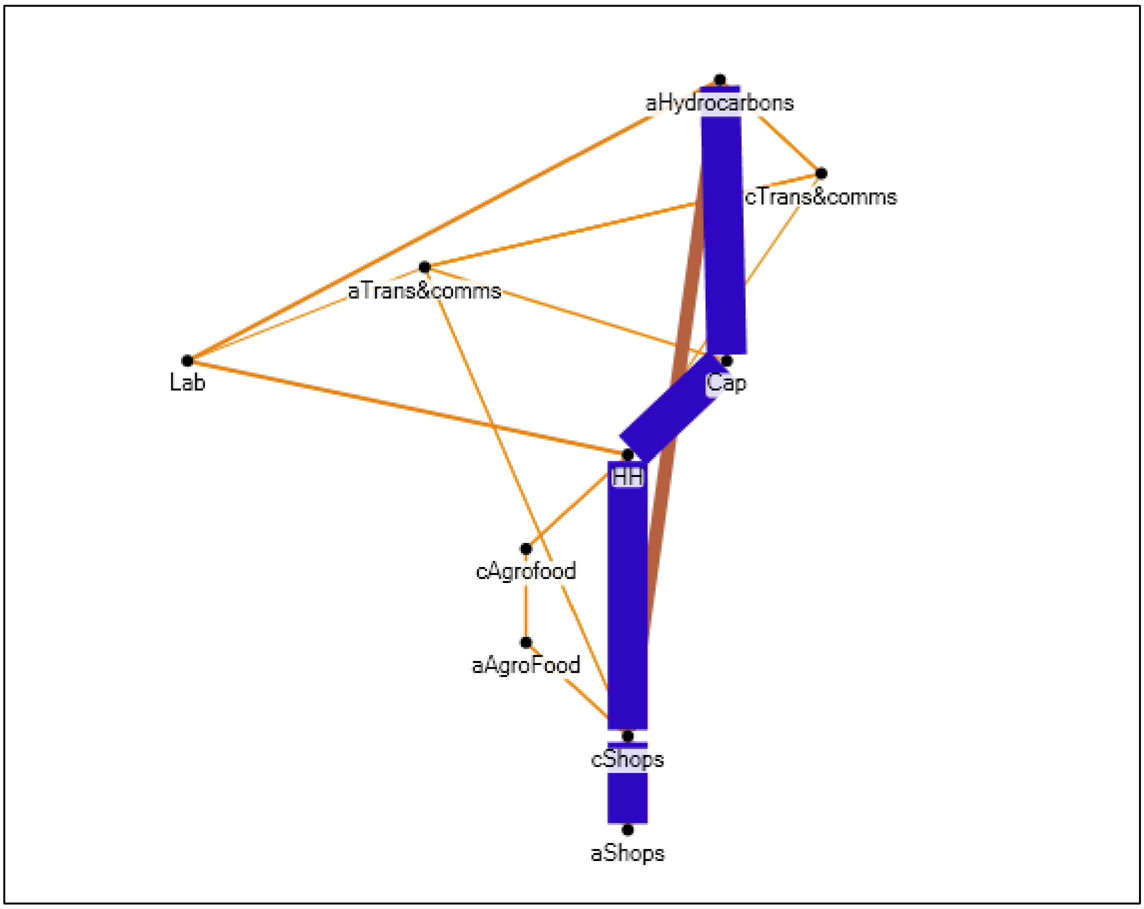
Note: Figure created using the weighted graph scheme of NodeXL. Paths depicted explain 95% of the accounting multiplier.

Figure II.3: Production Activities – Case III



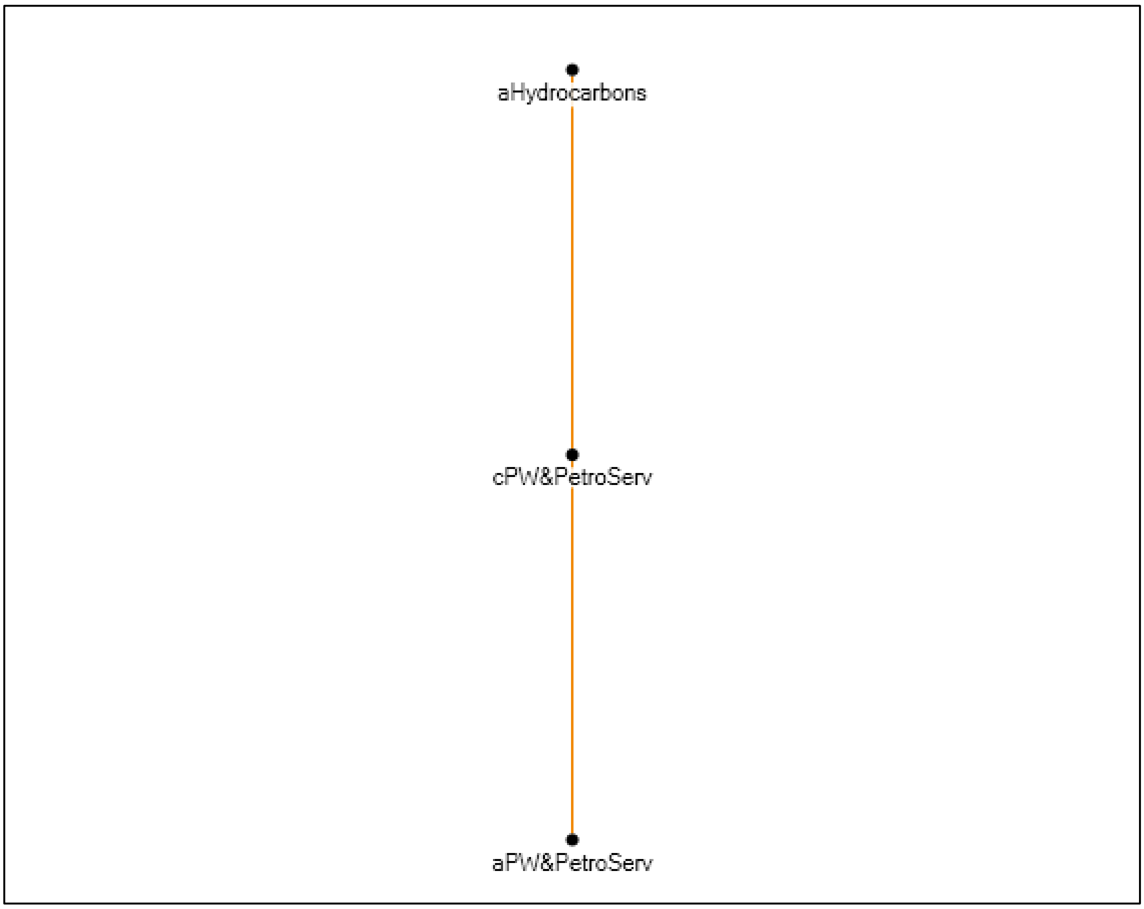
Note: Figure created using the weighted graph scheme of NodeXL. Paths depicted explain 90% of the accounting multiplier.

Figure II.4: Production Activities – Case IV



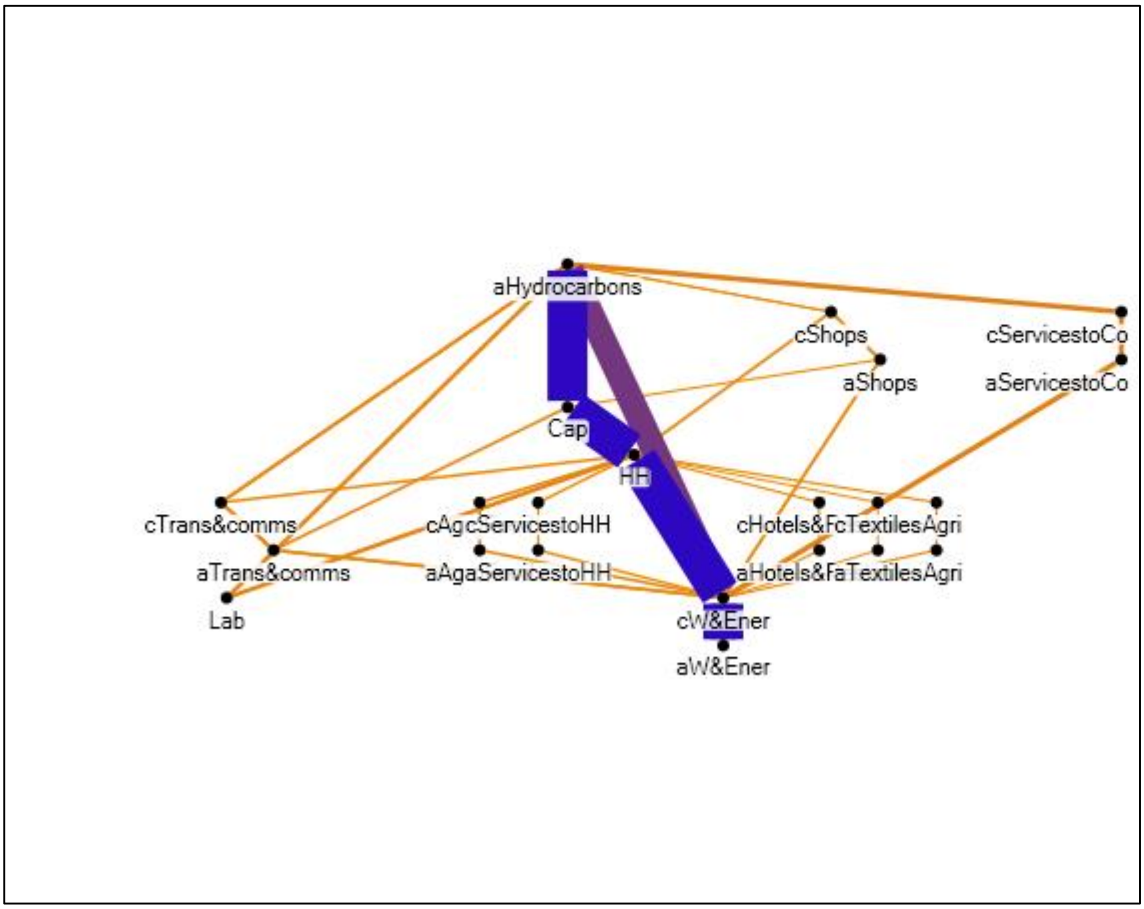
Note: Figure created using the weighted graph scheme of NodeXL. Paths depicted explain 90% of the accounting multiplier.

Figure II.5: Production Activities – Case V



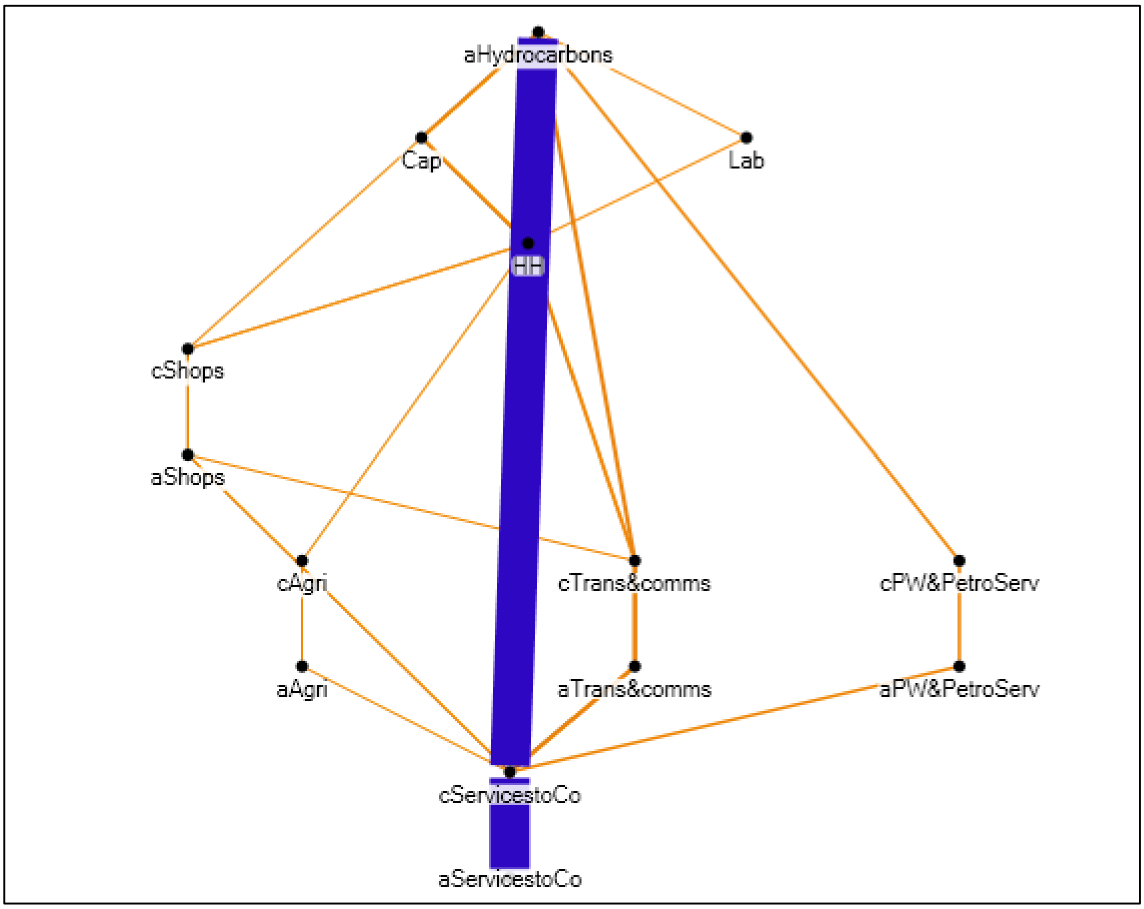
Note: Figure created using the weighted graph scheme of NodeXL. Paths depicted explain 90% of the accounting multiplier.

Figure II.6: Production Activities – Case VI



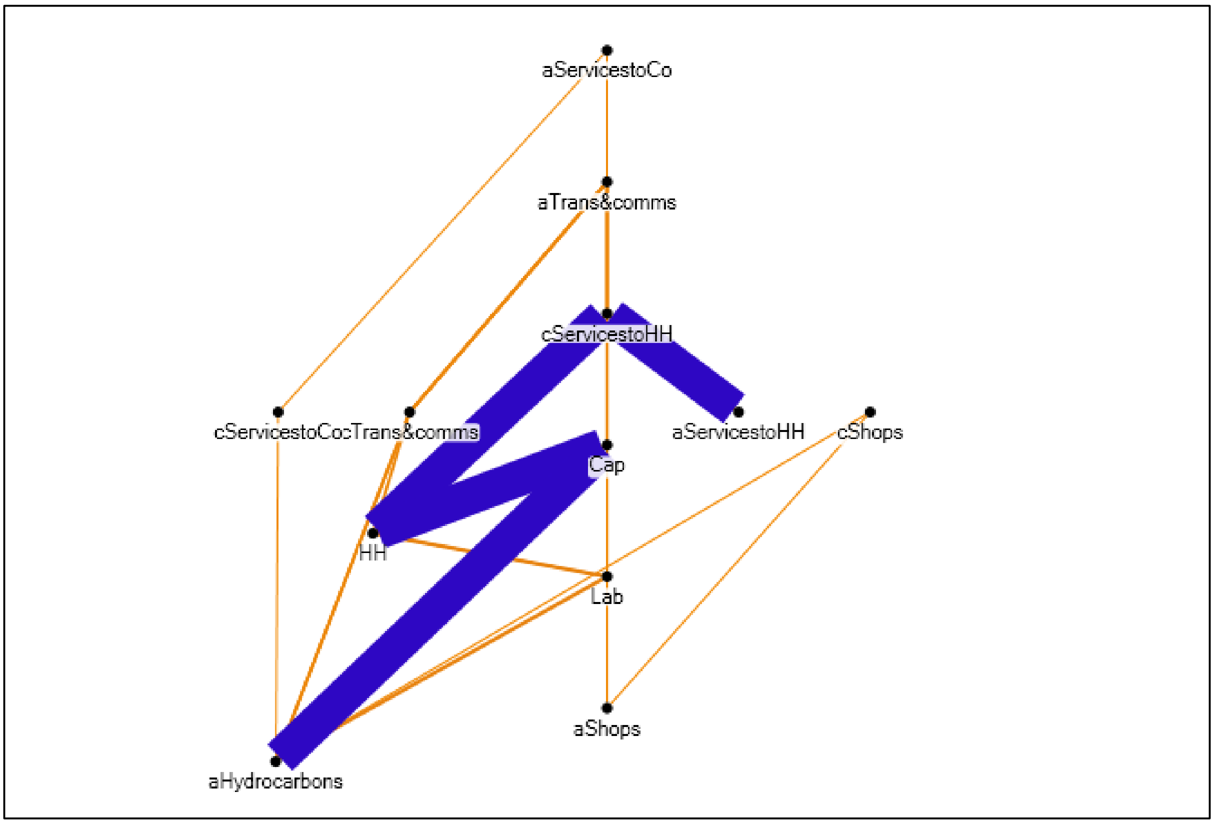
Note: Figure created using the weighted graph scheme of NodeXL. Paths depicted explain 99% of the accounting multiplier.

Figure II.7: Production Activities – Case VII



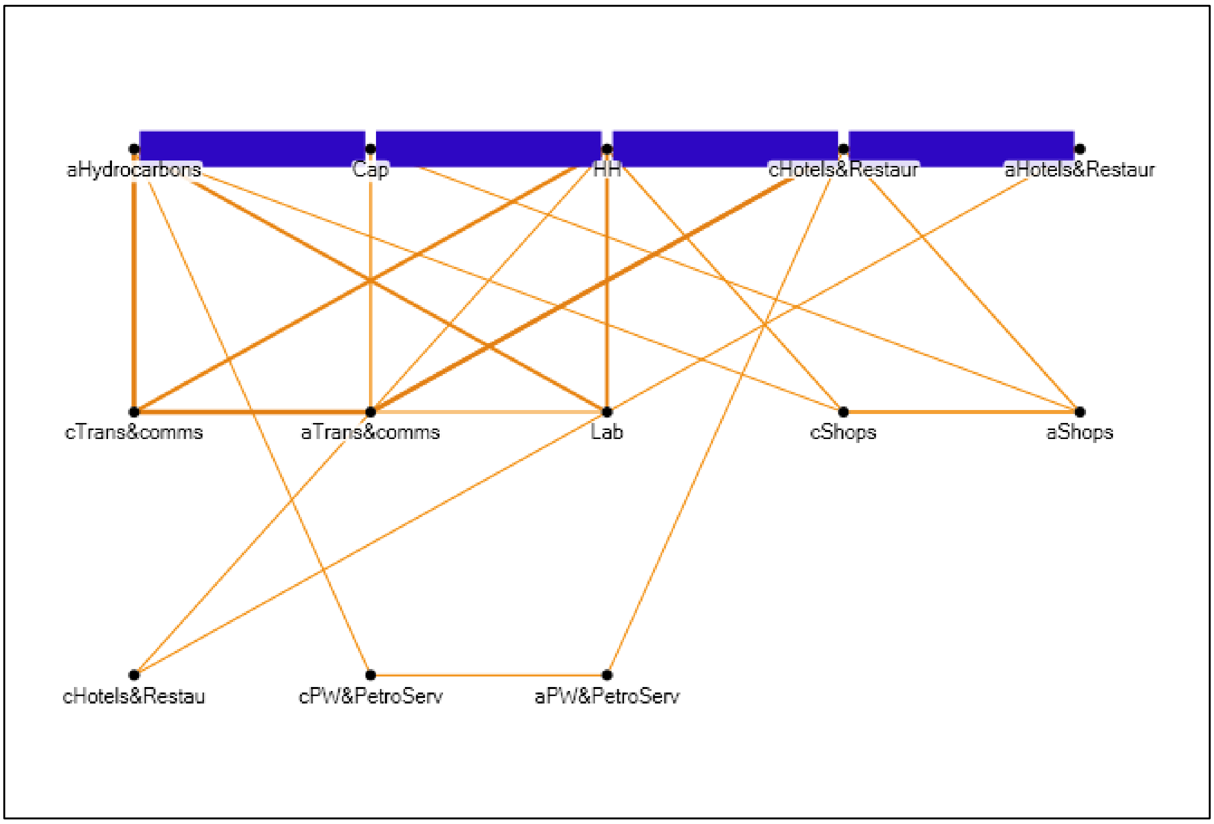
Note: Figure created using the weighted graph scheme of NodeXL. Paths depicted explain 98% of the accounting multiplier.

Figure II.8: Production Activities – Case VIII



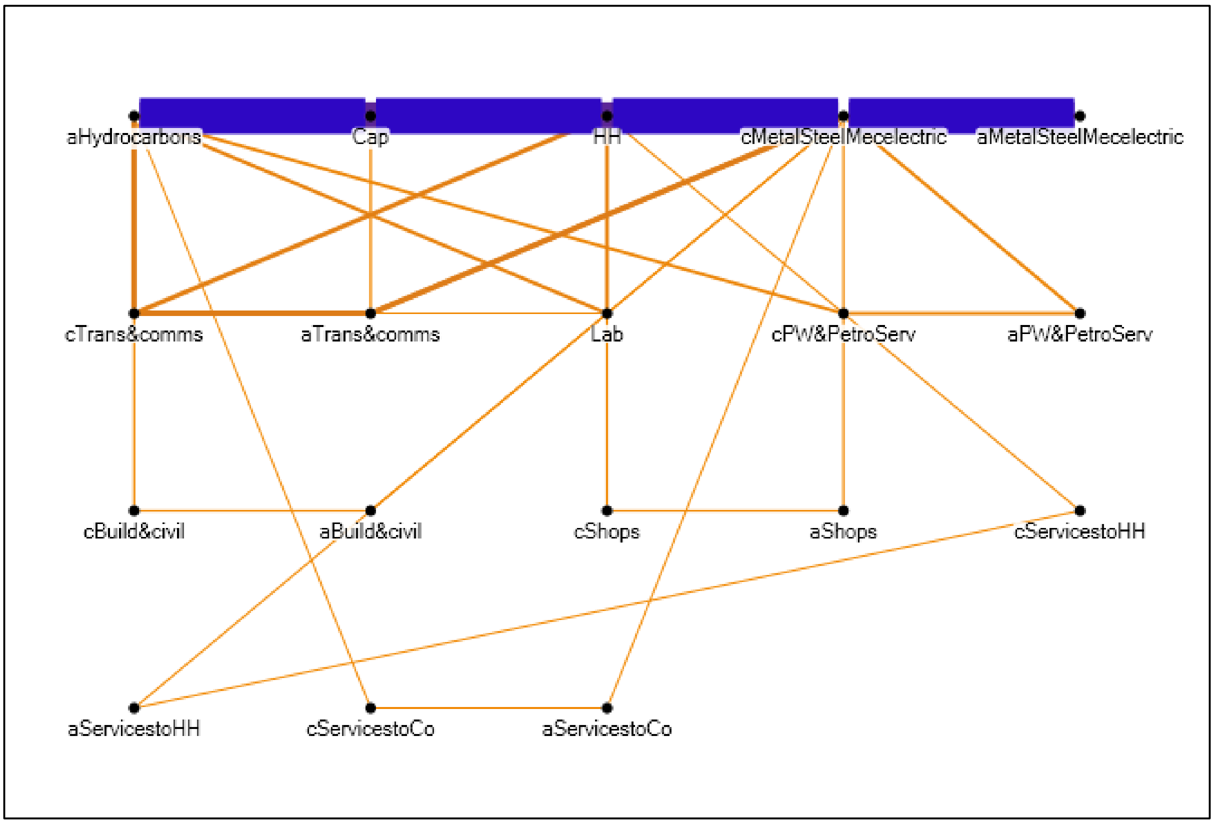
Note: Figure created using the weighted graph scheme of NodeXL. Paths depicted explain 93% of the accounting multiplier.

Figure II.9: Production Activities – Case IX



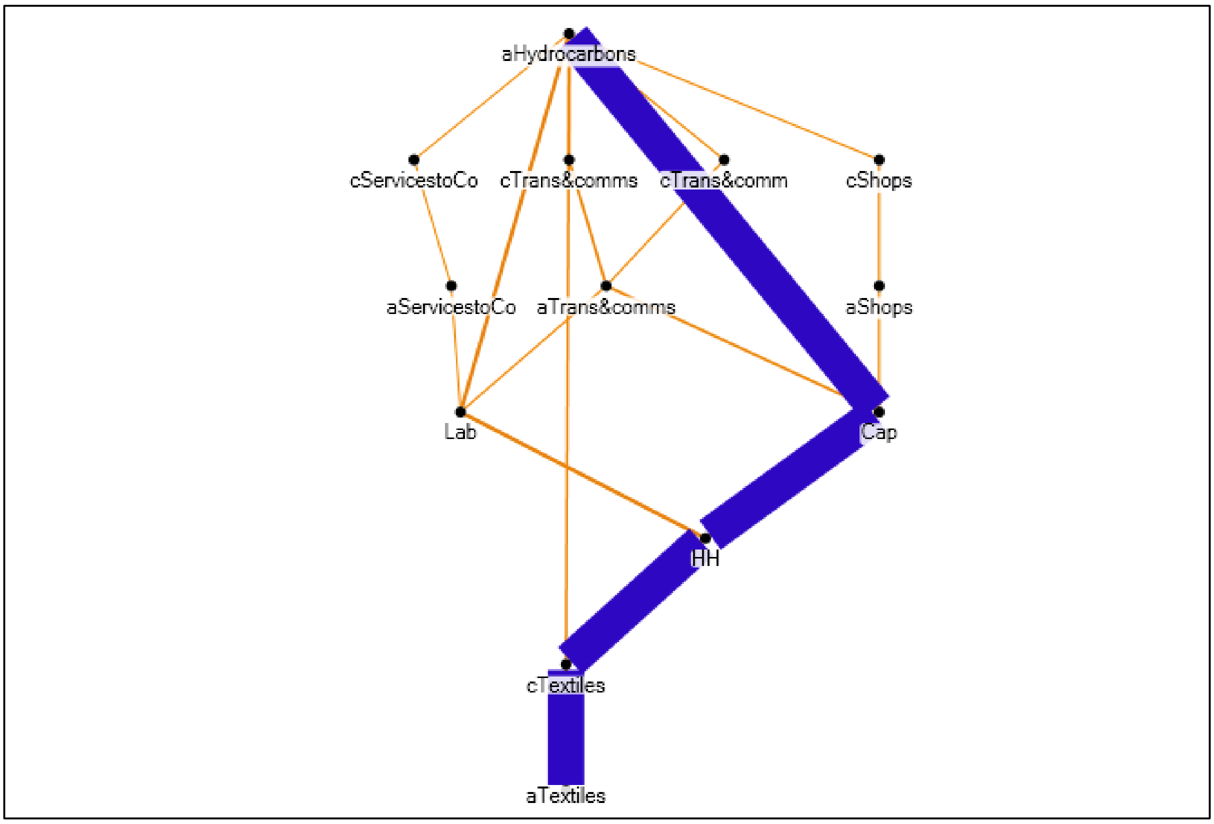
Note: Figure created using the weighted graph scheme of NodeXL. Paths depicted explain 90% of the accounting multiplier.

Figure II.10: Production Activities – Case X



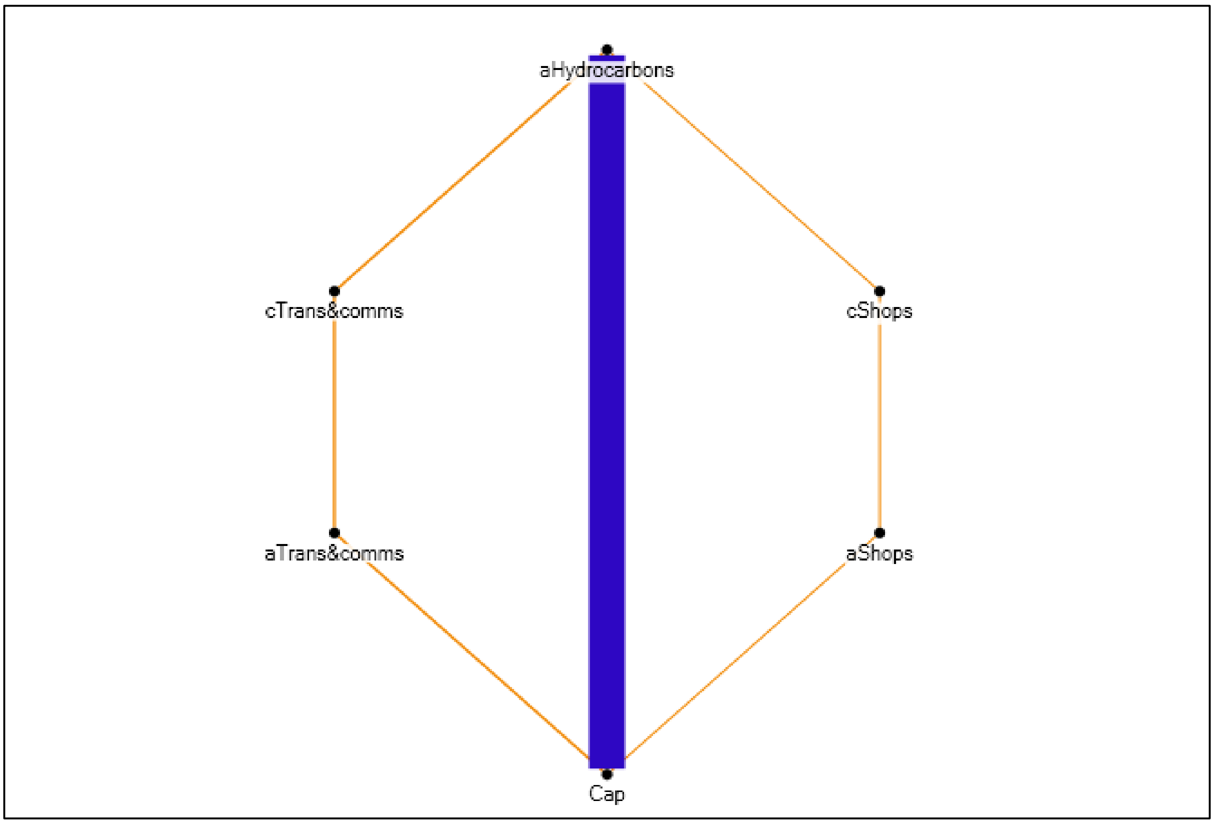
Note: Figure created using the weighted graph scheme of NodeXL. Paths depicted explain 90% of the accounting multiplier.

Figure II.11: Production Activities – Case XI



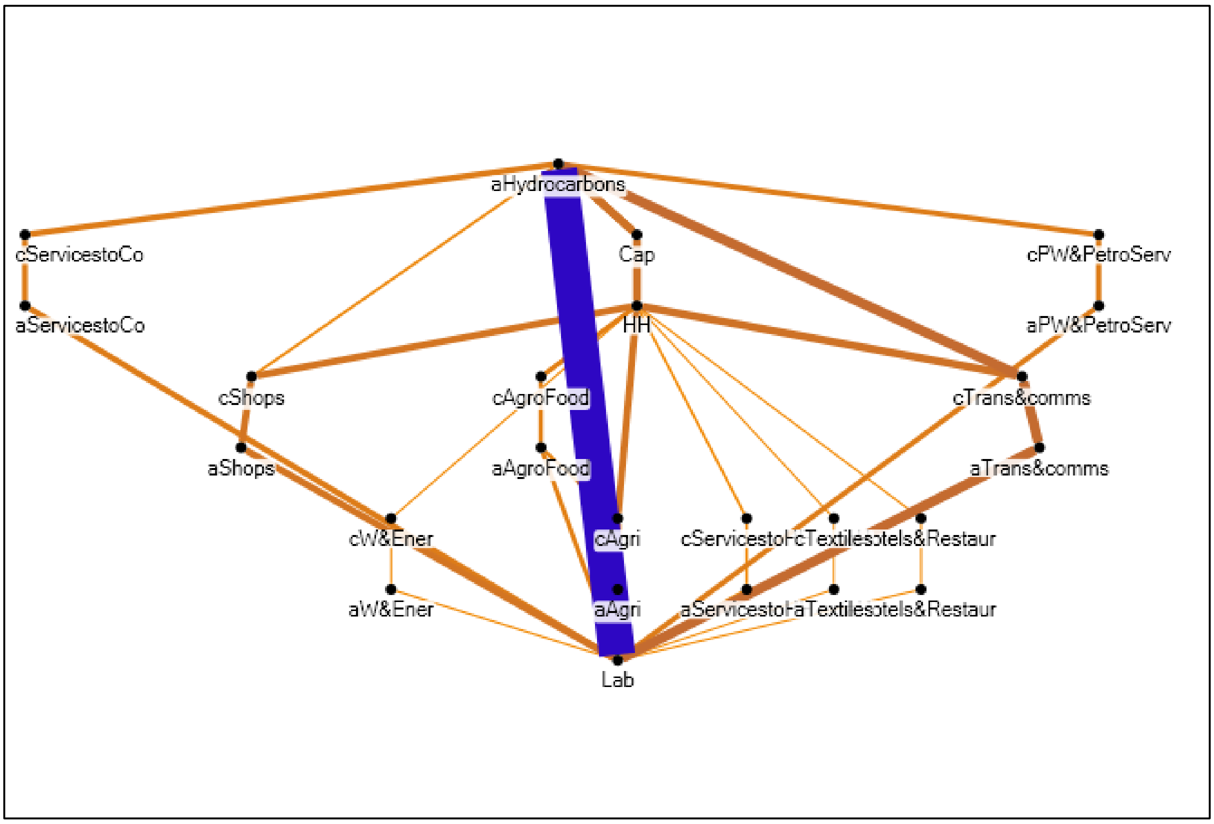
Note: Figure created using the weighted graph scheme of NodeXL. Paths depicted explain 93% of the accounting multiplier.

Figure II.12: Factors – Case I (Capital)



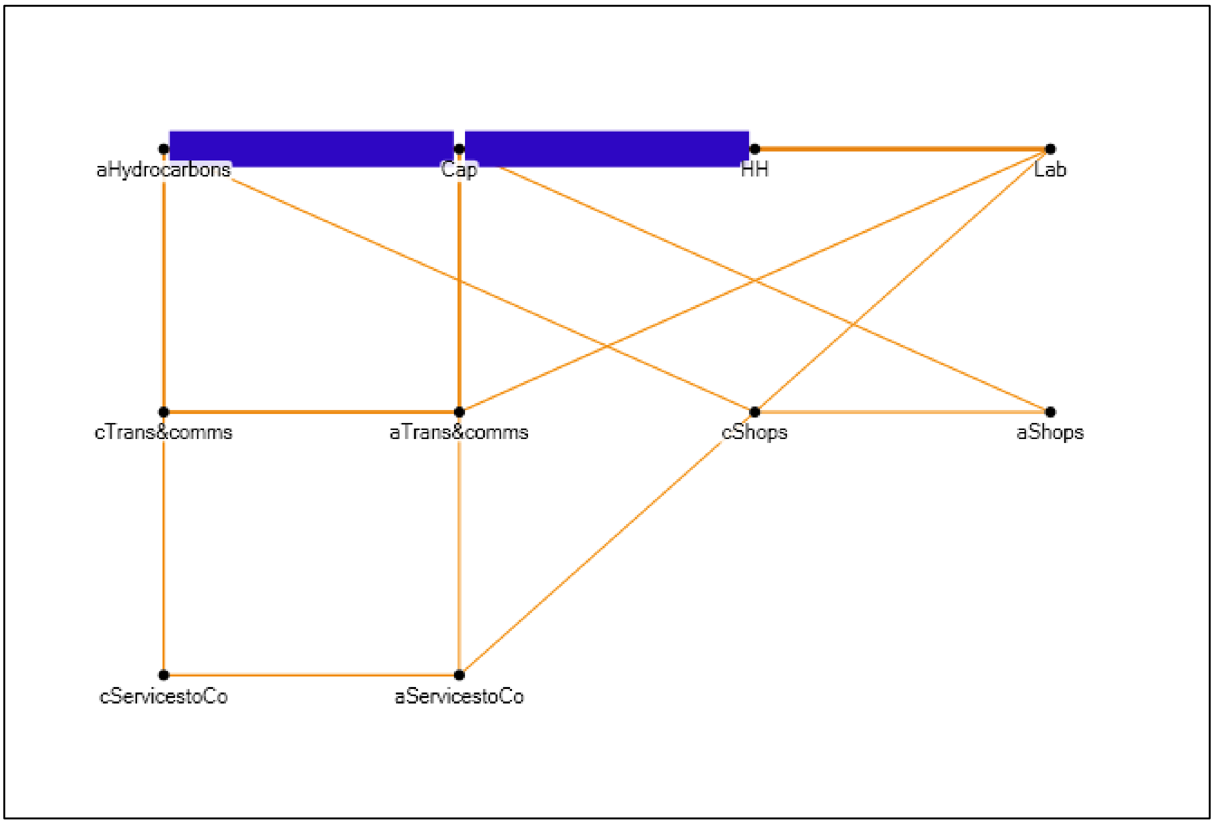
Note: Figure created using the weighted graph scheme of NodeXL. Paths depicted explain 95% of the accounting multiplier.

Figure II.13: Factors – Case II (Labour)



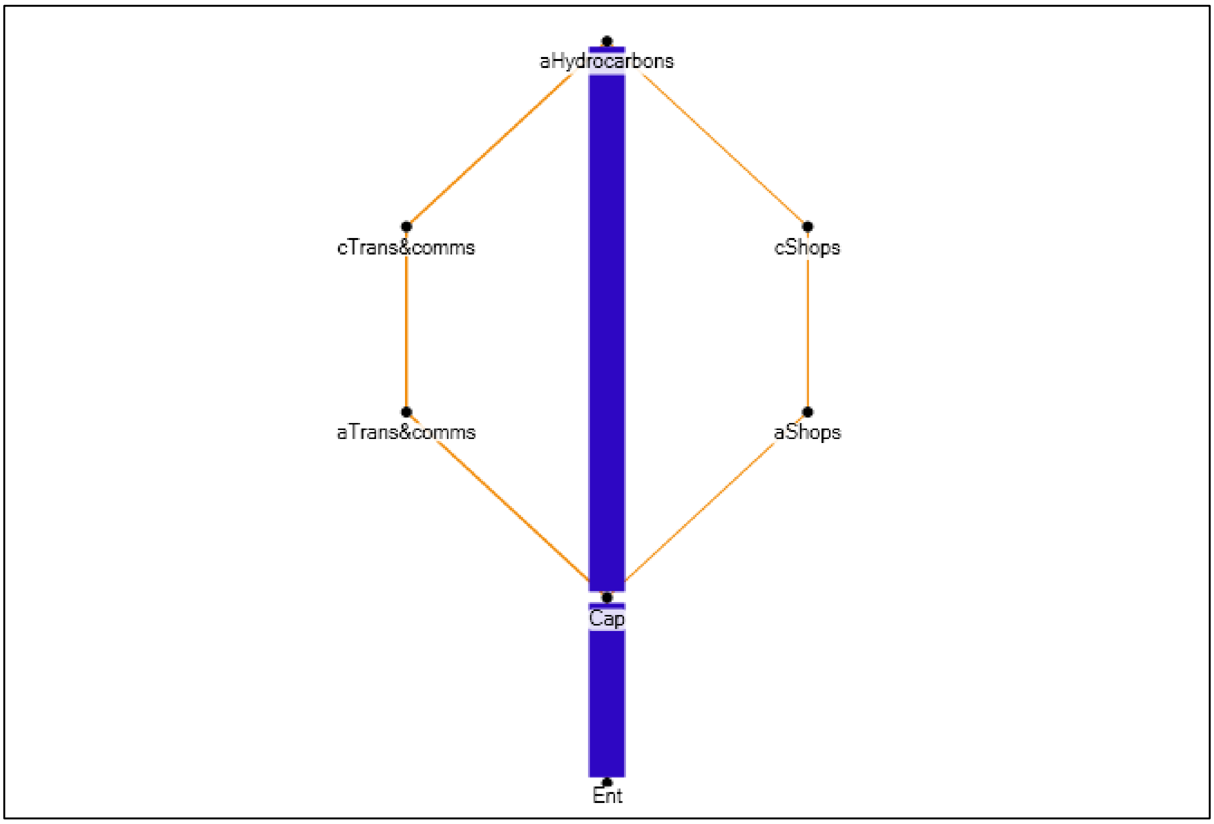
Note: Figure created using the weighted graph scheme of NodeXL. Paths depicted explain 85% of the accounting multiplier.

Figure II.14: Institutions – Case I (Households)



Note: Figure created using the weighted graph scheme of NodeXL. Paths depicted explain 95% of the accounting multiplier.

Figure II.15: Institutions – Case II (Enterprises)



Note: Figure created using the weighted graph scheme of NodeXL. Paths depicted explain 94% of the accounting multiplier.

Appendix III: Chad

This appendix lays the foundation for the analysis in Chapter 5. Tables III.1 summarises the macro structure of the Chad SAM used for the multiplier and SPA analysis in Chapter 5. Table III.2 and III.3 give the SAM account (activities and commodities) abbreviations and their corresponding names. Table III.4 provides the detailed results from the SPA performed in Chapter 5. Figure III.1 to III.13 are a graphical representation of the SPA results from Chapter 5.

Table III.1: Macro Social Accounting Matrix for Chad (2000)

Receipts \ Payments	Activities	Commodities	Land	Capital	Labour	Enterprises	Households	Government	Capital account	Rest of the world	Residual	Total
Activities		1 578.6									0.2	**1 578.8**
Commodities	623.0	185.7				207.5	676.4	77.6	221.1	197.0	-385.9	**1 802.4**
Land	80.0										0.1	**80.1**
Capital	293.6										0.1	**293.7**
Labour	580.5										-0.3	**580.2**
Enterprises			35.6	204.9				0.9				**241.4**
Households			44.5	51.0	580.2		66.4	12.0	14.4	4.6	0.2	**773.3**
Government	1.7	38.1		8.3		14.0	23.8			24.6	-0.4	**110.1**
Capital account						19.9	6.7	10.7		198.2		**235.5**
Rest of the world				29.5				8.9			386.0	**424.4**
Residual												
Total	**1 578.8**	**1 802.4**	**80.1**	**293.7**	**580.2**	**241.4**	**773.3**	**110.1**	**235.5**	**424.4**	**0.0**	**6 119.9**

Note: *Subgroups for the factors, capital and labour, have been aggregated into the capital and labour factors respectively. Furthermore, subgroups for households and the capital account (savings and investment) have also been aggregated into the repsective household and capital accounts.*

Table III.2: Chad SAM accounts: Activities

Account Number	Code	Description
1	a_ag	Non-Cotton Agriculture
2	a_agcot	Cotton Agriculture
3	a_live	Livestock
4	a_fish	Forestry, Fishing, (Non-Oil) Mining
5	a_man	Non-Cotton, Non-Oil Formal Manufacturing
6	a_cot	Cotton Fiber Manufacturing
7	a_dev	Oil Field Development
8	a_con	Informal Manufacturing
9	a_inf	Construction and Public Works
10	a_serv	Services
11	a_gov	Public Administration

Table III.3: Chad SAM accounts: Commodities

Account Number	Code	Description
1	c_ag	Non-Cotton Agriculture
2	c_agcot	Cotton Agriculture
3	c_live	Livestock
4	c_fish	Forestry, Fishing, (Non-Oil) Mining
5	c_man	Non-Cotton, Non-Oil Formal Manufacturing
6	c_cot	Cotton Fiber Manufacturing
7	c_dev	Oil Field Development
8	c_con	Informal Manufacturing
9	c_inf	Construction and Public Works
10	c_serv	Services
11	c_gov	Public Administration

Table III.4: SPA for selected activites: Chad (CASE I TO XIII)

Case	Origin	Dest.	Global infl.	Path	Direct infl.	Path mult.	Total infl.	Prop. (in %)	Accum. Prop.
I	a_dev	a_serv	5.17	a_dev / c_serv / a_serv	0.438	5.77	2.524	48.8	48.8
				a_dev / c_man / c_serv / a_serv	0.082	8.55	0.698	13.5	62.3
				a_dev / f_capital / h_ent / c_serv / a_serv	0.051	5.87	0.301	5.8	68.1
				a_dev / c_con / a_con / c_man / c_serv / a_serv	0.027	8.64	0.237	4.6	72.7
				a_dev / c_con / a_con / c_serv / a_serv	0.040	5.84	0.233	4.5	77.2
				a_dev / c_con / a_con / f_capital / h_ent / c_serv / a_serv	0.017	5.95	0.102	2.0	79.2
				a_dev / c_man / a_man / f_capital / h_ent / c_serv / a_serv	0.009	8.62	0.075	1.4	80.7
				a_dev / c_man / a_man / c_live / a_live / f_labour / households / c_serv / a_serv	0.005	13.67	0.070	1.4	82.0
				a_dev / c_con / a_con / c_fish / c_serv / a_serv	0.009	6.30	0.059	1.1	83.2
				a_dev / f_labour / households / c_serv / a_serv	0.005	10.86	0.054	1.0	84.2
II	a_dev	a_man	1.90	a_dev / c_man / a_man	0.121	4.20	0.508	26.8	26.8
				a_dev / c_serv / a_serv / c_man / a_man	0.050	8.55	0.430	22.6	49.4
				a_dev / c_serv / a_serv / f_labour / households / c_man / a_man	0.014	13.67	0.196	10.3	59.7
				a_dev / c_con / a_con / c_man / a_man	0.041	4.26	0.174	9.1	68.9
				a_dev / c_serv / a_serv / f_capital / households / c_man / a_man	0.004	13.67	0.054	2.9	71.7
				a_dev / f_capital / h_ent / c_serv / a_serv / c_man / a_man	0.006	8.62	0.051	2.7	74.4
				a_dev / c_con / a_con / c_serv / a_serv / c_man / a_man	0.005	8.64	0.040	2.1	76.5
				a_dev / f_labour / households / c_man / a_man	0.005	8.58	0.040	2.1	78.6
				a_dev / c_serv / a_serv / f_labour / households / c_inf / a_inf / c_man / a_man	0.002	15.17	0.035	1.8	80.4
				a_dev / c_con / a_con / c_fish / a_fish / f_labour / households / c_man / a_man	0.004	8.96	0.035	1.8	82.2
				a_dev / c_con / a_con / f_labour / households / c_man / a_man	0.004	8.66	0.032	1.7	83.9
				a_dev / f_capital / households / c_man / a_man	0.002	11.57	0.025	1.3	85.2
				a_dev / f_capital / h_ent / c_serv / a_serv / f_labour / households / c_man / a_man	0.002	13.67	0.023	1.2	86.4
				a_dev / c_serv / a_serv / c_ag / a_ag / f_labour / households / c_man / a_man	0.002	14.45	0.023	1.2	87.6

Table III.4: Continued

Case	Origin	Dest.	Global infl.	Path	Direct infl.	Path mult.	Total infl.	Prop. (in %)	Accum. Prop.
III	a_dev	a_ag	1.21	a_dev / c_serv / a_serv / f_labour / households / c_ag / a_ag	0.022	11.49	0.255	21.1	21.1
				a_dev / c_serv / a_serv / c_ag / a_ag	0.015	8.38	0.125	10.4	31.5
				a_dev / c_serv / a_serv / f_capital / households / c_ag / a_ag	0.006	11.49	0.071	5.9	37.3
				a_dev / c_man / a_man / c_live / a_live / f_labour / households / c_ag / a_ag	0.007	9.23	0.068	5.6	42.9
				a_dev / c_man / c_serv / a_serv / f_labour / households / c_ag / a_ag	0.004	14.45	0.060	5.0	47.9
				a_dev / c_serv / a_serv / c_man / a_man / c_live / a_live / f_labour / households / c_ag / a_ag	0.003	14.45	0.044	3.7	51.5
				a_dev / f_labour / households / c_ag / a_ag	0.007	5.94	0.042	3.5	55.0
				a_dev / c_con / a_con / c_fish / a_fish / f_labour / households / c_ag / a_ag	0.006	6.22	0.037	3.1	58.1
				a_dev / c_con / a_con / f_labour / households / c_ag / a_ag	0.006	6.01	0.034	2.8	60.9
				a_dev / c_man / c_serv / a_serv / c_ag / a_ag	0.003	11.78	0.033	2.7	63.6
				a_dev / f_capital / h_ent / c_serv / a_serv / f_labour / households / c_ag / a_ag	0.003	11.49	0.030	2.5	66.1
				a_dev / f_capital / households / c_ag / a_ag	0.003	8.57	0.028	2.3	68.5
				a_dev / c_con / a_con / c_serv / a_serv / f_labour / households / c_ag / a_ag	0.002	11.60	0.024	1.9	70.4
				a_dev / c_con / a_con / c_man / a_man / c_live / a_live / f_labour / households / c_ag / a_ag	0.002	9.32	0.023	1.9	72.3
				a_dev / c_man / a_man / c_ag / a_ag	0.003	6.70	0.021	1.7	74.0
				a_dev / c_con / a_con / c_man / c_serv / a_serv / f_labour / households / c_ag / a_ag	0.001	14.58	0.020	1.7	75.7
				a_dev / c_man / c_serv / a_serv / f_capital / households / c_ag / a_ag	0.001	14.45	0.017	1.4	77.1
				a_dev / c_man / a_man / c_live / a_live / f_land / households / c_ag / a_ag	0.002	9.23	0.016	1.3	78.4
				a_dev / c_serv / a_serv / c_man / a_man / c_ag / a_ag	0.001	11.78	0.015	1.2	79.6
				a_dev / f_capital / h_ent / c_serv / a_serv / c_ag / a_ag	0.002	8.49	0.015	1.2	80.9

Table III.4: Continued

Case	Origin	Dest.	Global infl.	Path	Direct infl.	Path mult.	Total infl.	Prop. (in %)	Accum. Prop.
IV	a_dev	a_live	0.97	a_dev / c_man / a_man / c_live / a_live	0.052	4.48	0.231	23.9	23.9
				a_dev / c_serv / a_serv / c_man / a_man / c_live / a_live	0.021	8.94	0.192	19.9	43.8
				a_dev / c_serv / a_serv / f_labour / households / c_man / a_man / c_live / a_live	0.006	13.67	0.084	8.7	52.5
				a_dev / c_con / a_con / c_man / a_man / c_live / a_live	0.017	4.54	0.079	8.2	60.6
				a_dev / c_serv / a_serv / f_labour / households / c_live / a_live	0.003	11.01	0.031	3.2	63.8
				a_dev / c_serv / a_serv / f_capital / households / c_man / a_man / c_live / a_live	0.002	13.67	0.023	2.4	66.2
				a_dev / f_capital / h_ent / c_serv / a_serv / c_man / a_man / c_live / a_live	0.003	9.01	0.023	2.3	68.5
				a_dev / c_con / a_con / c_serv / a_serv / c_man / a_man / c_live / a_live	0.002	9.03	0.018	1.8	70.4
				a_dev / f_labour / households / c_man / a_man / c_live / a_live	0.002	8.58	0.017	1.7	72.1
				a_dev / c_serv / a_serv / f_labour / households / c_inf / a_inf / c_man / a_man / c_live / a_live	0.001	15.17	0.015	1.6	73.7
				a_dev / c_con / a_con / c_fish / a_fish / f_labour / households / c_man / a_man / c_live / a_live	0.002	8.96	0.015	1.5	75.2
				a_dev / c_con / a_con / f_labour / households / c_man / a_man / c_live / a_live	0.002	8.67	0.014	1.4	76.6
				a_dev / f_capital / households / c_man / a_man / c_live / a_live	0.001	11.57	0.011	1.1	77.7
				a_dev / f_capital / h_ent / c_serv / a_serv / f_labour / households / c_man / a_man / c_live / a_live	0.001	13.67	0.010	1.0	78.7
V	a_dev	a_inf	0.59	a_dev / c_serv / a_serv / f_labour / households / c_inf / a_inf	0.013	12.05	0.155	26.4	26.4
				a_dev / c_serv / a_serv / f_capital / households / c_inf / a_inf	0.004	12.05	0.043	7.3	33.7
				a_dev / c_man / a_man / c_live / a_live / f_labour / households / c_inf / a_inf	0.004	9.53	0.040	6.9	40.6
				a_dev / c_man / c_serv / a_serv / f_labour / households / c_inf / a_inf	0.002	15.17	0.036	6.2	46.8
				a_dev / c_serv / a_serv / c_man / a_man / c_live / a_live / f_labour / households / c_inf / a_inf	0.002	15.17	0.027	4.6	51.3
				a_dev / f_labour / households / c_inf / a_inf	0.004	6.07	0.025	4.3	55.6
				a_dev / c_con / a_con / c_fish / a_fish / f_labour / households / c_inf / a_inf	0.003	6.36	0.022	3.7	59.3
				a_dev / c_con / a_con / f_labour / households / c_inf / a_inf	0.003	6.14	0.020	3.4	62.7

Table III.4: Continued

Case	Origin	Dest.	Global infl.	Path	Direct infl.	Path mult.	Total infl.	Prop. (in %)	Accum. Prop.
				a_dev / f_capital / h_ent / c_serv / a_serv / f_labour / households / c_inf / a_inf	0.002	12.05	0.018	3.1	65.8
				a_dev / c_serv / a_serv / c_ag / a_ag / f_labour / households / c_inf / a_inf	0.001	12.75	0.018	3.0	68.9
				a_dev / f_capital / households / c_inf / a_inf	0.002	8.83	0.017	2.9	71.7
				a_dev / c_con / a_con / c_serv / a_serv / f_labour / households / c_inf / a_inf	0.001	12.16	0.014	2.4	74.2
				a_dev / c_con / a_con / c_man / a_man / c_live / a_live / f_labour / households / c_inf / a_inf	0.001	9.62	0.014	2.3	76.5
				a_dev / c_con / a_con / c_man / c_serv / a_serv / f_labour / households / c_inf / a_inf	0.001	15.30	0.012	2.1	78.6
				a_dev / c_man / c_serv / a_serv / f_capital / households / c_inf / a_inf	0.001	15.17	0.010	1.7	80.3
				a_dev / c_man / a_man / c_live / a_live / f_land / households / c_inf / a_inf	0.001	9.55	0.010	1.6	82.0
				a_dev / c_serv / a_serv / c_man / a_man / c_live / a_live / f_land / households / c_inf / a_inf	0.000	15.17	0.006	1.1	83.0
				a_dev / c_con / a_con / f_capital / h_ent / c_serv / a_serv / f_labour / households / c_inf / a_inf	0.001	12.16	0.006	1.0	84.1
VI	a_dev	a_con	0.25	a_dev / c_con / a_con	0.213	1.05	0.223	88.4	88.4
				a_dev / c_serv / a_serv / c_con / a_con	0.001	5.84	0.006	2.2	90.6
				a_dev / c_serv / a_serv / f_labour / households / c_con / a_con	0.000	10.96	0.005	2.0	92.5
VII	a_dev	a_fish	0.17	a_dev / c_con / a_con / c_fish / a_fish	0.034	1.28	0.043	25.0	25.0
				a_dev / c_serv / a_serv / f_labour / households / c_fish / a_fish	0.002	11.21	0.028	16.1	41.1
				a_dev / c_serv / a_serv / c_fish / a_fish	0.002	6.22	0.009	5.4	46.5
				a_dev / c_serv / a_serv / f_capital / households / c_fish / a_fish	0.001	11.21	0.008	4.5	51.0
				a_dev / c_man / a_man / c_live / a_live / f_labour / households / c_fish / a_fish	0.001	8.88	0.007	4.2	55.3
				a_dev / c_man / c_serv / a_serv / f_labour / households / c_fish / a_fish	0.000	14.11	0.007	3.8	59.0
				a_dev / c_serv / a_serv / c_man / a_man / c_live / a_live / f_labour / households / c_fish / a_fish	0.000	14.11	0.005	2.8	61.8

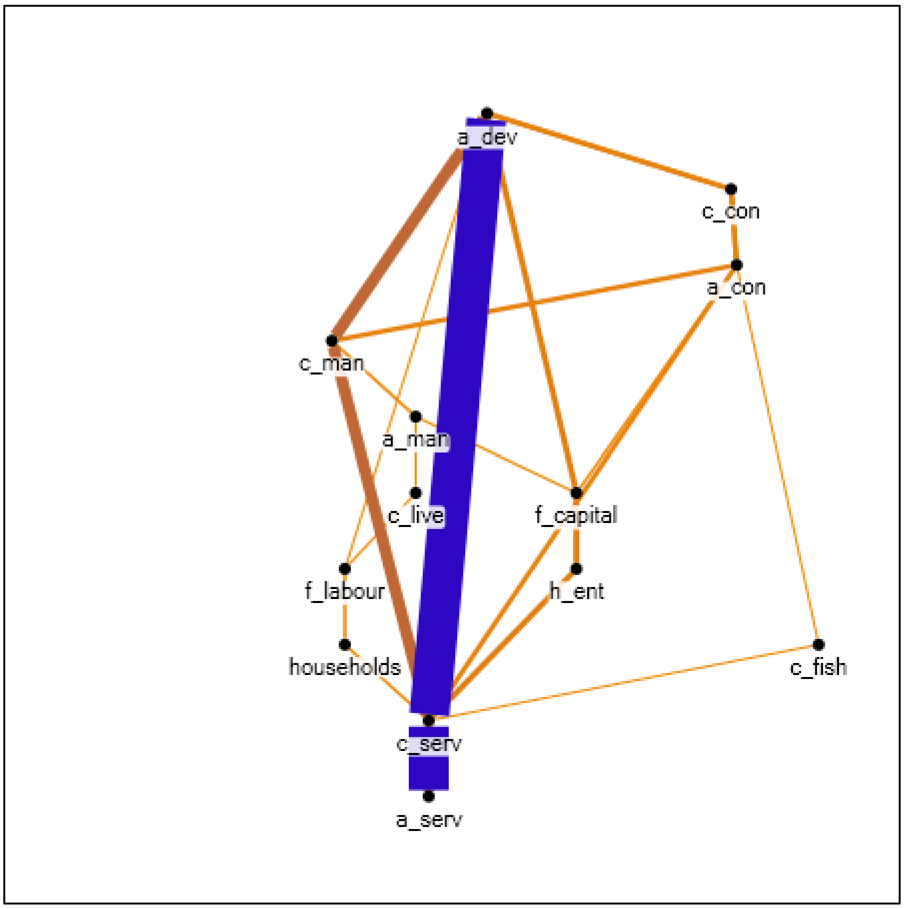
Table III.4: Continued

Case	Origin	Dest.	Global infl.	Path	Direct infl.	Path mult.	Total infl.	Prop. (in %)	Accum. Prop.
				a_dev / f_labour / households / c_fish / a_fish	0.001	5.66	0.005	2.6	64.5
				a_dev / c_con / a_con / f_labour / households / c_fish / a_fish	0.001	5.73	0.004	2.1	66.6
				a_dev / f_capital / h_ent / c_serv / a_serv / f_labour / households / c_fish / a_fish	0.000	11.21	0.003	1.9	68.4
				a_dev / c_serv / a_serv / c_ag / a_ag / f_labour / households / c_fish / a_fish	0.000	11.86	0.003	1.9	70.3
				a_dev / f_capital / households / c_fish / a_fish	0.000	8.23	0.003	1.8	72.1
				a_dev / c_man / c_serv / a_serv / c_fish / a_fish	0.000	9.15	0.003	1.5	73.5
				a_dev / c_con / a_con / c_serv / a_serv / f_labour / households / c_fish / a_fish	0.000	11.31	0.003	1.5	75.0
				a_dev / c_con / a_con / c_man / a_man / c_live / a_live / f_labour / households / c_fish / a_fish	0.000	8.96	0.002	1.4	76.5
				a_dev / c_con / a_con / c_man / c_serv / a_serv / f_labour / households / c_fish / a_fish	0.000	14.23	0.002	1.3	77.8
				a_dev / c_man / c_serv / a_serv / f_capital / households / c_fish / a_fish	0.000	14.11	0.002	1.1	78.8
				a_dev / c_man / a_man / c_live / a_live / f_land / households / c_fish / a_fish	0.000	8.90	0.002	1.0	79.8
VIII	a_dev	a_gov	0.02	a_dev / c_serv / a_serv / f_labour / households / c_gov / a_gov	0.000	10.86	0.004	23.0	23.0
				a_dev / c_serv / a_serv / f_capital / households / c_gov / a_gov	0.000	10.86	0.001	6.4	29.4
				a_dev / c_man / a_man / c_live / a_live / f_labour / households / c_gov / a_gov	0.000	8.59	0.001	6.0	35.4
				a_dev / c_man / c_serv / a_serv / f_labour / households / c_gov / a_gov	0.000	13.68	0.001	5.4	40.8
				a_dev / c_serv / a_serv / c_gov / a_gov	0.000	5.79	0.001	5.1	45.9
				a_dev / c_serv / a_serv / c_man / a_man / c_live / a_live / f_labour / households / c_gov / a_gov	0.000	13.68	0.001	4.0	49.9
				a_dev / f_labour / households / c_gov / a_gov	0.000	5.47	0.001	3.7	53.6
				a_dev / c_con / a_con / c_fish / a_fish / f_labour / households / c_gov / a_gov	0.000	5.73	0.001	3.3	56.9
				a_dev / c_con / a_con / f_labour / households / c_gov / a_gov	0.000	5.54	0.001	3.0	59.8
				a_dev / f_capital / h_ent / c_serv / a_serv / f_labour / households / c_gov / a_gov	0.000	10.86	0.000	2.7	62.5
				a_dev / c_serv / a_serv / c_ag / a_ag / f_labour / households / c_gov / a_gov	0.000	11.50	0.000	2.6	65.2

Table III.4: Continued

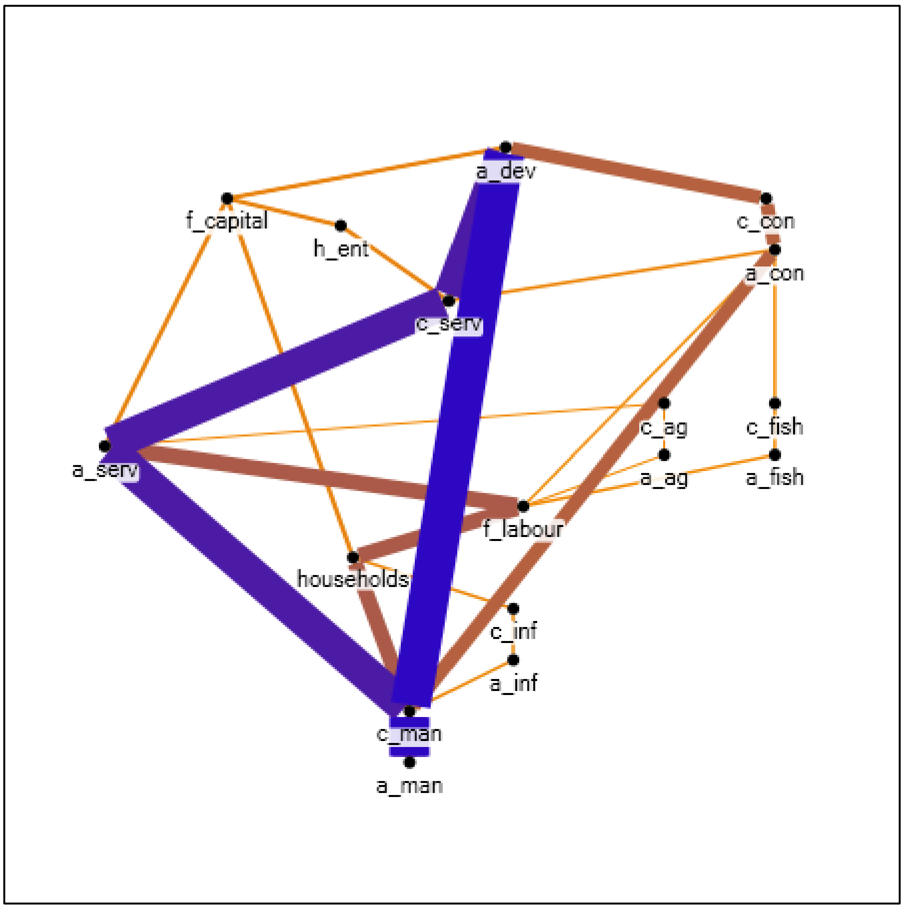
Case	Origin	Dest.	Global infl.	Path	Direct infl.	Path mult.	Total infl.	Prop. (in %)	Accum. Prop.
				a_dev / f_capital / households / c_gov / a_gov	5.76E-05	7.96	0.000	2.5	67.7
				a_dev / c_con / a_con / c_serv / a_serv / f_labour / households / c_gov / a_gov	3.54E-05	10.97	0.000	2.1	69.8
				a_dev / c_con / a_con / c_gov / a_gov	0.000363	1.07	0.000	2.1	71.9
				a_dev / c_con / a_con / c_man / a_man / c_live / a_live / f_labour / households / c_gov / a_gov	4.31E-05	8.67	0.000	2.0	74.0
				a_dev / c_con / a_con / c_man / c_serv / a_serv / f_labour / households / c_gov / a_gov	2.43E-05	13.79	0.000	1.8	75.8
				a_dev / c_man / c_serv / a_serv / f_capital / households / c_gov / a_gov	2.01E-05	13.68	0.000	1.5	77.3
				a_dev / c_man / a_man / c_live / a_live / f_land / households / c_gov / a_gov	3.04E-05	8.61	0.000	1.4	78.7
				a_dev / c_man / c_serv / a_serv / c_gov / a_gov	3.00E-05	8.57	0.000	1.4	80.1

Figure III.1: Production activities – Case I



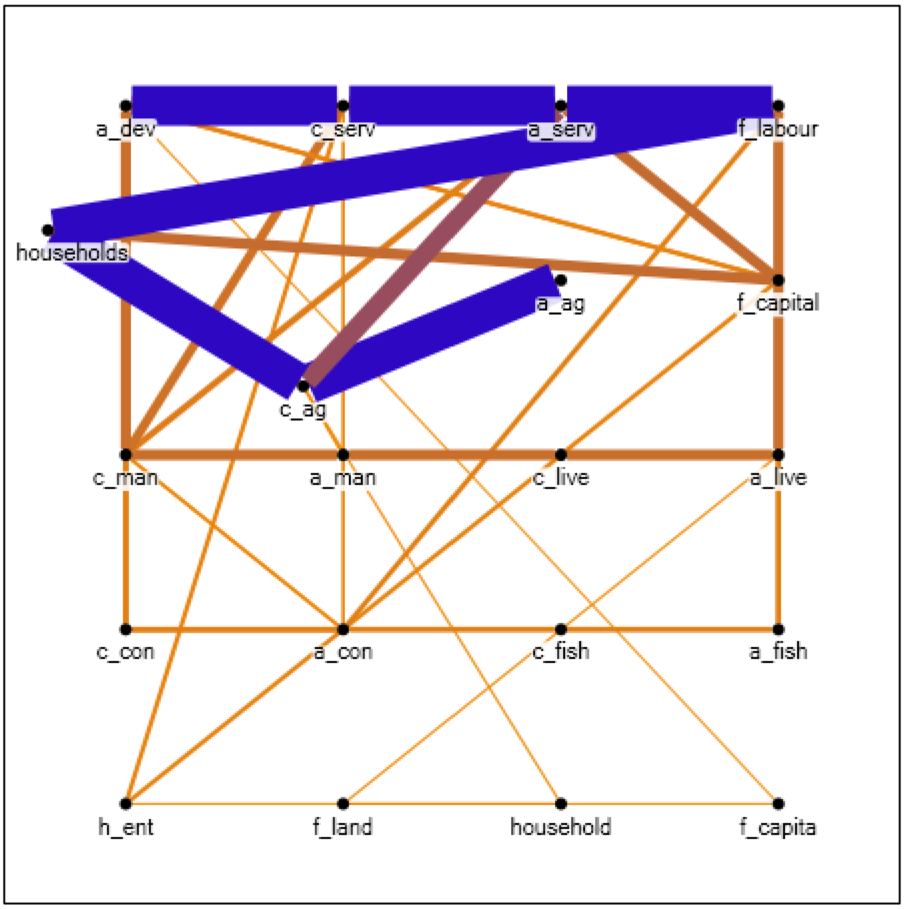
Note: Figure created using the weighted graph scheme of NodeXL. Paths depicted explain 84% of the accounting multiplier.

Figure III.2: Production activities – Case II



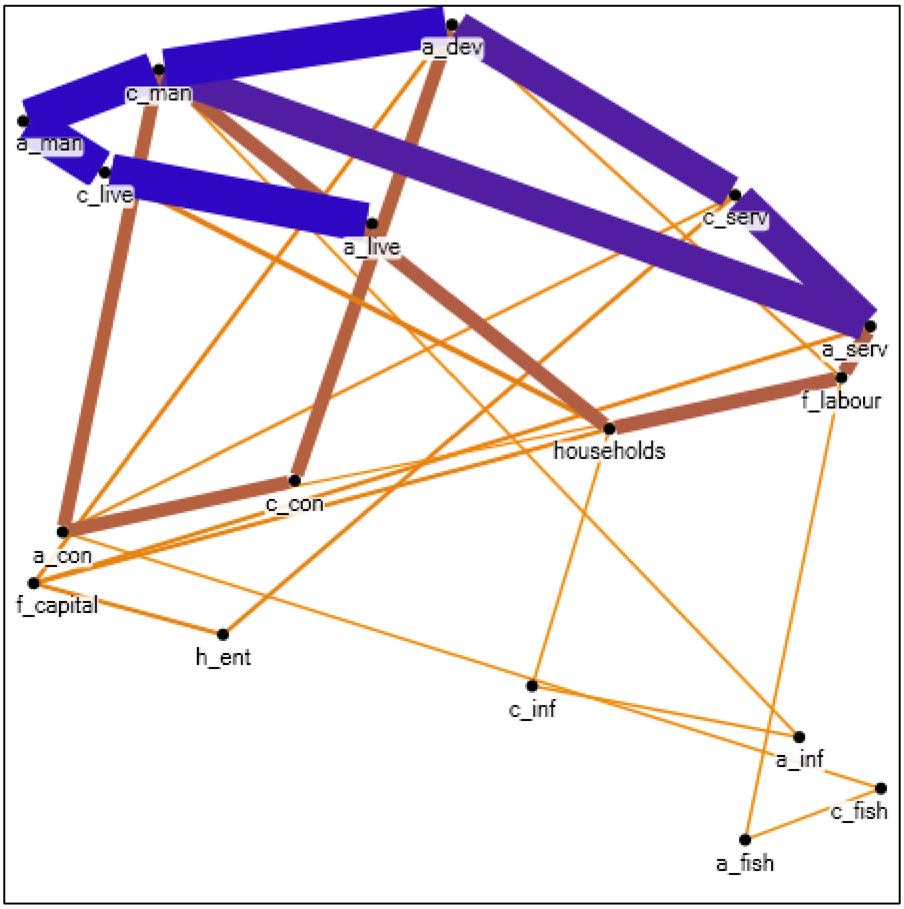
Note: Figure created using the weighted graph scheme of NodeXL. Paths depicted explain 87% of the accounting multiplier.

Figure III.3: Production activities – Case III



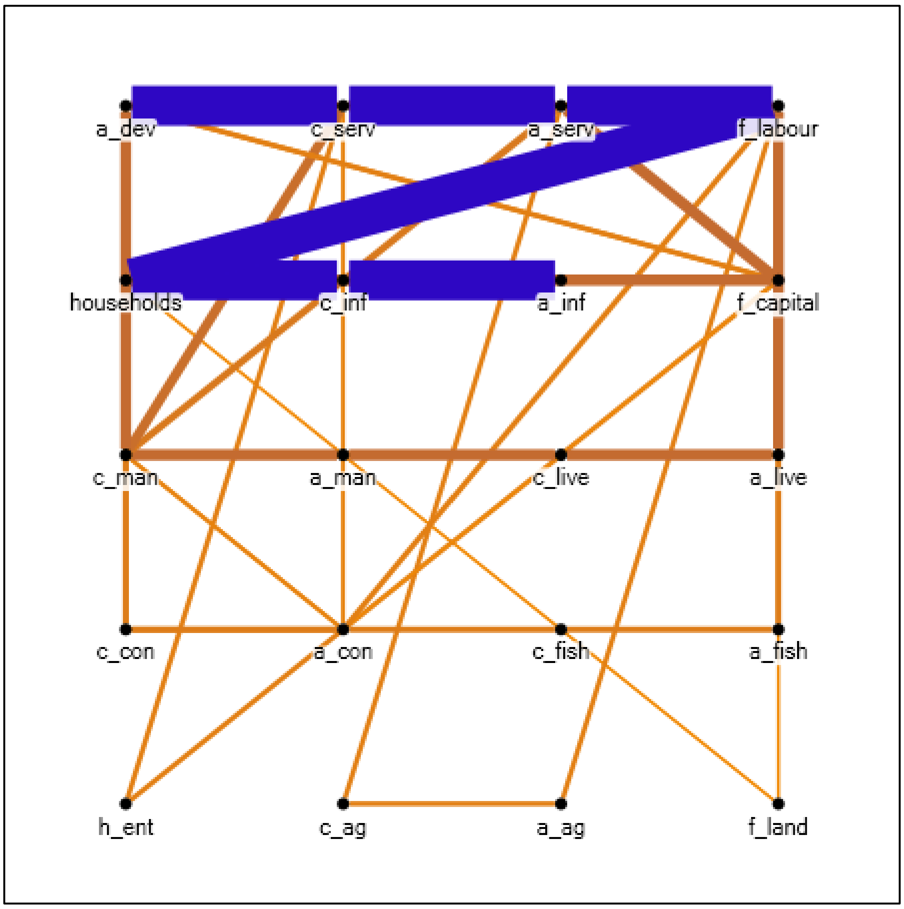
Note: Figure created using the weighted graph scheme of NodeXL. Paths depicted explain 80% of the accounting multiplier.

Figure III.4: Production activities – Case IV



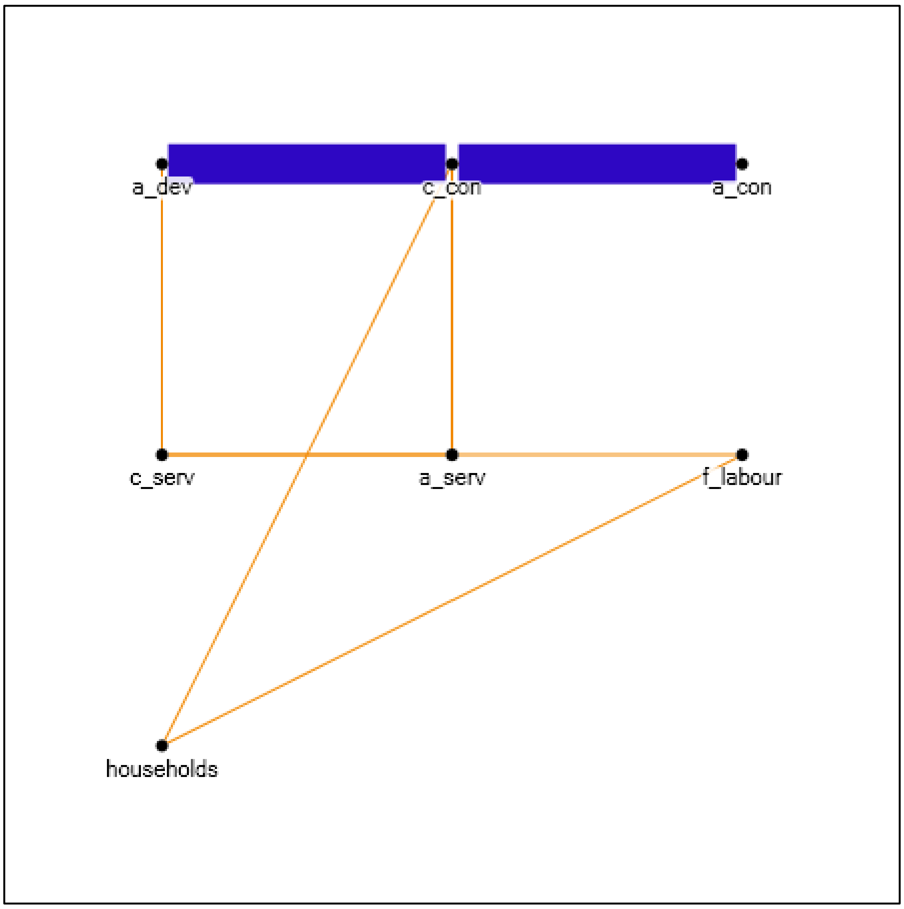
Note: Figure created using the weighted graph scheme of NodeXL. Paths depicted explain 79% of the accounting multiplier.

Figure III.5: Production activities – Case V



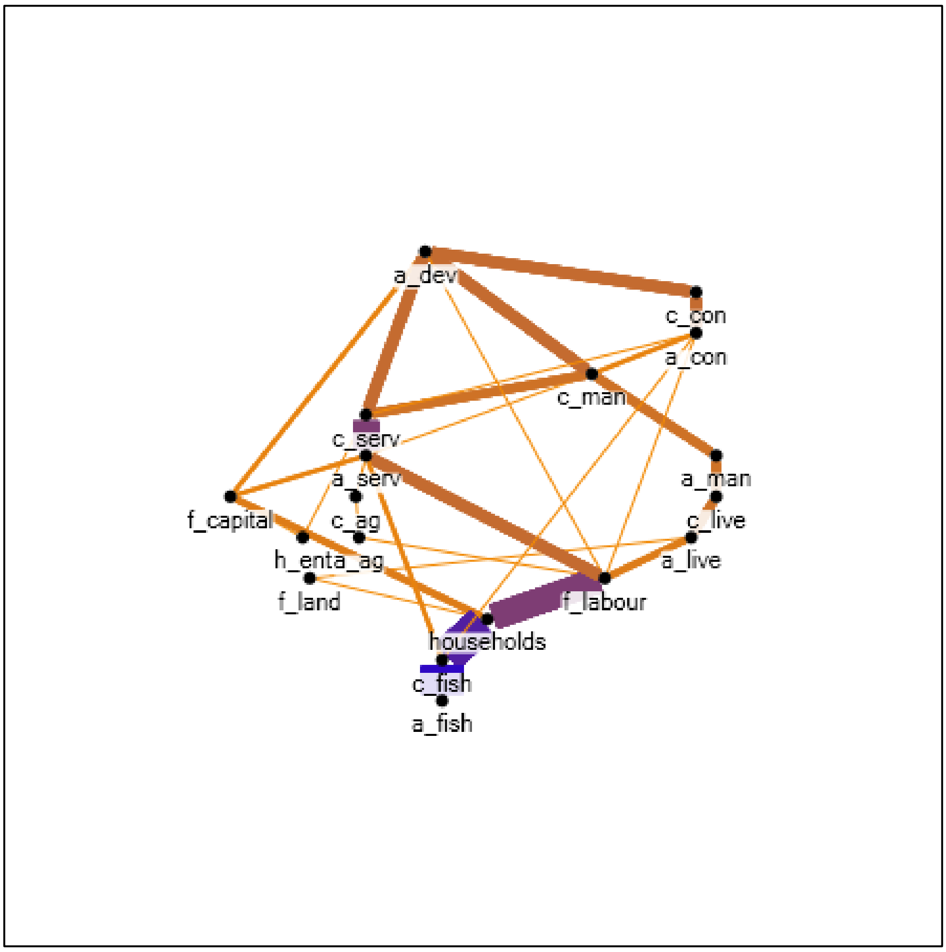
Note: Figure created using the weighted graph scheme of NodeXL. Paths depicted explain 84% of the accounting multiplier.

Figure III.6: Production activities – Case VI



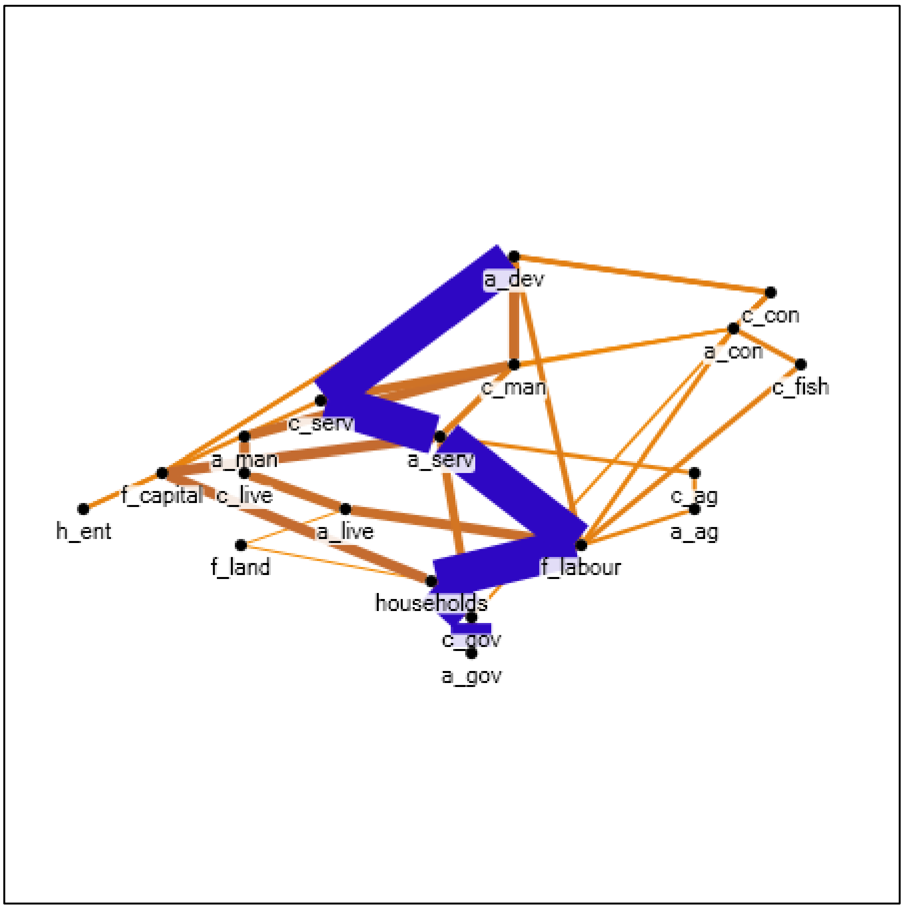
Note: Figure created using the weighted graph scheme of NodeXL. Paths depicted explain 93% of the accounting multiplier.

Figure III.7: Production activities – Case VII



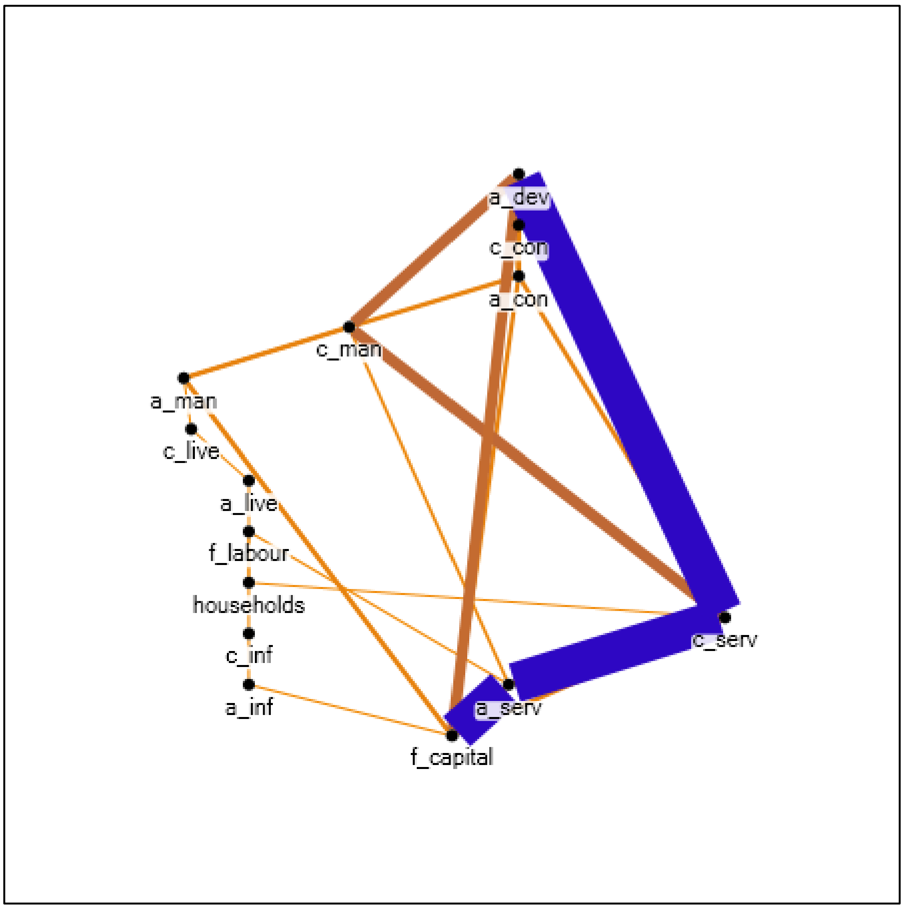
Note: Figure created using the weighted graph scheme of NodeXL. Paths depicted explain 80% of the accounting multiplier.

Figure III.8: Production activities – Case VIII



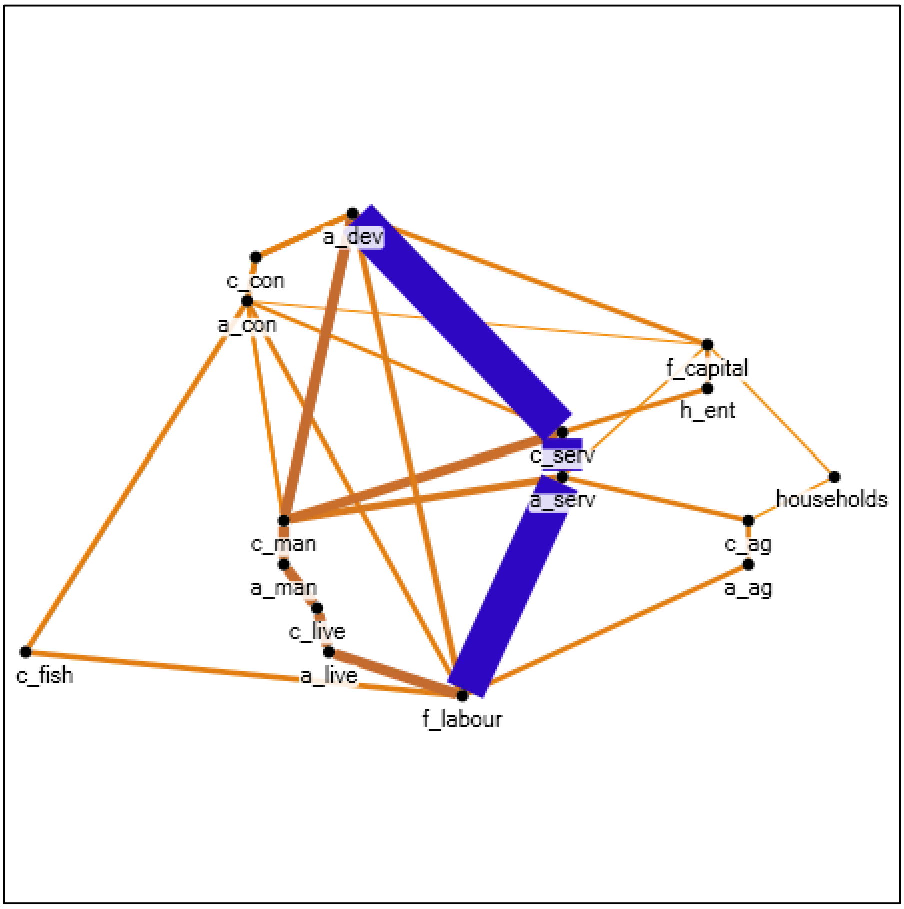
Note: Figure created using the weighted graph scheme of NodeXL. Paths depicted explain 80% of the accounting multiplier.

Figure III.9: Factors – Case I (Capital)



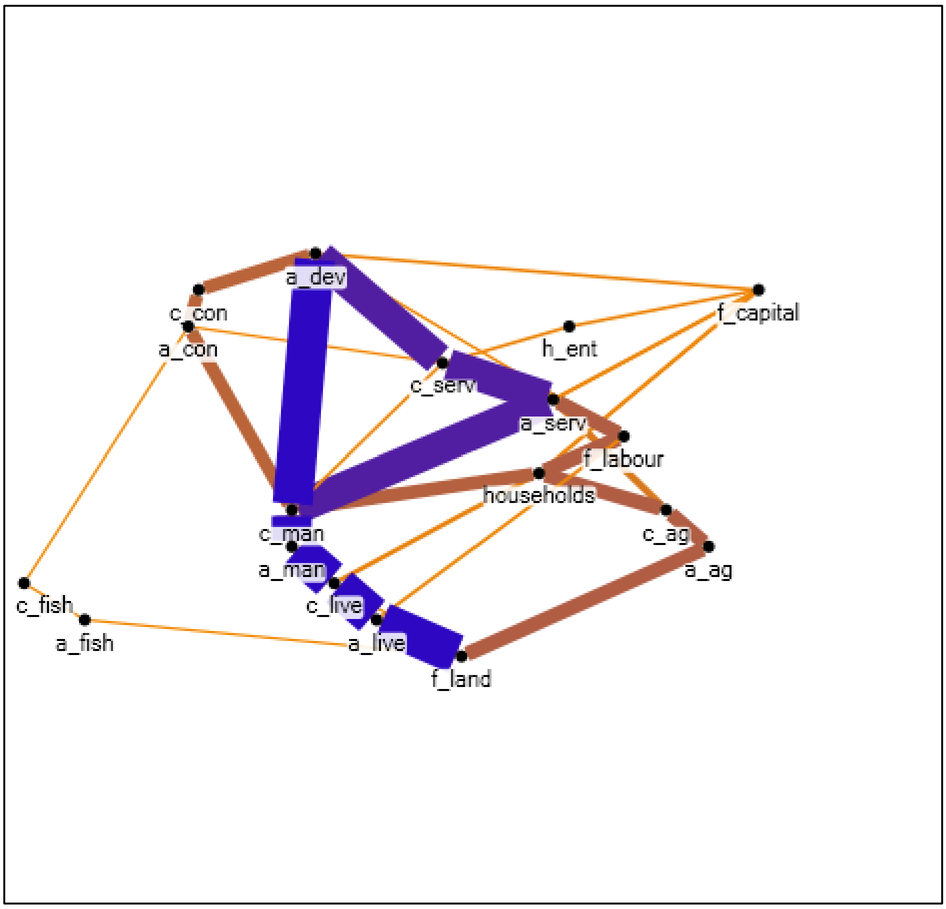
Note: Figure created using the weighted graph scheme of NodeXL. Paths depicted explain 82% of the accounting multiplier.

Figure III.10: Factors – Case II (Labour)



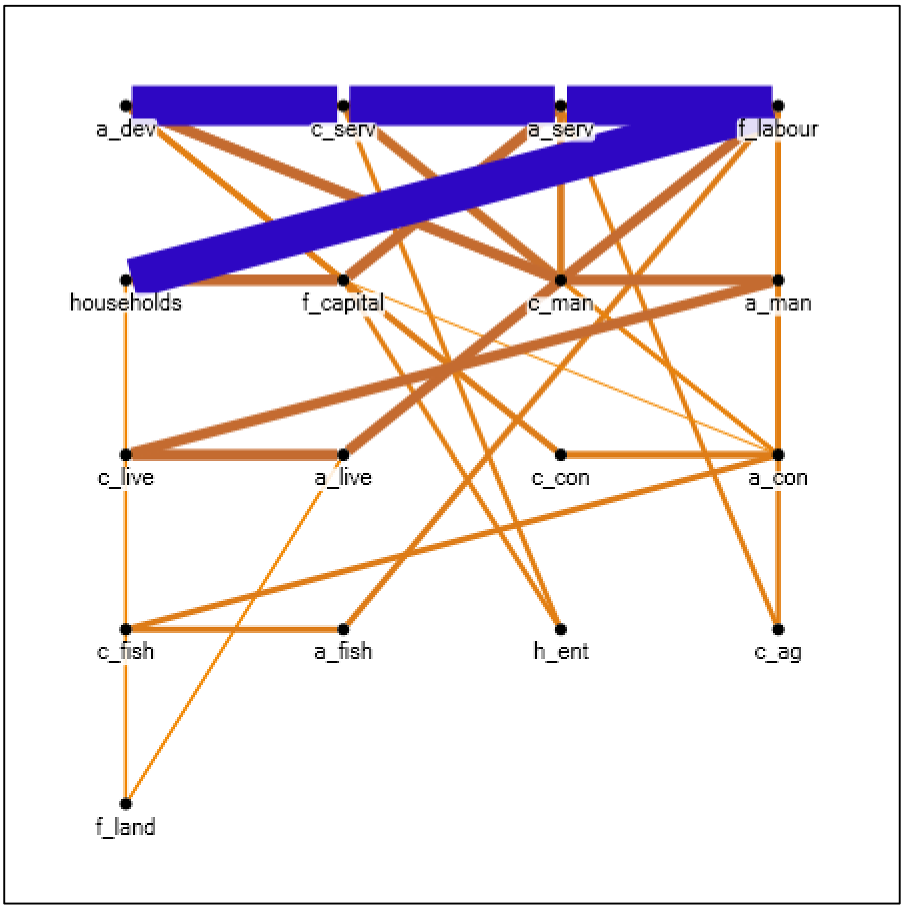
Note: Figure created using the weighted graph scheme of NodeXL. Paths depicted explain 80% of the accounting multiplier.

Figure III.11: Factors – Case III (Land)



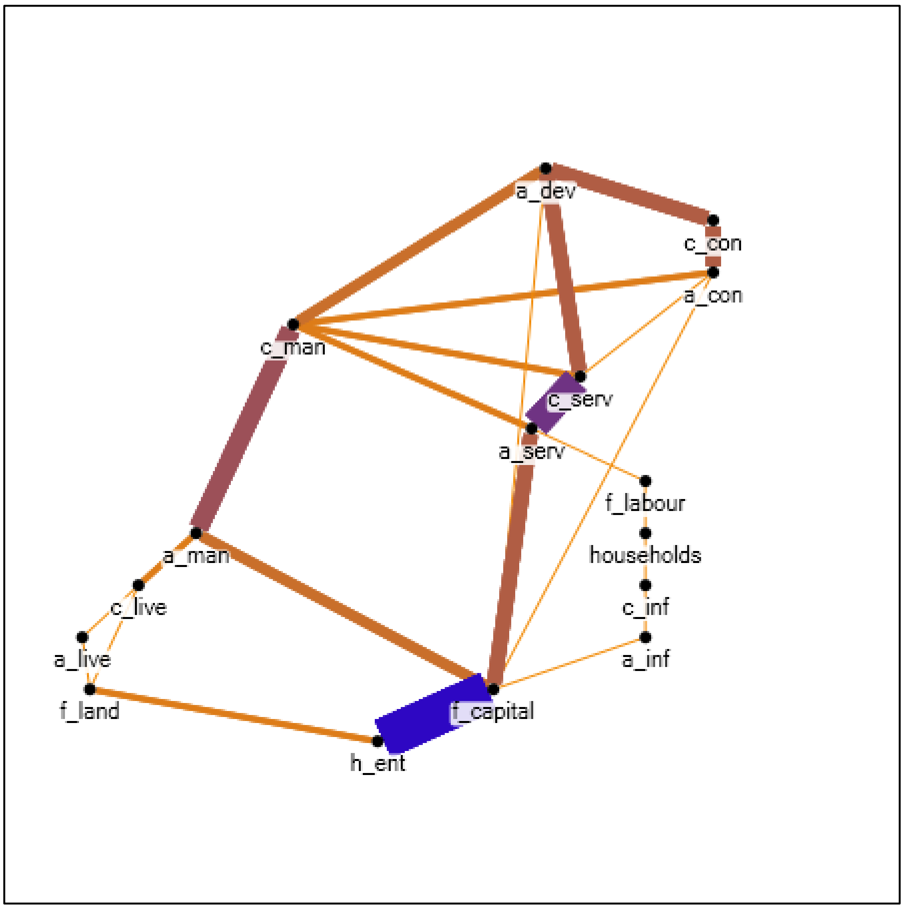
Note: Figure created using the weighted graph scheme of NodeXL. Paths depicted explain 66% of the accounting multiplier.

Figure III.12: Institutions – Case I (Households)



Note: Figure created using the weighted graph scheme of NodeXL. Paths depicted explain 84% of the accounting multiplier.

Figure III.13: Institutions – Case II (Enterprises)



Note: Figure created using the weighted graph scheme of NodeXL. Paths depicted explain 77% of the accounting multiplier.

Appendix I: Nigeria

This appendix lays the foundation for the analysis in Chapter 5. Tables I.1 summarises the macro structure of the Nigeria SAM used for the multiplier and SPA analysis in Chapter 5. Table I.2 and I.3 give the SAM account (activities and commodities) abbreviations and their corresponding names. Table I.4 provides the detailed results from the SPA performed in Chapter 5. Figure I.1 to I.16 are a graphical representation of the SPA results from Chapter 5.

Table I.1: Macro Social Accounting Matrix for Nigeria (2006)

Receipts \ Payments	Activities	Commodities	Labour	Capital	Land	Enterprises	Households	Government	Capital account	Rest of the world	Total
Activities		26 868 389.7						26 730.6			**26 895 120.3**
Commodities	6 814 769.5		677 153.9				12 788 014.2	3 716 689.7	976 109.0	7 836 670.9	**32 809 407.2**
Labour	9 099 655.2	677 153.9									**9 776 809.1**
Capital	8 618 833.3										**8 618 833.3**
Land	2 190 044.0										**2 190 044.0**
Enterprises				4 865 843.7							**4 865 843.7**
Households			9 099 655.2		2 190 044.0	2 632 477.6		171 781.1		1 359 241.7	**15 453 199.6**
Government	171 818.2	296 800.0		2 760 884.3		2 233 366.1	125 405.2	2 800 658.9		206 333.8	**8 595 266.5**
Capital account							2 539 780.2	1 879 406.2			**4 419 186.4**
Rest of the world		4 967 063.6		992 105.4					3 443 077.5		**9 402 246.4**
Total	**26 895 120.3**	**32 809 407.2**	**9 776 809.1**	**8 618 833.3**	**2 190 044.0**	**4 865 843.7**	**15 453 199.6**	**8 595 266.5**	**4 419 186.4**	**9 402 246.4**	**123 025 956.5**

Note: *Trade costs (TRC) where incorporated into the labour account for the macro SAM, Household subgroups have been aggregated.*

Table I.2: Nigeria SAM accounts: Activities

Account Number	Code	Description	Account Number	Code	Description
1	arice	Rice	31	aoliv	Other live animals
2	awhet	Wheat	32	afish	Fish and fish meat
3	amaze	Maize	33	afore	Forestry
4	asorg	Sorghum	34	abeef	Beef
5	amilt	Millet	35	agsmt	Goat and sheep meat
6	acass	Cassava	36	apmet	Poultry meat
7	ayams	Yams	37	aeggs	Eggs
8	acyam	Cocoyams	38	amilk	Milk and dairy products
9	apota	Irish potato	39	aomet	Other livestock meat
10	aspot	Sweet potato	40	abevg	Beverages and tobacco products
11	aplan	Banana and plantain	41	aofod	Processed food products (excluding beverages)
12	abean	Beans	42	atext	Textiles and leather products
13	agnut	Groundnuts	43	awood	Wood, wood products, furniture
14	asoys	Soyabeans	44	aemfc	Transportation and other equipment
15	aosed	Beniseed	45	aomfc	Other manufactured products
16	aveg	Vegetables	46	acoil	Crude petroleum and natural gas
17	afrt	Fruits	47	aroil	Refined oil
18	acoco	Cocoa	48	aomin	Other mining
19	acoff	Coffee	49	acons	Building and construction
20	acott	Cotton	50	autil	Electricity and water
21	apalm	Oil palm	51	artra	Road transport
22	asuga	Sugar and sugar cane	52	aotra	Other transportation
23	atoba	Unprocessed tobacco	53	atrad	Wholesale and retail trade
24	anuts	Nuts	54	ahotl	Hotel and restaurants
25	acash	Cashew	55	acomm	Telecommunications, Post, broadcasting
26	arube	Rubber	56	abser	Financial institutions, Insurance, Business services (not health or education)
27	aocrp	Other crops not specified	57	arest	Real estate
28	acatl	Cattle	58	aeduc	Education

Table I.2: Continued

29	agshp	Live goats and sheep	59	aheal	Health
30	apoul	Live poultry	60	apser	Public administration
			61	aoser	Private non profit organisations, Other services

Table I.3: Nigeria SAM accounts: Commodities

Account Number	Code	Description	Account Number	Code	Description
1	crice	Rice	31	coliv	Other live animals
2	cwhet	Wheat	32	cfish	Fish and fish meat
3	cmaze	Maize	33	cfore	Forestry
4	csorg	Sorghum	34	cbeef	Beef
5	cmilt	Millet	35	cgsmt	Goat and sheep meat
6	ccass	Cassava	36	cpmet	Poultry meat
7	cyams	Yams	37	ceggs	Eggs
8	ccyam	Cocoyams	38	cmilk	Milk and dairy products
9	cpota	Irish potato	39	comet	Other livestock meat
10	cspot	Sweet potato	40	cbevg	Beverages and tobacco products
11	cplan	Banana and plantain	41	cofod	Processed food products (excluding beverages)
12	cbean	Beans	42	ctext	Textiles and leather products
13	cgnut	Groundnuts	43	cwood	Wood, wood products, furniture
14	csoys	Soyabeans	44	cemfc	Transportation and other equipment
15	cosed	Beniseed	45	comfc	Other manufactured products
16	cveg	Vegetables	46	cfert	Fertilizer
17	cfrt	Fruits	47	ccoil	Crude petroleum and natural gas
18	ccoco	Cocoa	48	croil	Refined oil
19	ccoff	Coffee	49	comin	Other mining
20	ccott	Cotton	50	ccons	Building and construction
21	cpalm	Oil palm	51	cutil	Electricity and water
22	csuga	Sugar and sugar cane	52	crtra	Road transport

Table I.3: Continued

Account Number	Code	Description	Account Number	Code	Description
23	ctoba	Unprocessed tobacco	53	cotra	Other transportation
24	cnuts	Nuts	54	ctrad	Wholesale and retail trade
25	ccash	Cashew	55	chotl	Hotel and restaurants
26	crube	Rubber	56	ccomm	Telecommunications, Post, broadcasting
27	cocrp	Other crops not specified	57	cbser	Financial institutions, Insurance, Business services (not health or education)
28	ccatl	Cattle	58	crest	Real estate
29	cgshp	Live goats and sheep	59	ceduc	Education
30	cpoul	Live poultry	60	cheal	Health
			61	cpser	Public administration
			62	coser	Private non profit organisations, Other services

Table I.4: SPA for selected activities: Nigeria (CASE I TO XI)

Case	Origin	Dest.	Global infl.	Path	Direct infl.	Path mult.	Total infl.	Prop. (in %)	Accum. Prop.
I	acoil	atrad	0.06	acoil / fcap / ent / Households / cgsmt / agsmt / ctrad / atrad	0.002	2.53	0.005	8.4	8.4
				acoil / fcap / ent / Households / cyams / trc / ctrad / atrad	0.002	2.61	0.004	7.2	15.7
				acoil / fcap / ent / Households / ccass / trc / ctrad / atrad	0.001	2.61	0.003	5.6	21.3
				acoil / fcap / ent / Households / crice / trc / ctrad / atrad	0.001	2.54	0.003	4.7	26.1
				acoil / fcap / ent / Households / ctrad / atrad	0.001	2.53	0.003	4.4	30.5
				acoil / fcap / ent / Households / cbeef / abeef / ctrad / atrad	0.001	2.53	0.002	3.7	34.1
				acoil / fcap / ent / Households / ccass / acass / ctrad / atrad	0.001	2.61	0.002	3.4	37.5
				acoil / fcap / ent / Households / cyams / ayams / ctrad / atrad	0.001	2.61	0.001	2.4	39.9
				acoil / fcap / ent / Households / cfish / trc / ctrad / atrad	0.001	2.54	0.001	2.3	42.2
				acoil / fcap / ent / Households / cmilt / trc / ctrad / atrad	0.001	2.53	0.001	2.2	44.4
				acoil / fcap / ent / Households / cbean / trc / ctrad / atrad	0.000	2.56	0.001	1.8	46.1
				acoil / fcap / ent / Households / cmaze / trc / ctrad / atrad	0.000	2.54	0.001	1.7	47.8
				acoil / fcap / ent / Households / crice / arice / ctrad / atrad	0.000	2.54	0.001	1.6	49.4

Table I.4: Continued

Case	Origin	Dest.	Global infl.	Path	Direct infl.	Path mult.	Total infl.	Prop. (in %)	Accum. Prop.
II	acoil	acass	0.04	acoil / fcap / ent / Households / ccass / acass	0.017	2.42	0.041	94.1	94.1
				acoil / crtra / artra / flab / Households / ccass / acass	0.000	2.43	0.001	1.7	95.8
				acoil / flab / Households / ccass / acass	0.000	2.42	0.000	0.8	96.6
				acoil / crtra / artra / fcap / ent / Households / ccass / acass	0.000	2.43	0.000	0.3	96.9
				acoil / cbser / abser / flab / Households / ccass / acass	0.000	2.53	0.000	0.3	97.3
				acoil / fcap / ent / Households / chotl / ahotl / ccass / acass	0.000	2.44	0.000	0.3	97.5
				acoil / fcap / ent / Households / cofod / aofod / ccass / acass	0.000	2.43	0.000	0.2	97.8
				acoil / comfc / aomfc / fcap / ent / Households / ccass / acass	0.000	2.50	0.000	0.2	98.0
				acoil / cemfc / aemfc / fcap / ent / Households / ccass / acass	0.000	2.50	0.000	0.2	98.2
				acoil / cemfc / trc / ctrad / atrad / flab / Households / ccass / acass	0.000	2.69	0.000	0.2	98.3
III	acoil	ayams	0.04	acoil / fcap / ent / Households / cyams / ayams	0.015	2.41	0.037	94.3	94.3
				acoil / crtra / artra / flab / Households / cyams / ayams	0.000	2.43	0.001	1.7	96.0
				acoil / flab / Households / cyams / ayams	0.000	2.41	0.000	0.8	96.8
				acoil / crtra / artra / fcap / ent / Households / cyams / ayams	0.000	2.43	0.000	0.3	97.2
				acoil / cbser / abser / flab / Households / cyams / ayams	0.000	2.52	0.000	0.3	97.5
				acoil / fcap / ent / Households / cofod / aofod / cyams / ayams	0.000	2.43	0.000	0.3	97.8
				acoil / comfc / aomfc / fcap / ent / Households / cyams / ayams	0.000	2.50	0.000	0.2	98.0
				acoil / cemfc / aemfc / fcap / ent / Households / cyams / ayams	0.000	2.49	0.000	0.2	98.2
				acoil / cemfc / trc / ctrad / atrad / flab / Households / cyams / ayams	0.000	2.69	0.000	0.2	98.4
				acoil / cemfc / aemfc / flab / Households / cyams / ayams	0.000	2.49	0.000	0.2	98.5

Table I.4: Continued

Case	Origin	Dest.	Global infl.	Path	Direct infl.	Path mult.	Total infl.	Prop. (in %)	Accum. Prop.
IV	acoil	agsmt	0.03	acoil / fcap / ent / Households / cgsmt / agsmt	0.014	2.34	0.032	94.6	94.6
				acoil / crtra / artra / flab / Households / cgsmt / agsmt	0.000	2.36	0.001	1.7	96.3
				acoil / flab / Households / cgsmt / agsmt	0.000	2.34	0.000	0.8	97.1
				acoil / crtra / artra / fcap / ent / Households / cgsmt / agsmt	0.000	2.36	0.000	0.3	97.5
				acoil / cbser / abser / flab / Households / cgsmt / agsmt	0.000	2.45	0.000	0.3	97.8
				acoil / comfc / aomfc / fcap / ent / Households / cgsmt / agsmt	0.000	2.42	0.000	0.2	98.0
				acoil / cemfc / aemfc / fcap / ent / Households / cgsmt / agsmt	0.000	2.42	0.000	0.2	98.2
				acoil / cemfc / trc / ctrad / atrad / flab / Households / cgsmt / agsmt	0.000	2.61	0.000	0.2	98.4
				acoil / cemfc / aemfc / flab / Households / cgsmt / agsmt	0.000	2.42	0.000	0.2	98.5
				acoil / comfc / aomfc / flab / Households / cgsmt / agsmt	0.000	2.42	0.000	0.2	98.7
V	acoil	arice	0.03	acoil / fcap / ent / Households / crice / arice	0.010	2.35	0.024	94.6	94.6
				acoil / crtra / artra / flab / Households / crice / arice	0.000	2.36	0.000	1.7	96.3
				acoil / flab / Households / crice / arice	0.000	2.35	0.000	0.8	97.2
				acoil / crtra / artra / fcap / ent / Households / crice / arice	0.000	2.36	0.000	0.3	97.5
				acoil / cbser / abser / flab / Households / crice / arice	0.000	2.46	0.000	0.3	97.8
				acoil / comfc / aomfc / fcap / ent / Households / crice / arice	0.000	2.43	0.000	0.2	98.0
				acoil / cemfc / aemfc / fcap / ent / Households / crice / arice	0.000	2.43	0.000	0.2	98.2
				acoil / cemfc / trc / ctrad / atrad / flab / Households / crice / arice	0.000	2.62	0.000	0.2	98.4
				acoil / cemfc / aemfc / flab / Households / crice / arice	0.000	2.43	0.000	0.2	98.6
				acoil / comfc / aomfc / flab / Households / crice / arice	0.000	2.43	0.000	0.2	98.7
VI	acoil	artra	0.02	acoil / crtra / artra	0.014	1.03	0.014	59.0	59.0
				acoil / fcap / ent / Households / crtra / artra	0.002	2.36	0.005	22.2	81.1
				acoil / fcap / ent / Households / cgsmt / agsmt / crtra / artra	0.000	2.36	0.000	1.0	82.2
				acoil / fcap / ent / Households / coser / aoser / crtra / artra	0.000	2.36	0.000	0.9	83.1
				acoil / fcap / ent / Households / cbser / abser / crtra / artra	0.000	2.46	0.000	0.9	84.0
				acoil / fcap / ent / Households / cgsmt / agsmt / ctrad / atrad / crtra / artra	0.000	2.54	0.000	0.8	84.8
				acoil / fcap / ent / Households / cfish / afish / crtra / artra	0.000	2.37	0.000	0.7	85.5

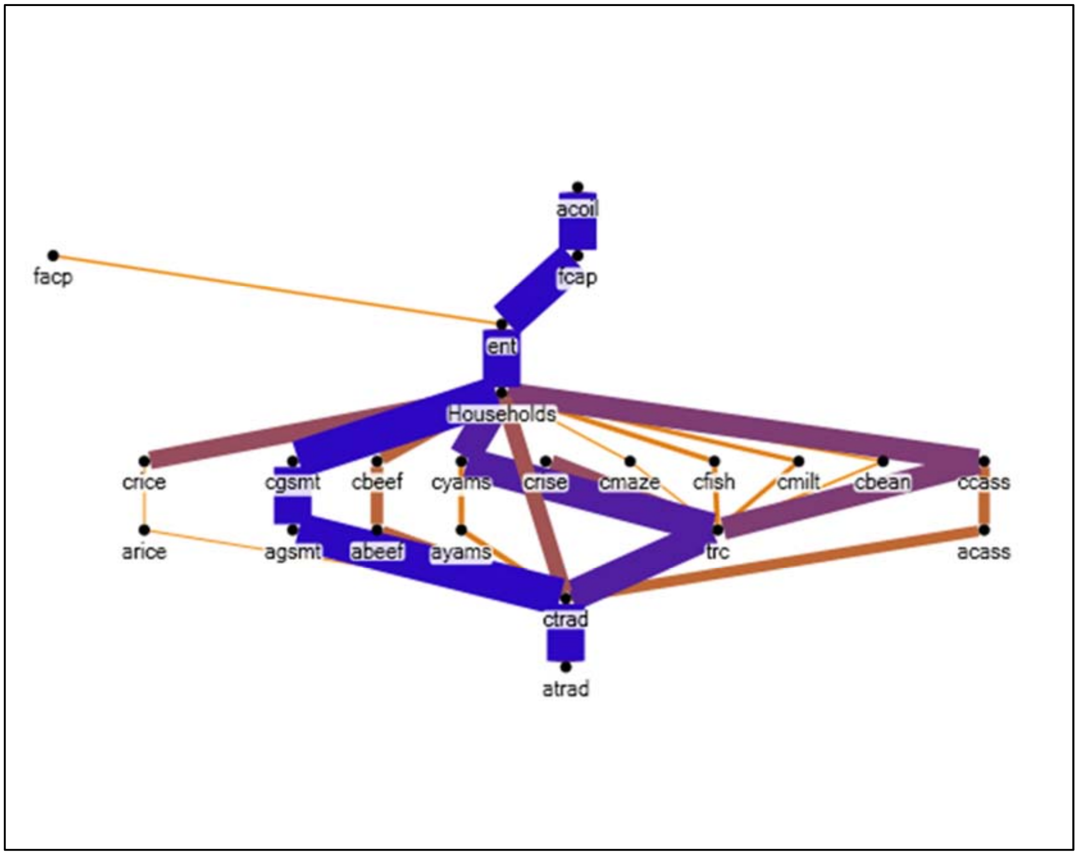
Table I.4: Continued

Case	Origin	Dest.	Global infl.	Path	Direct infl.	Path mult.	Total infl.	Prop. (in %)	Accum. Prop.
				acoil / fcap / ent / Households / cyams / trc / ctrad / atrad / crtra / artra	0.000	2.62	0.000	0.7	86.2
				acoil / fcap / ent / Households / cbeef / abeef / crtra / artra	0.000	2.36	0.000	0.5	86.7
				acoil / fcap / ent / Households / ccass / trc / ctrad / atrad / crtra / artra	0.000	2.62	0.000	0.5	87.3
VII	acoil	autil	0.02	acoil / fcap / ent / Households / cutil / autil	0.008	2.35	0.018	80.1	80.1
				acoil / fcap / ent / Households / chotl / ahotl / cutil / autil	0.000	2.37	0.001	3.0	83.1
				acoil / fcap / ent / Households / ceduc / aeduc / cutil / autil	0.000	2.35	0.000	2.1	85.1
				acoil / fcap / ent / Households / cheal / aheal / cutil / autil	0.000	2.35	0.000	2.0	87.2
				acoil / crtra / artra / flab / Households / cutil / autil	0.000	2.37	0.000	1.4	88.6
				acoil / fcap / ent / Households / coser / aoser / cutil / autil	0.000	2.35	0.000	1.4	90.1
				acoil / fcap / ent / Households / cbser / abser / cutil / autil	0.000	2.46	0.000	1.3	91.3
				acoil / fcap / ent / Households / cmaze / amaze / cutil / autil	0.000	2.36	0.000	0.8	92.2
				acoil / flab / Households / cutil / autil	0.000	2.35	0.000	0.7	92.9
				acoil / croil / aroil / cutil / autil	0.000	1.07	0.000	0.7	93.5
VIII	acoil	amaze	0.02	acoil / fcap / ent / Households / cmaze / amaze	0.009	2.35	0.020	94.4	94.4
				acoil / crtra / artra / flab / Households / cmaze / amaze	0.000	2.36	0.000	1.7	96.1
				acoil / flab / Households / cmaze / amaze	0.000	2.35	0.000	0.8	97.0
				acoil / crtra / artra / fcap / ent / Households / cmaze / amaze	0.000	2.36	0.000	0.3	97.3
				acoil / cbser / abser / flab / Households / cmaze / amaze	0.000	2.45	0.000	0.3	97.6
				acoil / comfc / aomfc / fcap / ent / Households / cmaze / amaze	0.000	2.43	0.000	0.2	97.8
				acoil / cemfc / aemfc / fcap / ent / Households / cmaze / amaze	0.000	2.42	0.000	0.2	98.0
				acoil / cemfc / trc / ctrad / atrad / flab / Households / cmaze / amaze	0.000	2.61	0.000	0.2	98.2
				acoil / cemfc / aemfc / flab / Households / cmaze / amaze	0.000	2.42	0.000	0.2	98.4
				acoil / comfc / aomfc / flab / Households / cmaze / amaze	0.000	2.43	0.000	0.2	98.5
IX	acoil	arest	0.02	acoil / fcap / ent / Households / crest / arest	0.008	2.34	0.018	92.8	92.8
				acoil / crtra / artra / flab / Households / crest / arest	0.000	2.36	0.000	1.7	94.4
				acoil / fcap / ent / Households / cbser / abser / crest / arest	0.000	2.45	0.000	1.5	95.9
				acoil / flab / Households / crest / arest	0.000	2.34	0.000	0.8	96.7

Table I.4: Continued

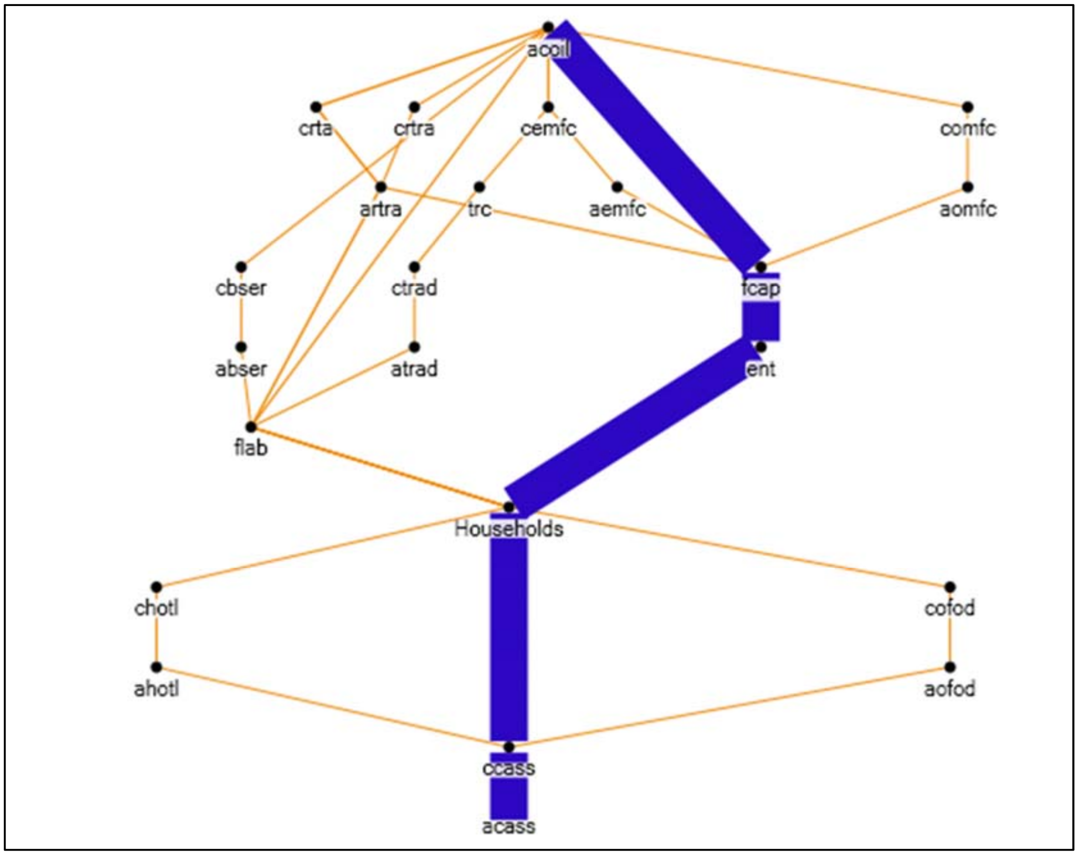
Case	Origin	Dest.	Global infl.	Path	Direct infl.	Path mult.	Total infl.	Prop. (in %)	Accum. Prop.
				acoil / crtra / artra / fcap / ent / Households / crest / arest	0.000	2.36	0.000	0.3	97.1
				acoil / cbser / abser / flab / Households / crest / arest	0.000	2.45	0.000	0.3	97.4
				acoil / cbser / abser / crest / arest	0.000	1.14	0.000	0.2	97.6
				acoil / comfc / aomfc / fcap / ent / Households / crest / arest	0.000	2.42	0.000	0.2	97.8
				acoil / cemfc / aemfc / fcap / ent / Households / crest / arest	0.000	2.42	0.000	0.2	98.0
				acoil / cemfc / trc / ctrad / atrad / flab / Households / crest / arest	0.000	2.61	0.000	0.2	98.2
X	acoil	aveg	0.02	acoil / fcap / ent / Households / cveg / aveg	0.008	2.35	0.018	94.6	94.6
				acoil / crtra / artra / flab / Households / cveg / aveg	0.000	2.36	0.000	1.7	96.3
				acoil / flab / Households / cveg / aveg	0.000	2.35	0.000	0.8	97.1
				acoil / crtra / artra / fcap / ent / Households / cveg / aveg	0.000	2.36	0.000	0.3	97.5
				acoil / cbser / abser / flab / Households / cveg / aveg	0.000	2.45	0.000	0.3	97.8
				acoil / comfc / aomfc / fcap / ent / Households / cveg / aveg	0.000	2.42	0.000	0.2	98.0
				acoil / cemfc / aemfc / fcap / ent / Households / cveg / aveg	0.000	2.42	0.000	0.2	98.2
				acoil / cemfc / trc / ctrad / atrad / flab / Households / cveg / aveg	0.000	2.61	0.000	0.2	98.4
				acoil / cemfc / aemfc / flab / Households / cveg / aveg	0.000	2.42	0.000	0.2	98.5
				acoil / comfc / aomfc / flab / Households / cveg / aveg	0.000	2.42	0.000	0.2	98.7
XI	acoil	abser	0.02	acoil / fcap / ent / Households / cbser / abser	0.005	2.45	0.012	73.3	73.3
				acoil / cbser / abser	0.002	1.08	0.002	11.2	84.5
				acoil / fcap / ent / Households / crest / arest / cbser / abser	0.000	2.45	0.000	2.0	86.6
				acoil / crtra / artra / flab / Households / cbser / abser	0.000	2.46	0.000	1.3	87.9
				acoil / fcap / ent / Households / ccomm / acomm / cbser / abser	0.000	2.58	0.000	1.1	88.9
				acoil / fcap / ent / Households / cutil / autil / cbser / abser	0.000	2.46	0.000	0.8	89.7
				acoil / fcap / ent / Households / chotl / ahotl / cbser / abser	0.000	2.47	0.000	0.7	90.4
				acoil / flab / Households / cbser / abser	0.000	2.45	0.000	0.7	91.1
				acoil / fcap / ent / Households / cfore / afore / cbser / abser	0.000	2.47	0.000	0.6	91.7
				acoil / crtra / artra / cbser / abser	0.000	1.11	0.000	0.5	92.1

Figure I.1: Production activities – Case I



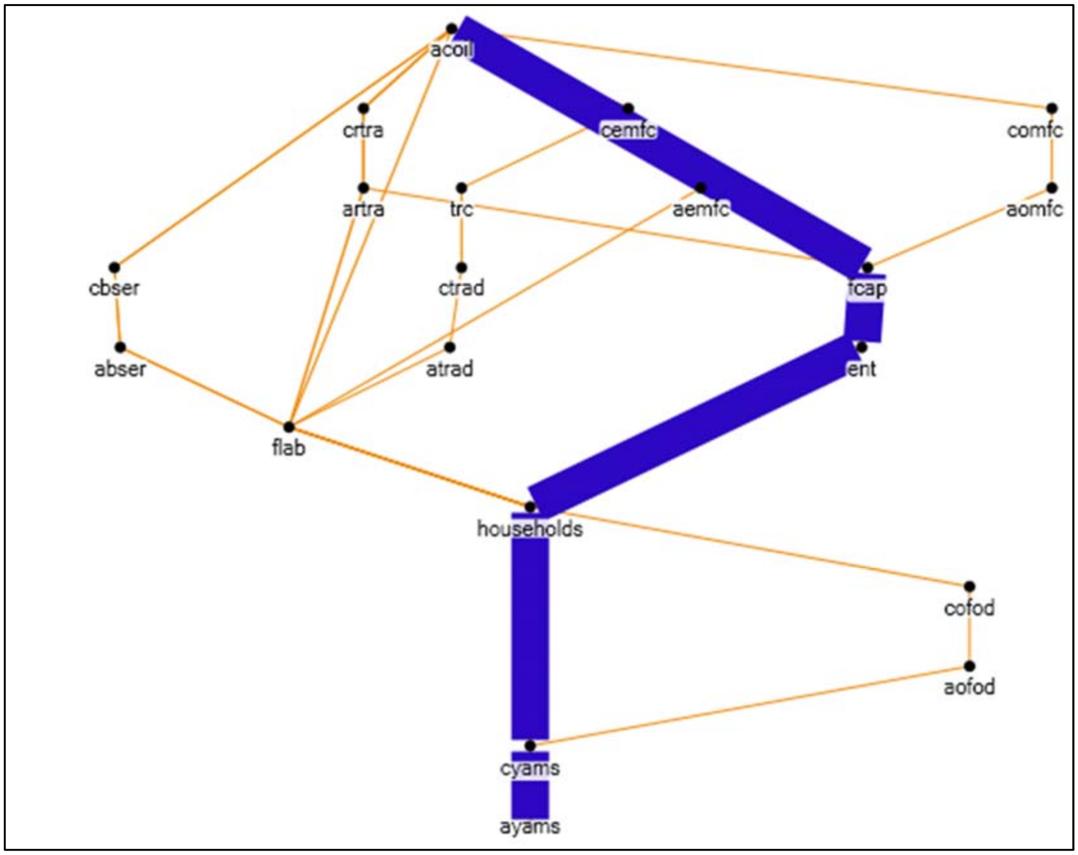
Note: Figure created using the weighted graph scheme of NodeXL. Paths depicted explain 49% of the accounting multiplier.

Figure I.2: Production activities – Case II



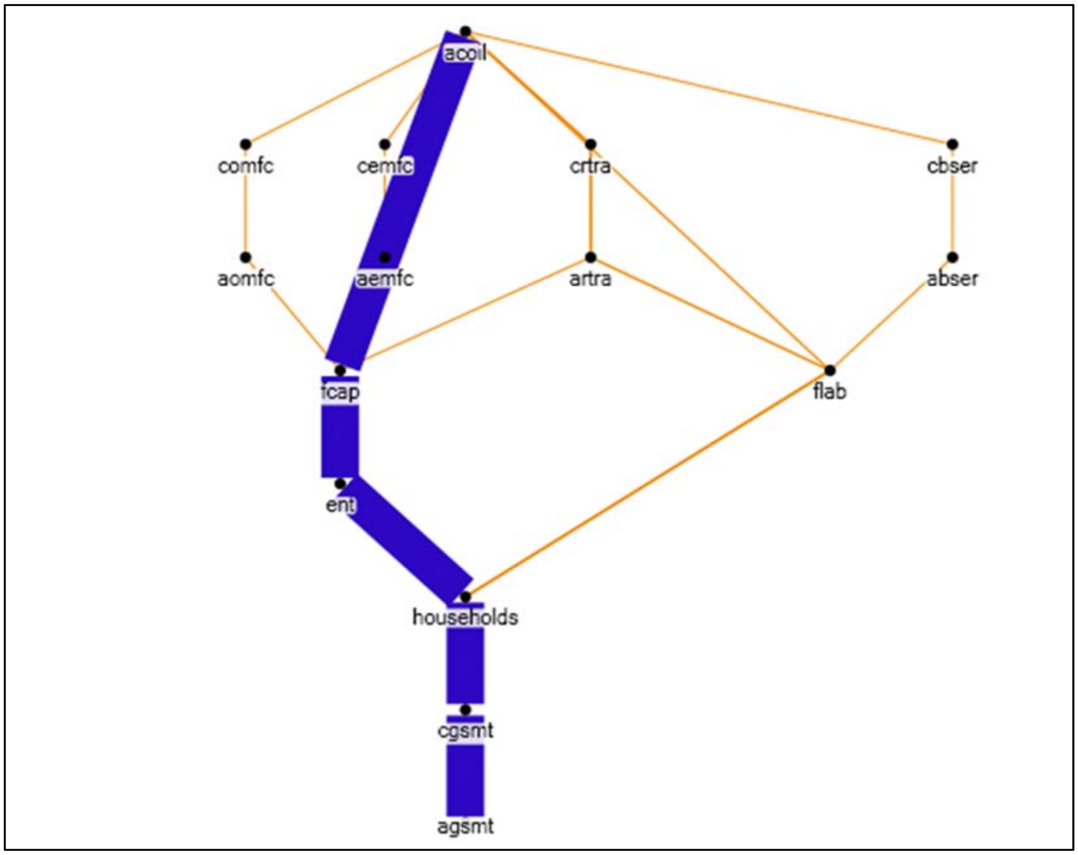
Note: Figure created using the weighted graph scheme of NodeXL. Paths depicted explain 98% of the accounting multiplier.

Figure I.3: Production activities – Case III



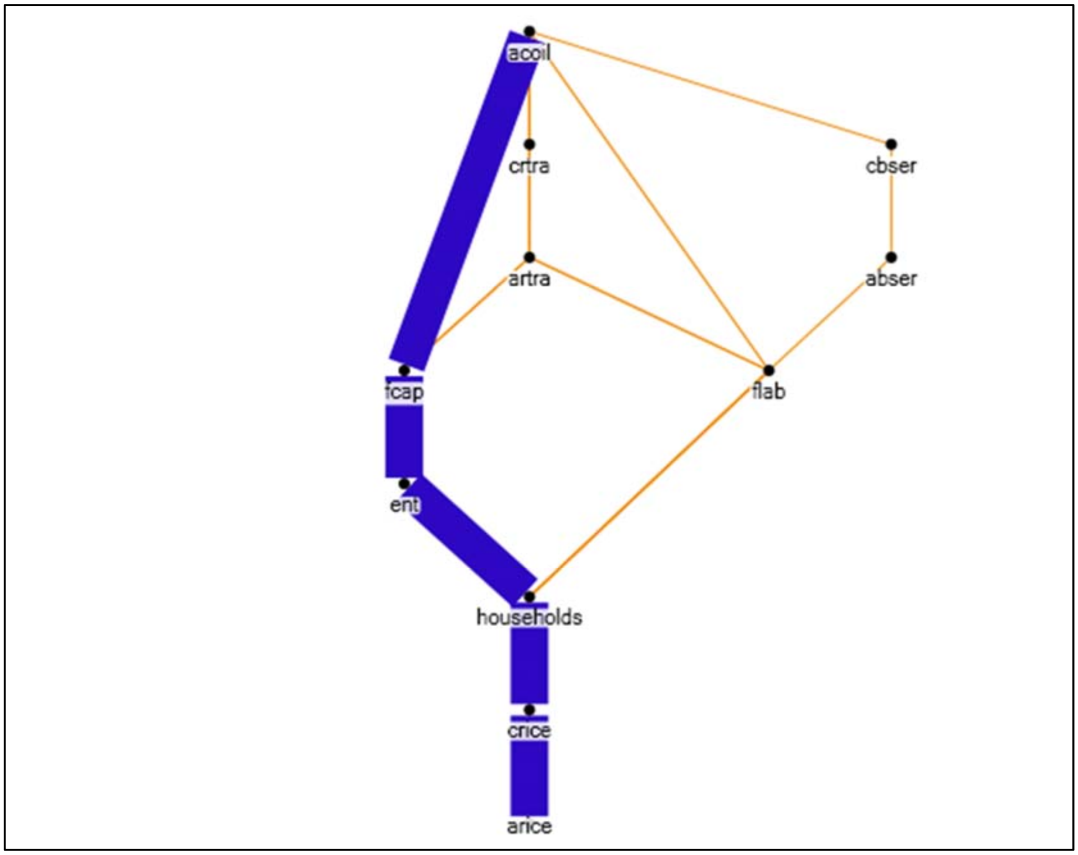
Note: Figure created using the weighted graph scheme of NodeXL. Paths depicted explain 99% of the accounting multiplier.

Figure I.4: Production activities – Case IV



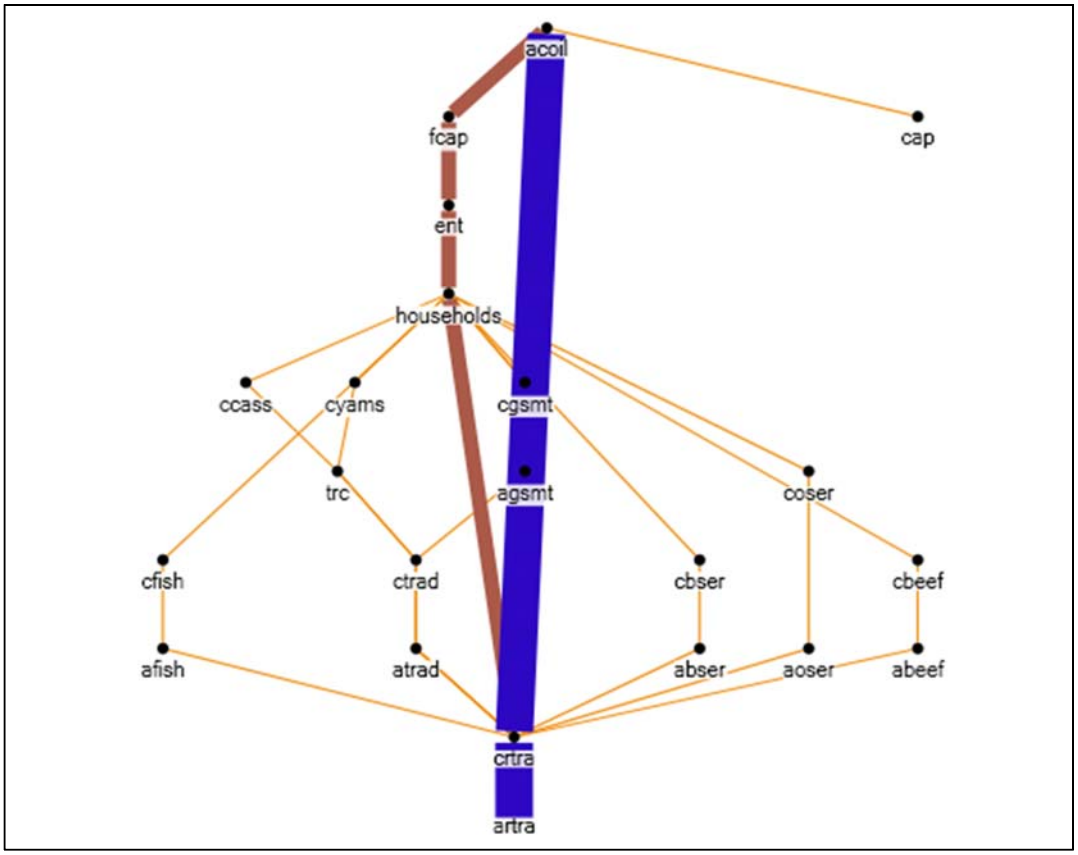
Note: Figure created using the weighted graph scheme of NodeXL. Paths depicted explain 98% of the accounting multiplier.

Figure I.5: Production activities – Case V



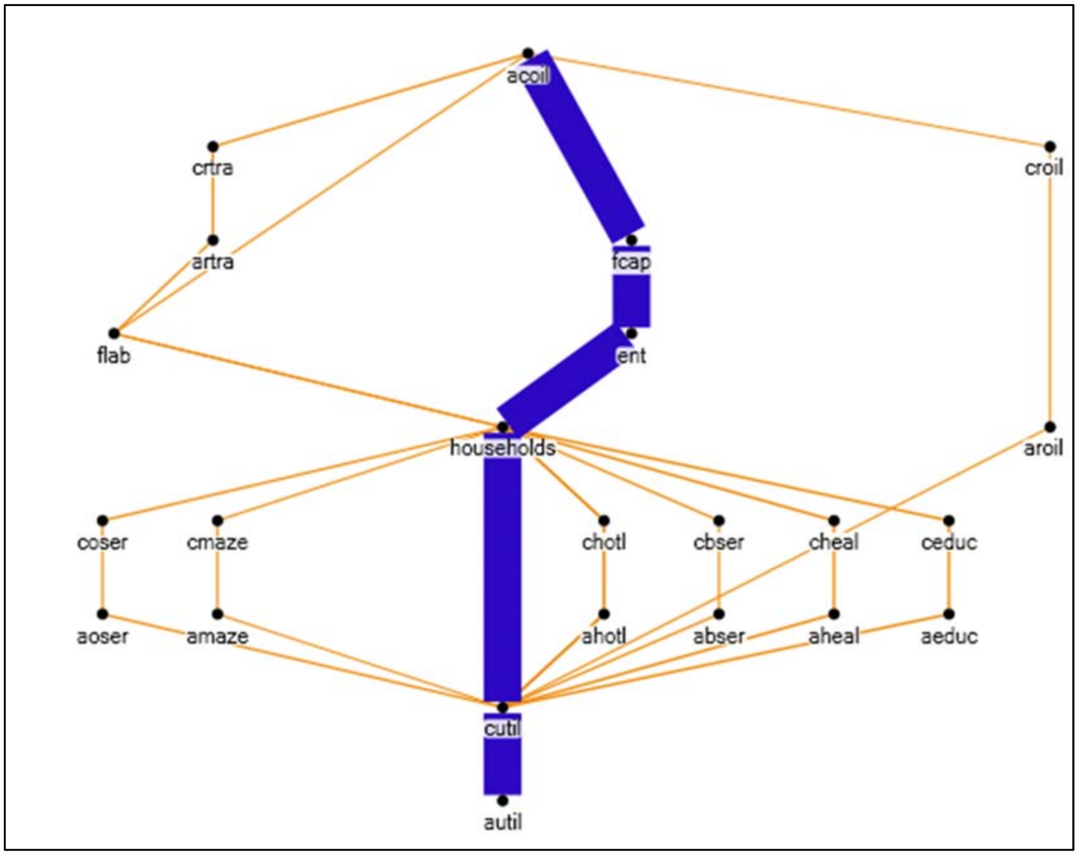
Note: Figure created using the weighted graph scheme of NodeXL. Paths depicted explain 98% of the accounting multiplier.

Figure I.6: Production activities – Case VI



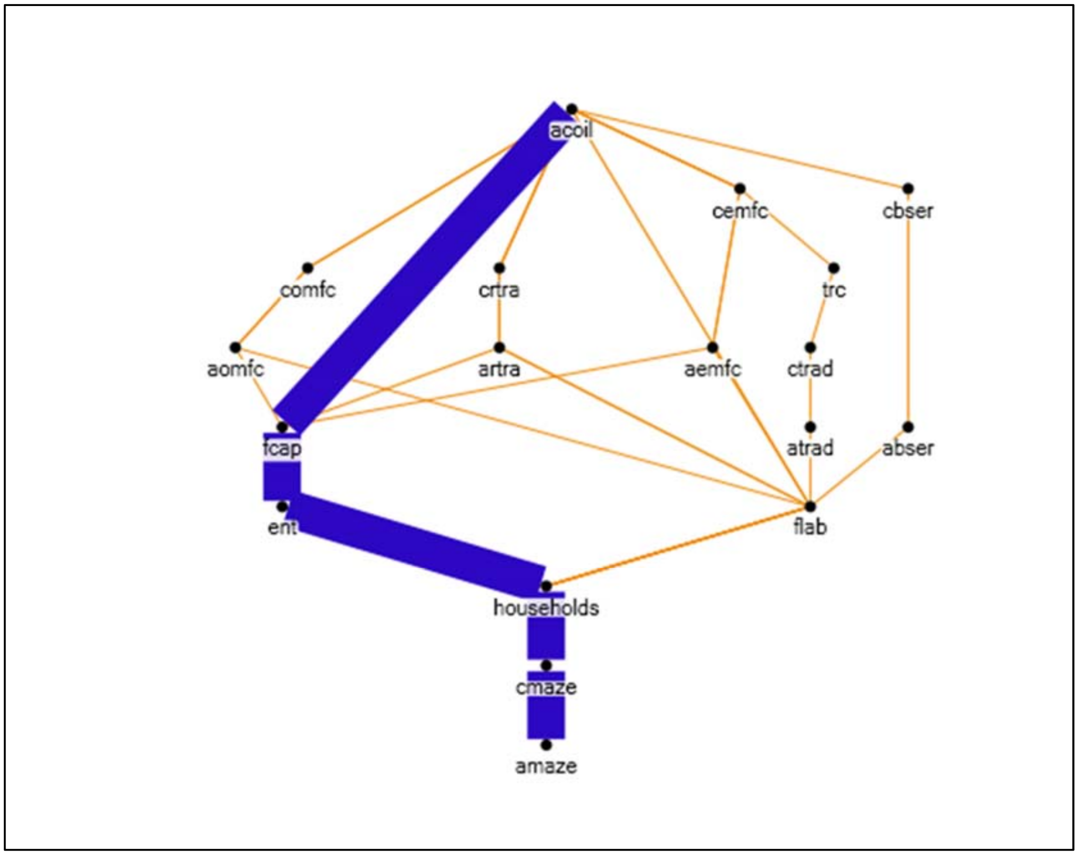
Note: Figure created using the weighted graph scheme of NodeXL. Paths depicted explain 87% of the accounting multiplier.

Figure I.7: Production activities – Case VII



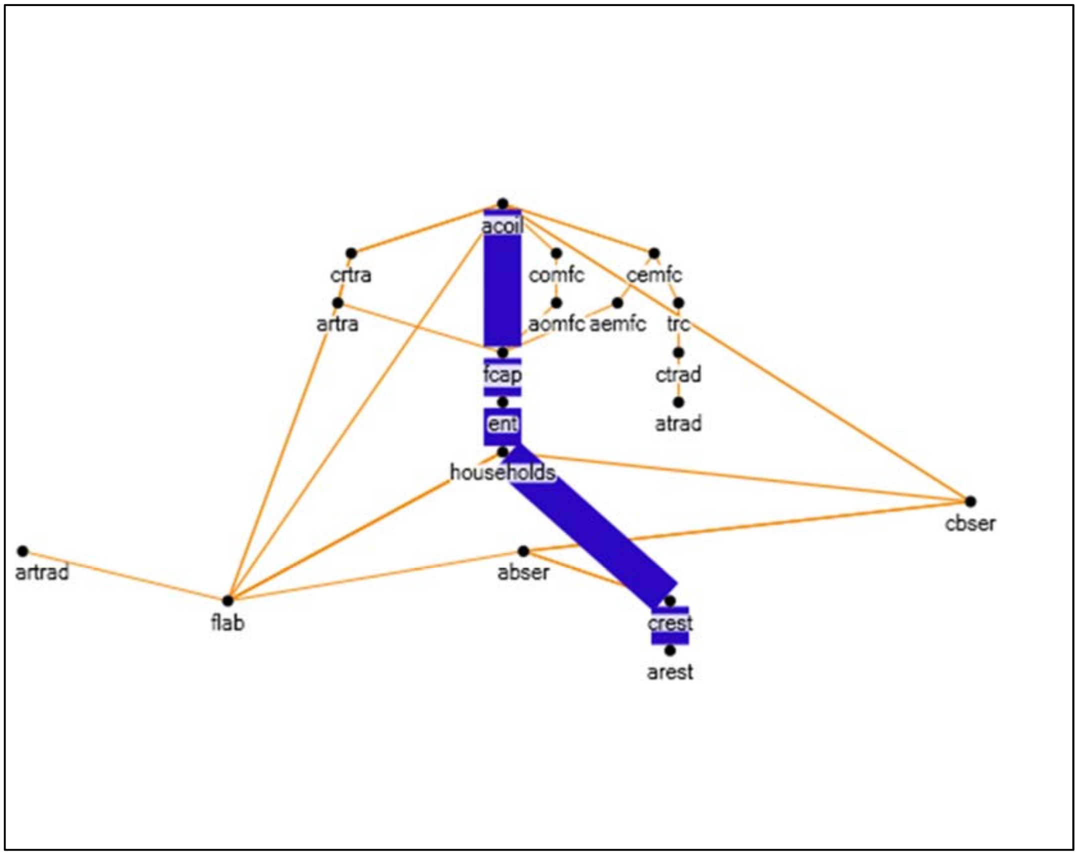
Note: Figure created using the weighted graph scheme of NodeXL. Paths depicted explain 94% of the accounting multiplier.

Figure I.8: Production activities – Case VIII



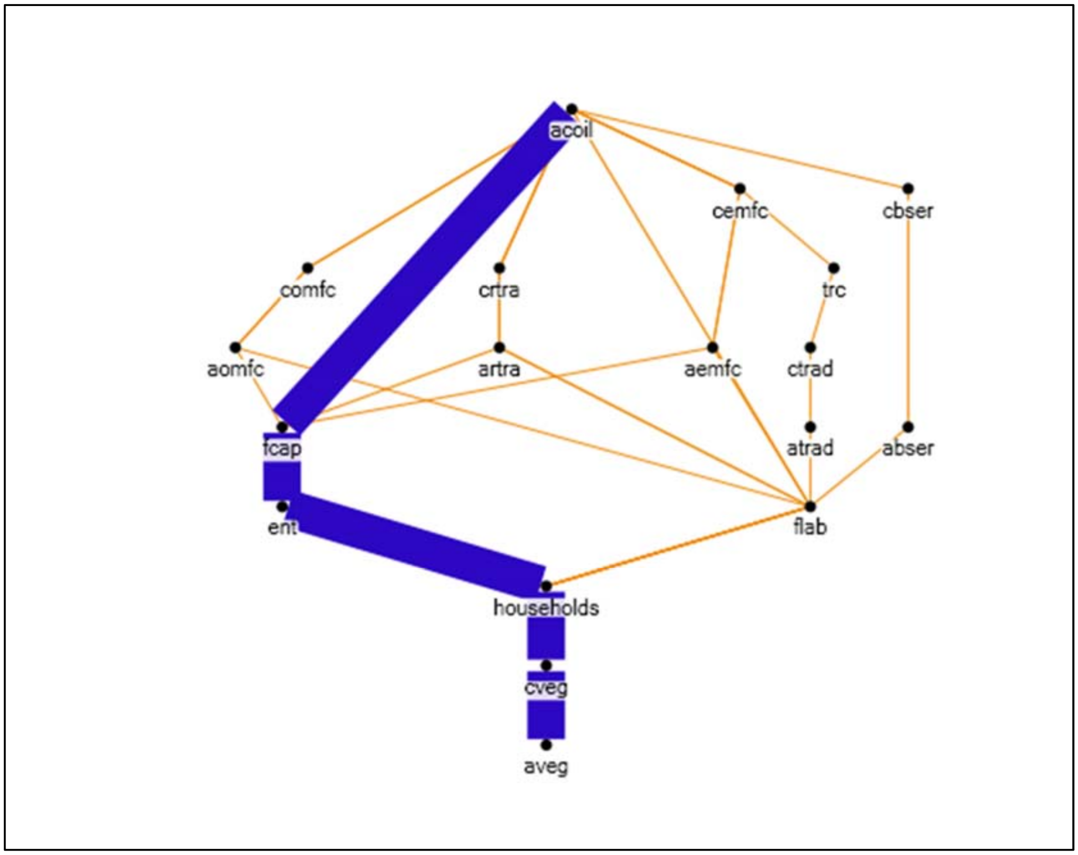
Note: Figure created using the weighted graph scheme of NodeXL. Paths depicted explain 99% of the accounting multiplier.

Figure I.9: Production activities – Case IX



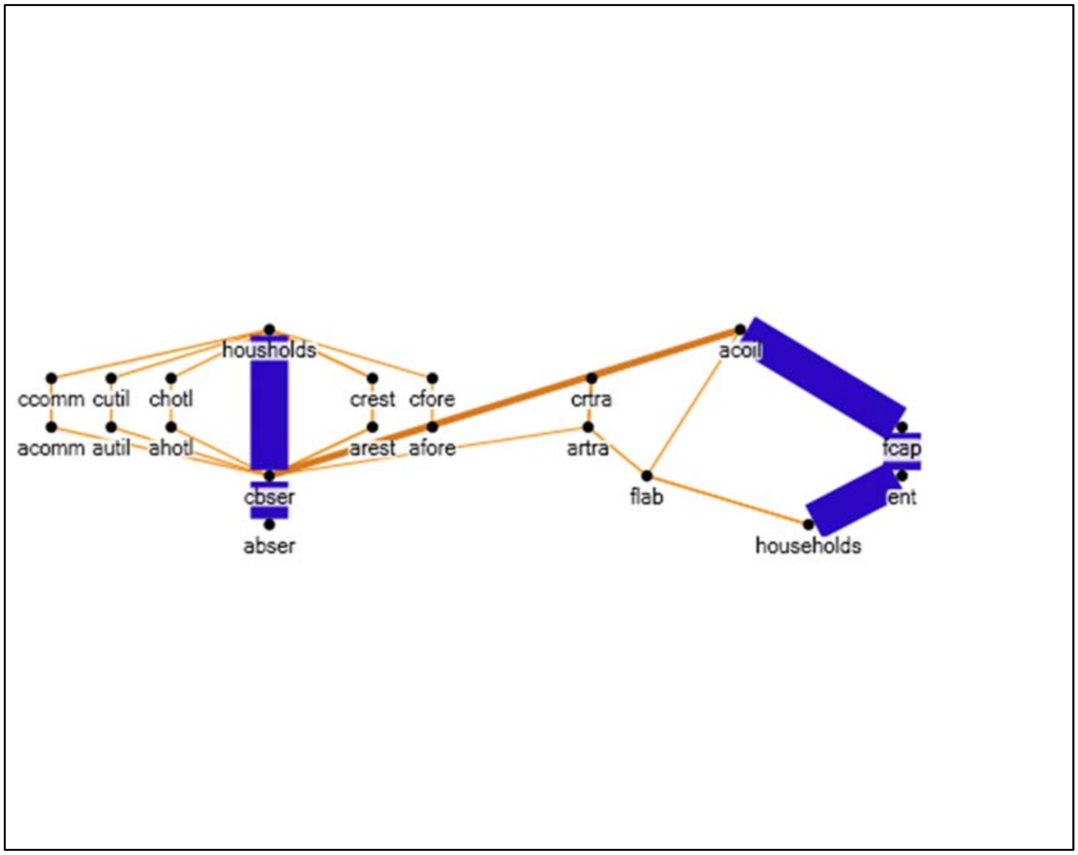
Note: Figure created using the weighted graph scheme of NodeXL. Paths depicted explain 98% of the accounting multiplier.

Figure I.10: Production activities – Case X



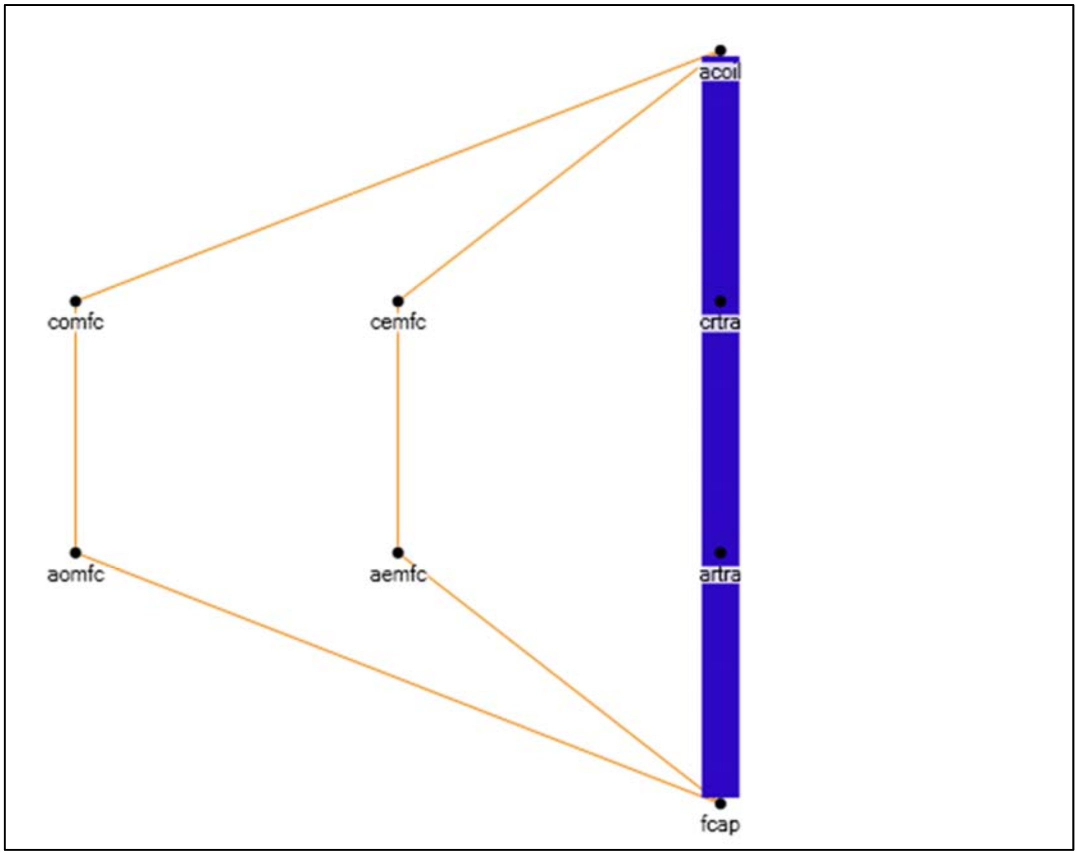
Note: Figure created using the weighted graph scheme of NodeXL. Paths depicted explain 99% of the accounting multiplier.

Figure I.11: Production activities – Case XI



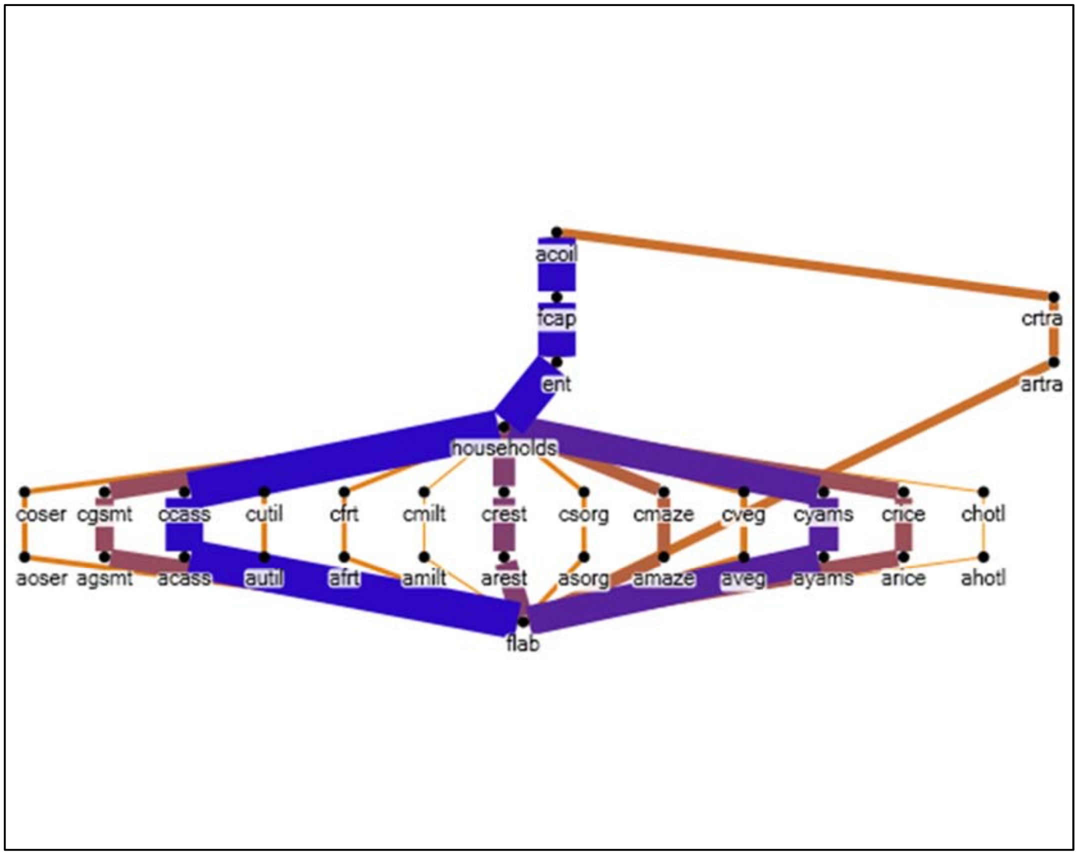
Note: Figure created using the weighted graph scheme of NodeXL. Paths depicted explain 92% of the accounting multiplier.

Figure I.12: Factors – Case I (Capital)



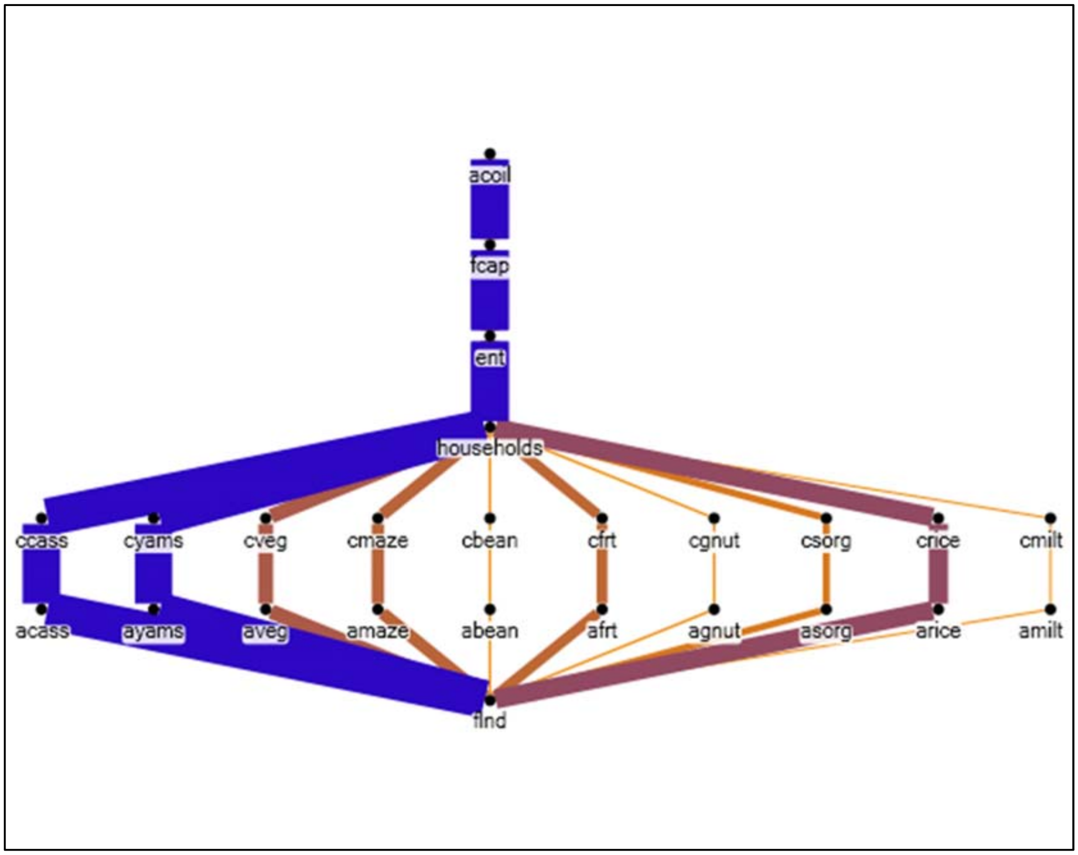
Note: Figure created using the weighted graph scheme of NodeXL. Paths depicted explain 100% of the accounting multiplier.

Figure I.13: Factors – Case II (Labour)



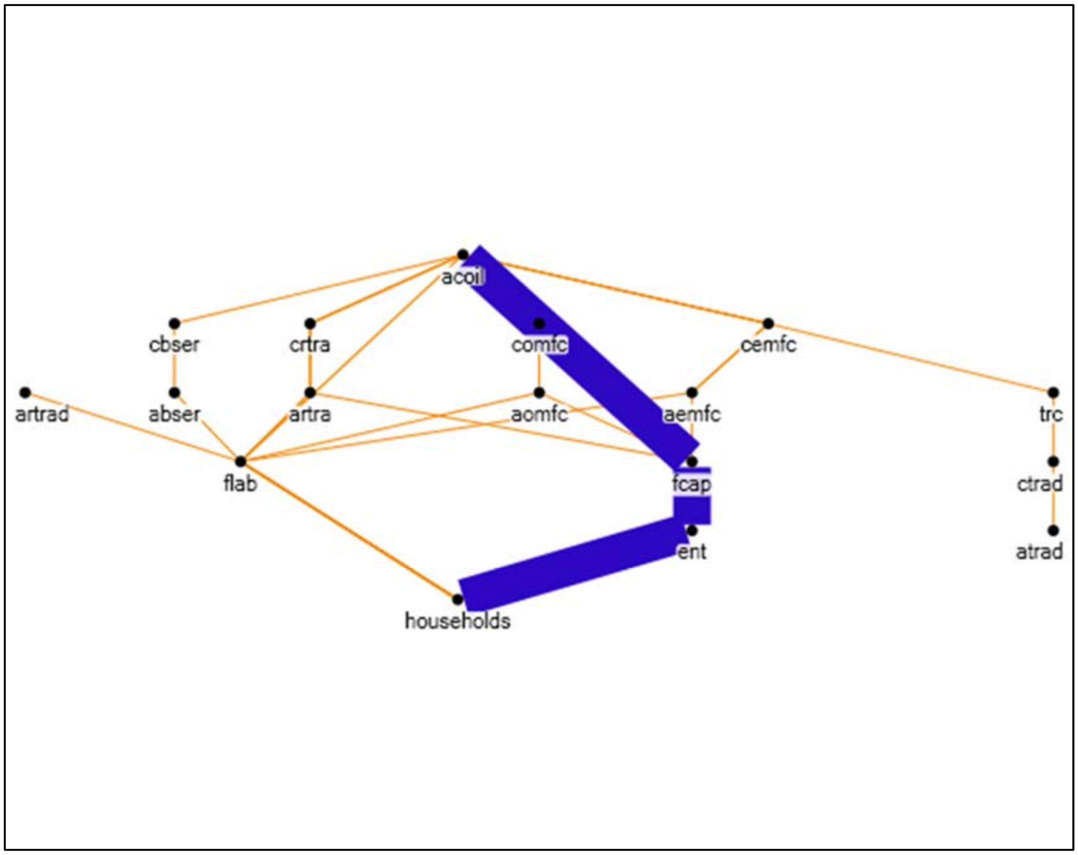
Note: Figure created using the weighted graph scheme of NodeXL. Paths depicted explain 53% of the accounting multiplier.

Figure I.14: Factors – Case III (Land)



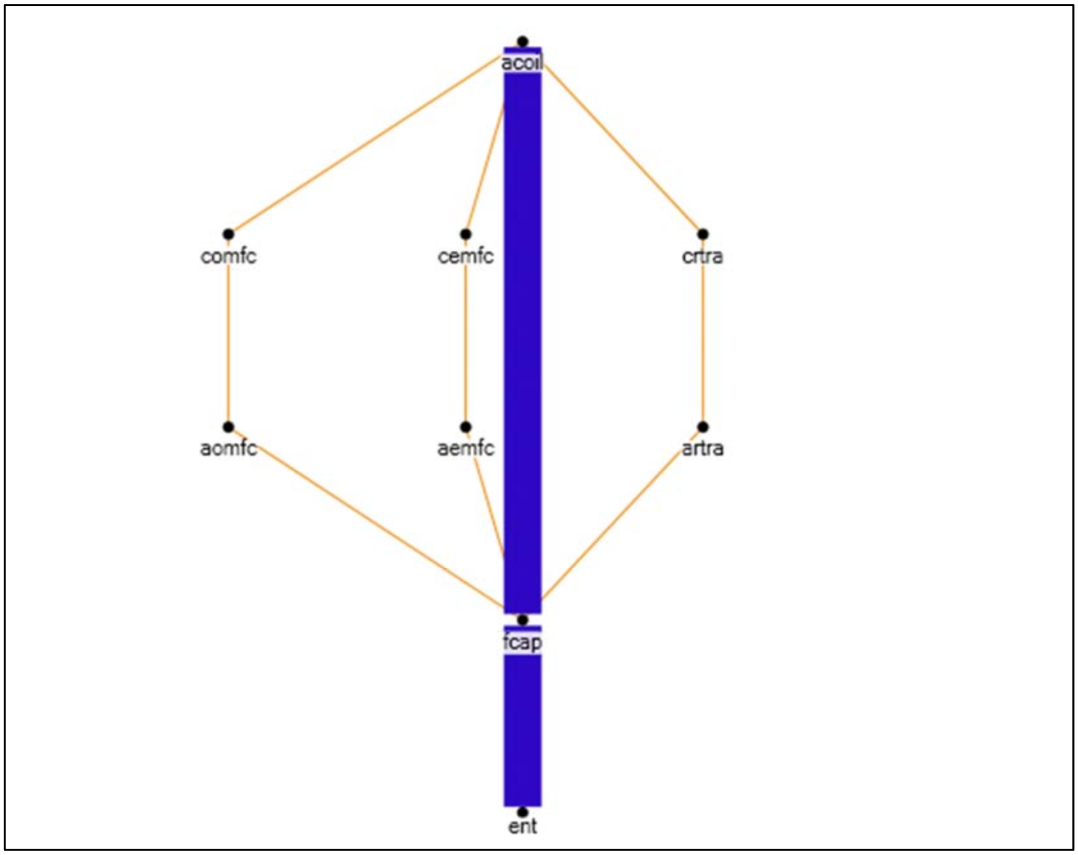
Note: Figure created using the weighted graph scheme of NodeXL. Paths depicted explain 79% of the accounting multiplier.

Figure I.15: Institutions – Case I (Households)



Note: Figure created using the weighted graph scheme of NodeXL. Paths depicted explain 99% of the accounting multiplier.

Figure I.16: Institutions – Case II (Enterprises)



Note: Figure created using the weighted graph scheme of NodeXL. Paths depicted explain 100% of the accounting multiplier.

Appendix II: Algeria

This appendix lays the foundation for the analysis in Chapter 5. Tables II.1 summarises the macro structure of the Algeria SAM used for the multiplier and SPA analysis in Chapter 5. Table II.2 and II.3 give the SAM account (activities and commodities) abbreviations and their corresponding names. Table II.4 provides the detailed results from the SPA performed in Chapter 5. Figure II.1 to II.15 are a graphical representation of the SPA results from Chapter 5.

Table II.1: Macro Social Accounting Matrix for Algeria (2002)

Receipts \ Payments	Activities	Commodities	Labour	Capital	Households	Enterprises	Government	Rest of the world	Residual	Total
Activities		5 555 791.6							0.0	5 555 791.6
Commodities	1 915 205.5				1 988 263.3		240 331.8	1 538 803.6	1 414 405.4	7 097 009.6
Labour	505 930.9						523 023.8		0.0	1 028 954.7
Capital	2 679 893.2								0.0	2 679 893.2
Households		3 227.3	1 028 954.7	1 338 786.5	27 026.5	6 936.6	528 755.2	13 460.8	0.0	2 947 147.6
Enterprises				1 341 106.7	218.2	2 458.7	202 195.8	4 243.0	0.0	1 550 222.4
Government	454 762.0	355 783.2			421 405.6	823 476.8	227 790.9	208 080.0	0.0	2 491 298.6
Rest of the world		1 182 207.5			21.7	160 217.2	162 122.1			1 504 568.5
Residual					510 212.3	557 133.1	607 078.9	-260 018.9	0.0	1 414 405.4
Total	5 555 791.6	7 097 009.6	1 028 954.7	2 679 893.2	2 947 147.6	1 550 222.4	2 491 298.6	1 504 568.5	1 414 405.4	26 269 291.7

Table II.2: Algeria SAM accounts: Activities

Account Number	Code	Description	Account Number	Code	Description
1	aAgri	Agriculture	11	aTextiles	Textiles
2	aW&Ener	Water and Energy	12	aLeather&Shoes	Leather and footwear
3	aHydrocarbons	Hydrocarbons (petroleum)	13	aWoodcorkpaper	Wood, cork and paper
4	aPW&PetroServ	Services and construction for petroleum	14	aVarious industries	Other manufacturing
5	aMines&Quar	Mining and quarrying	15	aTrans&comms	Transport and communications
6	aMetalSteelMecelectric	Metal sector (Metal steel industries, mechanical and electrical)	16	aShops	Trade
7	aBuildingM	Construction materials	17	aHotels&Restaur	Hotels and restaurants
8	aBuild&civil	Building and construction	18	aServicestoCo	Other private services (Services Provided to companies)
9	aChemRubberPlastic	Chemicals, Rubber and Plastic	19	aServicestoHH	Public services (Services provided to households)
10	aAgroFood	Food processing			

Table II.3: Algeria SAM accounts: Commodities

Account Number	Code	Description	Account Number	Code	Description
1	cAgri	Agriculture	11	cTextiles	Textiles
2	cW&Ener	Water and Energy	12	cLeather&Shoes	Leather and footwear
3	cHydrocarbons	Hydrocarbons (petroleum)	13	cWoodcorkpaper	Wood, cork and paper
4	cPW&PetroServ	Services and construction for petroleum	14	cVarious industries	Other manufacturing
5	cMines&Quar	Mining and quarrying	15	cTrans&comms	Transport and communications
6	cMetalSteelMecelectric	Metal sector (Metal steel industries, mechanical and electrical)	16	cShops	Trade
7	cBuildingM	Construction materials	17	cHotels&Restaur	Hotels and restaurants
8	cBuild&civil	Building and construction	18	cServicestoCo	Other private services (Services Provided to companies)
9	cChemRubberPlastic	Chemicals, Rubber and Plastic	19	cServicestoHH	Public services (Services provided to households)
10	cAgroFood	Food processing			

Table II.4: SPA for selected activites: Algeria (CASE I TO XI)

Case	Origin	Dest.	Global infl.	Path	Direct infl.	Path mult.	Total infl.	Prop. (in %)	Accum. Prop.
I	aHydrocarbons	aTrans&comms	0.12	aHydrocarbons / cTrans&comms / aTrans&comms	0.037	1.44	0.054	46.4	46.4
				aHydrocarbons / Cap / HH / cTrans&comms / aTrans&comms	0.025	1.77	0.044	38.2	84.6
				aHydrocarbons / Cap / HH / cShops / aShops / cTrans&comms / aTrans&comms	0.003	1.78	0.005	3.9	88.6
				aHydrocarbons / Lab / HH / cTrans&comms / aTrans&comms	0.002	1.77	0.003	2.6	91.2
				aHydrocarbons / cPW&PetroServ / aPW&PetroServ / cTrans&comms / aTrans&comms	0.001	1.51	0.002	1.4	92.6
				aHydrocarbons / cShops / aShops / cTrans&comms / aTrans&comms	0.001	1.54	0.002	1.3	93.9
				aHydrocarbons / cShops / aShops / Cap / HH / cTrans&comms / aTrans&comms	0.000	1.78	0.001	0.6	94.5
				aHydrocarbons / cServicestoCo / aServicestoCo / Lab / HH / cTrans&comms / aTrans&comms	0.000	1.78	0.001	0.4	94.9
				aHydrocarbons / Cap / HH / cAgroFood / aAgroFood / cTrans&comms / aTrans&comms	0.000	2.00	0.000	0.4	95.2
				aHydrocarbons / cServicestoCo / aServicestoCo / Cap / HH / cTrans&comms / aTrans&comms	0.000	1.78	0.000	0.3	95.6
				aHydrocarbons / cPW&PetroServ / aPW&PetroServ / Lab / HH / cTrans&comms / aTrans&comms	0.000	1.85	0.000	0.3	95.9
				aHydrocarbons / Lab / HH / cShops / aShops / cTrans&comms / aTrans&comms	0.000	1.78	0.000	0.3	96.2
				aHydrocarbons / cPW&PetroServ / aPW&PetroServ / Cap / HH / cTrans&comms / aTrans&comms	0.000	1.85	0.000	0.2	96.4
				aHydrocarbons / Cap / HH / cAgroFood / aAgroFood / cShops / aShops / cTrans&comms / aTrans&comms	0.000	2.01	0.000	0.2	96.6
				aHydrocarbons / Cap / Ent / HH / cTrans&comms / aTrans&comms	0.000	1.77	0.000	0.2	96.8
				aHydrocarbons / Cap / HH / cHotels&Restaur / aHotels&Restaur / cTrans&comms / aTrans&comms	0.000	1.77	0.000	0.2	97.0
				aHydrocarbons / cServicestoCo / aServicestoCo / cTrans&comms / aTrans&comms	0.000	1.45	0.000	0.2	97.1
				aHydrocarbons / cShops / aShops / Lab / HH / cTrans&comms / aTrans&comms	0.000	1.78	0.000	0.2	97.3
				aHydrocarbons / cBuildingM / aBuildingM / cTrans&comms / aTrans&comms	0.000	1.45	0.000	0.1	97.4
				aHydrocarbons / cAgroFood / aAgroFood / Cap / HH / cTrans&comms / aTrans&comms	0.000	2.00	0.000	0.1	97.5
				aHydrocarbons / Cap / HH / cServicestoHH / aServicestoHH / cTrans&comms / aTrans&comms	0.000	1.77	0.000	0.1	97.6
				aHydrocarbons / cW&Ener / aW&Ener / Cap / HH / cTrans&comms / aTrans&comms	0.000	1.80	0.000	0.1	97.7

Table II.4: Continued

Case	Origin	Dest.	Global infl.	Path	Direct infl.	Path mult.	Total infl.	Prop. (in %)	Accum. Prop.
II	aHydrocarbons	aAgroFood	0.09	aHydrocarbons / Cap / HH / cAgroFood / aAgroFood	0.036	1.82	0.065	72.8	72.8
				aHydrocarbons / cAgroFood / aAgroFood	0.005	1.49	0.008	8.8	81.6
				aHydrocarbons / Lab / HH / cAgroFood / aAgroFood	0.003	1.82	0.005	5.0	86.6
				aHydrocarbons / cTrans&comms / aTrans&comms / Cap / HH / cAgroFood / aAgroFood	0.001	2.00	0.003	2.8	89.5
				aHydrocarbons / cTrans&comms / aTrans&comms / Lab / HH / cAgroFood / aAgroFood	0.001	2.00	0.001	1.3	90.7
				aHydrocarbons / Cap / HH / cAgri / aAgri / cAgroFood / aAgroFood	0.001	1.95	0.001	1.2	91.9
				aHydrocarbons / cShops / aShops / Cap / HH / cAgroFood / aAgroFood	0.001	1.83	0.001	1.1	93.0
				aHydrocarbons / cServicestoCo / aServicestoCo / Lab / HH / cAgroFood / aAgroFood	0.000	1.84	0.001	0.7	93.7
				aHydrocarbons / cServicestoCo / aServicestoCo / Cap / HH / cAgroFood / aAgroFood	0.000	1.84	0.001	0.7	94.4
				aHydrocarbons / cPW&PetroServ / aPW&PetroServ / Lab / HH / cAgroFood / aAgroFood	0.000	1.90	0.001	0.7	95.0
				aHydrocarbons / cPW&PetroServ / aPW&PetroServ / Cap / HH / cAgroFood / aAgroFood	0.000	1.90	0.000	0.4	95.5
				aHydrocarbons / cPW&PetroServ / aPW&PetroServ / cAgroFood / aAgroFood	0.000	1.56	0.000	0.4	95.9
				aHydrocarbons / Cap / Ent / HH / cAgroFood / aAgroFood	0.000	1.82	0.000	0.3	96.2
				aHydrocarbons / Cap / HH / cHotels&Restaur / aHotels&Restaur / cAgroFood / aAgroFood	0.000	1.82	0.000	0.3	96.5
				aHydrocarbons / cShops / aShops / Lab / HH / cAgroFood / aAgroFood	0.000	1.83	0.000	0.3	96.8
				aHydrocarbons / cW&Ener / aW&Ener / Cap / HH / cAgroFood / aAgroFood	0.000	1.85	0.000	0.2	97.0
				aHydrocarbons / cBuild&civil / aBuild&civil / Lab / HH / cAgroFood / aAgroFood	0.000	1.82	0.000	0.1	97.1
				aHydrocarbons / cBuildingM / aBuildingM / Lab / HH / cAgroFood / aAgroFood	0.000	1.83	0.000	0.1	97.2
				aHydrocarbons / cW&Ener / aW&Ener / Lab / HH / cAgroFood / aAgroFood	0.000	1.85	0.000	0.1	97.4
				aHydrocarbons / Cap / HH / cChemRubberPlastic / aChemRubberPlastic / cAgroFood / aAgroFood	0.000	1.90	0.000	0.1	97.5

Table II.4: Continued

Case	Origin	Dest.	Global infl.	Path	Direct infl.	Path mult.	Total infl.	Prop. (in %)	Accum. Prop.
III	aHydrocarbons	aAgri	0.09	aHydrocarbons / Cap / HH / cAgri / aAgri	0.025	1.74	0.044	51.3	51.3
				aHydrocarbons / Cap / HH / cAgroFood / aAgroFood / cAgri / aAgri	0.010	1.95	0.020	23.7	75.0
				aHydrocarbons / Lab / HH / cAgri / aAgri	0.002	1.74	0.003	3.6	78.6
				aHydrocarbons / cAgroFood / aAgroFood / cAgri / aAgri	0.002	1.69	0.003	3.0	81.6
				aHydrocarbons / cTrans&comms / aTrans&comms / Cap / HH / cAgri / aAgri	0.001	1.91	0.002	2.0	83.6
				aHydrocarbons / Lab / HH / cAgroFood / aAgroFood / cAgri / aAgri	0.001	1.95	0.001	1.6	85.3
				aHydrocarbons / cTrans&comms / aTrans&comms / cAgri / aAgri	0.001	1.69	0.001	1.5	86.8
				aHydrocarbons / Cap / HH / cTrans&comms / aTrans&comms / cAgri / aAgri	0.001	1.91	0.001	1.1	87.9
				aHydrocarbons / cTrans&comms / aTrans&comms / Cap / HH / cAgroFood / aAgroFood / cAgri / aAgri	0.000	2.15	0.001	0.9	88.8
				aHydrocarbons / cTrans&comms / aTrans&comms / Lab / HH / cAgri / aAgri	0.000	1.91	0.001	0.9	89.7
				aHydrocarbons / cShops / aShops / Cap / HH / cAgri / aAgri	0.000	1.75	0.001	0.8	90.5
				aHydrocarbons / Cap / HH / cHotels&Restaur / aHotels&Restaur / cAgri / aAgri	0.000	1.74	0.001	0.6	91.1
				aHydrocarbons / cServicestoCo / aServicestoCo / Lab / HH / cAgri / aAgri	0.000	1.76	0.000	0.5	91.6
				aHydrocarbons / cServicestoCo / aServicestoCo / Cap / HH / cAgri / aAgri	0.000	1.76	0.000	0.5	92.1
				aHydrocarbons / cPW&PetroServ / aPW&PetroServ / Lab / HH / cAgri / aAgri	0.000	1.82	0.000	0.5	92.6
				aHydrocarbons / cTrans&comms / aTrans&comms / Lab / HH / cAgroFood / aAgroFood / cAgri / aAgri	0.000	2.15	0.000	0.4	93.0
				aHydrocarbons / Cap / HH / cShops / aShops / cAgri / aAgri	0.000	1.75	0.000	0.4	93.4
				aHydrocarbons / cPW&PetroServ / aPW&PetroServ / cAgri / aAgri	0.000	1.52	0.000	0.4	93.7
				aHydrocarbons / cShops / aShops / Cap / HH / cAgroFood / aAgroFood / cAgri / aAgri	0.000	1.97	0.000	0.4	94.1
				aHydrocarbons / cPW&PetroServ / aPW&PetroServ / Cap / HH / cAgri / aAgri	0.000	1.82	0.000	0.3	94.4
				aHydrocarbons / cServicestoCo / aServicestoCo / Lab / HH / cAgroFood / aAgroFood / cAgri / aAgri	0.000	1.97	0.000	0.2	94.6
				aHydrocarbons / Cap / Ent / HH / cAgri / aAgri	0.000	1.74	0.000	0.2305	94.869

Table II.4: Continued

Case	Origin	Dest.	Global infl.	Path	Direct infl.	Path mult.	Total infl.	Prop. (in %)	Accum. Prop.
				aHydrocarbons / cServicestoCo / aServicestoCo / Cap / HH / cAgroFood / aAgroFood / cAgri / aAgri	0.000	1.97	0.000	0.2	95.1
				aHydrocarbons / cPW&PetroServ / aPW&PetroServ / Lab / HH / cAgroFood / aAgroFood / cAgri / aAgri	0.000	2.05	0.000	0.2	95.3
				aHydrocarbons / cShops / aShops / Lab / HH / cAgri / aAgri	0.000	1.75	0.000	0.2	95.5
				aHydrocarbons / cAgroFood / aAgroFood / Cap / HH / cAgri / aAgri	0.000	1.95	0.000	0.2	95.7
				aHydrocarbons / cShops / aShops / cAgri / aAgri	0.000	1.57	0.000	0.1	95.8
				aHydrocarbons / cPW&PetroServ / aPW&PetroServ / cAgroFood / aAgroFood / cAgri / aAgri	0.000	1.77	0.000	0.1	95.9
				aHydrocarbons / cPW&PetroServ / aPW&PetroServ / Cap / HH / cAgroFood / aAgroFood / cAgri / aAgri	0.000	2.05	0.000	0.1	96.1
				aHydrocarbons / cW&Ener / aW&Ener / Cap / HH / cAgri / aAgri	0.000	1.78	0.000	0.1	96.2
				aHydrocarbons / Cap / HH / cShops / aShops / cTrans&comms / aTrans&comms / cAgri / aAgri	0.000	1.92	0.000	0.1	96.3
				aHydrocarbons / Cap / Ent / HH / cAgroFood / aAgroFood / cAgri / aAgri	0.000	1.96	0.000	0.1	96.4
IV	aHydrocarbons	aShops	0.08	aHydrocarbons / Cap / HH / cShops / aShops	0.030	1.62	0.049	58.7	95.1
				aHydrocarbons / cShops / aShops	0.012	1.34	0.016	19.1	95.3
				aHydrocarbons / Lab / HH / cShops / aShops	0.002	1.62	0.003	4.1	95.5
				aHydrocarbons / Cap / HH / cAgroFood / aAgroFood / cShops / aShops	0.001	1.83	0.002	2.8	95.7
				aHydrocarbons / cTrans&comms / aTrans&comms / Cap / HH / cShops / aShops	0.001	1.78	0.002	2.3	95.8
				aHydrocarbons / cTrans&comms / aTrans&comms / cShops / aShops	0.001	1.54	0.001	1.2	95.9
				aHydrocarbons / cTrans&comms / aTrans&comms / Lab / HH / cShops / aShops	0.001	1.78	0.001	1.0	96.1
				aHydrocarbons / Cap / HH / cTrans&comms / aTrans&comms / cShops / aShops	0.000	1.78	0.001	0.9	96.2
				aHydrocarbons / cPW&PetroServ / aPW&PetroServ / cShops / aShops	0.000	1.40	0.001	0.7	96.3
				aHydrocarbons / cServicestoCo / aServicestoCo / Lab / HH / cShops / aShops	0.000	1.63	0.001	0.6	96.4
				aHydrocarbons / cServicestoCo / aServicestoCo / Cap / HH / cShops / aShops	0.000	1.63	0.000	0.5	95.1
				aHydrocarbons / cPW&PetroServ / aPW&PetroServ / Lab / HH / cShops / aShops	0.000	1.70	0.000	0.5	95.3
				aHydrocarbons / Cap / HH / cTextiles / aTextiles / cShops / aShops	0.000	1.91	0.000	0.5	95.5

Table II.4: Continued

Case	Origin	Dest.	Global infl.	Path	Direct infl.	Path mult.	Total infl.	Prop. (in %)	Accum. Prop.
				aHydrocarbons / Cap / HH / cAgri / aAgri / cShops / aShops	0.000	1.75	0.000	0.4	93.3
				aHydrocarbons / cAgroFood / aAgroFood / cShops / aShops	0.000	1.60	0.000	0.4	93.6
				aHydrocarbons / cPW&PetroServ / aPW&PetroServ / Cap / HH / cShops / aShops	0.000	1.70	0.000	0.3	94.0
				aHydrocarbons / cBuild&civil / aBuild&civil / cShops / aShops	0.000	1.34	0.000	0.3	94.3
				aHydrocarbons / Cap / Ent / HH / cShops / aShops	0.000	1.62	0.000	0.3	94.5
				aHydrocarbons / Cap / HH / cMetalSteelMecelectric / aMetalSteelMecelectric / cShops / aShops	0.000	1.66	0.000	0.2	94.8
				aHydrocarbons / Lab / HH / cAgroFood / aAgroFood / cShops / aShops	0.000	1.83	0.000	0.2	95.0
				aHydrocarbons / Cap / HH / cAgroFood / aAgroFood / cAgri / aAgri / cShops / aShops	0.000	1.97	0.000	0.2	95.1
				aHydrocarbons / Cap / HH / cChemRubberPlastic / aChemRubberPlastic / cShops / aShops	0.000	1.69	0.000	0.2	95.3
				aHydrocarbons / cMetalSteelMecelectric / aMetalSteelMecelectric / cShops / aShops	0.000	1.38	0.000	0.2	95.5
				aHydrocarbons / cServicestoCo / aServicestoCo / cShops / aShops	0.000	1.35	0.000	0.2	95.7
				aHydrocarbons / cAgroFood / aAgroFood / Cap / HH / cShops / aShops	0.000	1.83	0.000	0.2	95.9
				aHydrocarbons / cW&Ener / aW&Ener / Cap / HH / cShops / aShops	0.000	1.65	0.000	0.2	96.0
				aHydrocarbons / Cap / HH / cServicestoHH / aServicestoHH / cShops / aShops	0.000	1.62	0.000	0.1	96.2
				aHydrocarbons / Cap / HH / cW&Ener / aW&Ener / cShops / aShops	0.000	1.65	0.000	0.1	96.3
				aHydrocarbons / cAgroFood / aAgroFood / cAgri / aAgri / Cap / HH / cShops / aShops	0.000	1.97	0.000	0.1	96.4
				aHydrocarbons / cBuildingM / aBuildingM / cShops / aShops	0.000	1.35	0.000	0.1	96.6
				aHydrocarbons / cBuild&civil / aBuild&civil / Lab / HH / cShops / aShops	0.000	1.62	0.000	0.1	96.7
				aHydrocarbons / cTrans&comms / aTrans&comms / Cap / HH / cAgroFood / aAgroFood / cShops / aShops	0.000	2.01	0.000	0.1	96.8
				aHydrocarbons / cBuildingM / aBuildingM / Lab / HH / cShops / aShops	0.000	1.63	0.000	0.1	96.9
V	aHydrocarbons	aPW&PetroServ	0.02	aHydrocarbons / cPW&PetroServ / aPW&PetroServ	0.012	1.291	0.015	100	100

Table II.4: Continued

Case	Origin	Dest.	Global infl.	Path	Direct infl.	Path mult.	Total infl.	Prop. (in %)	Accum. Prop.
VI	aHydrocarbons	aW&Ener	0.01	aHydrocarbons / Cap / HH / cW&Ener / aW&Ener	0.004	1.64	0.006	42.4	42.4
				aHydrocarbons / cW&Ener / aW&Ener	0.003	1.27	0.004	27.3	69.7
				aHydrocarbons / cServicestoCo / aServicestoCo / cW&Ener / aW&Ener	0.001	1.28	0.001	4.0	73.7
				aHydrocarbons / Lab / HH / cW&Ener / aW&Ener	0.000	1.64	0.000	2.9	76.7
				aHydrocarbons / cTrans&comms / aTrans&comms / cW&Ener / aW&Ener	0.000	1.48	0.000	1.8	78.5
				aHydrocarbons / Cap / HH / cShops / aShops / cW&Ener / aW&Ener	0.000	1.65	0.000	1.7	80.2
				aHydrocarbons / cTrans&comms / aTrans&comms / Cap / HH / cW&Ener / aW&Ener	0.000	1.80	0.000	1.7	81.9
				aHydrocarbons / Cap / HH / cAgroFood / aAgroFood / cW&Ener / aW&Ener	0.000	1.85	0.000	1.6	83.5
				aHydrocarbons / Cap / HH / cTrans&comms / aTrans&comms / cW&Ener / aW&Ener	0.000	1.80	0.000	1.5	85.0
				aHydrocarbons / Cap / HH / cServicestoHH / aServicestoHH / cW&Ener / aW&Ener	0.000	1.64	0.000	1.3	86.2
				aHydrocarbons / Cap / HH / cAgri / aAgri / cW&Ener / aW&Ener	0.000	1.78	0.000	0.8	87.1
				aHydrocarbons / Cap / HH / cHotels&Restaur / aHotels&Restaur / cW&Ener / aW&Ener	0.000	1.64	0.000	0.8	87.9
				aHydrocarbons / cTrans&comms / aTrans&comms / Lab / HH / cW&Ener / aW&Ener	0.000	1.80	0.000	0.7	88.6
				aHydrocarbons / cShops / aShops / Cap / HH / cW&Ener / aW&Ener	0.000	1.65	0.000	0.6	89.2
				aHydrocarbons / cShops / aShops / cW&Ener / aW&Ener	0.000	1.38	0.000	0.6	89.8
				aHydrocarbons / Cap / HH / cTextiles / aTextiles / cW&Ener / aW&Ener	0	1.93	0.000	0.5	90.4
				aHydrocarbons / cServicestoCo / aServicestoCo / Lab / HH / cW&Ener / aW&Ener	0	1.66	0.000	0.4	90.8
				aHydrocarbons / cPW&PetroServ / aPW&PetroServ / cW&Ener / aW&Ener	0	1.33	0.000	0.4	91.2
				aHydrocarbons / Cap / HH / cAgroFood / aAgroFood / cAgri / aAgri / cW&Ener / aW&Ener	0	1.99	0.000	0.4	91.6
				aHydrocarbons / cServicestoCo / aServicestoCo / Cap / HH / cW&Ener / aW&Ener	0	1.66	0.000	0.4	92.0
				aHydrocarbons / cPW&PetroServ / aPW&PetroServ / Lab / HH / cW&Ener / aW&Ener	0	1.72	0.000	0.4	92.4
				aHydrocarbons / Cap / HH / cMetalSteelMecelectric / aMetalSteelMecelectric / cW&Ener / aW&Ener	0	1.68	0	0.3	92.7
				aHydrocarbons / cPW&PetroServ / aPW&PetroServ / Cap / HH / cW&Ener / aW&Ener	0	1.72	0	0.2	92.9
				aHydrocarbons / cMetalSteelMecelectric / aMetalSteelMecelectric / cW&Ener / aW&Ener	0	1.31	0	0.2	93.1

Table II.4: Continued

Case	Origin	Dest.	Global infl.	Path	Direct infl.	Path mult.	Total infl.	Prop. (in %)	Accum. Prop.
				aHydrocarbons / cTrans&comms / aTrans&comms / cServicestoCo / aServicestoCo / cW&Ener / aW&Ener	0	1.50	0	0.2	93.4
				aHydrocarbons / cAgroFood / aAgroFood / cW&Ener / aW&Ener	0	1.53	0	0.2	93.6
				aHydrocarbons / Cap / Ent / HH / cW&Ener / aW&Ener	0	1.64	0	0.2	93.8
				aHydrocarbons / Cap / HH / cTrans&comms / aTrans&comms / cServicestoCo / aServicestoCo / cW&Ener / aW&Ener	0	1.82	0	0.2	93.9
				aHydrocarbons / cShops / aShops / Lab / HH / cW&Ener / aW&Ener	0	1.65	0	0.2	94.1
				aHydrocarbons / Cap / HH / cShops / aShops / cTrans&comms / aTrans&comms / cW&Ener / aW&Ener	0	1.81	0	0.2	94.3
				aHydrocarbons / cBuild&civil / aBuild&civil / cW&Ener / aW&Ener	0	1.27	0	0.1	94.4
				aHydrocarbons / Cap / HH / cChemRubberPlastic / aChemRubberPlastic / cW&Ener / aW&Ener	0	1.71	0	0.1	94.6
				aHydrocarbons / cAgroFood / aAgroFood / Cap / HH / cW&Ener / aW&Ener	0	1.85	0	0.1	94.7
				aHydrocarbons / cPW&PetroServ / aPW&PetroServ / cServicestoCo / aServicestoCo / cW&Ener / aW&Ener	0	1.34	0	0.1	94.8
				aHydrocarbons / Lab / HH / cShops / aShops / cW&Ener / aW&Ener	0	1.65	0	0.1	94.9
				aHydrocarbons / cBuildingM / aBuildingM / cW&Ener / aW&Ener	0	1.28	0	0.1	95.0
				aHydrocarbons / Lab / HH / cAgroFood / aAgroFood / cW&Ener / aW&Ener	0	1.85	0	0.1	95.2
				aHydrocarbons / Lab / HH / cTrans&comms / aTrans&comms / cW&Ener / aW&Ener	0	1.80	0	0.1	95.3
VII	aHydrocarbons	aServicestoCo	0.01	aHydrocarbons / cServicestoCo / aServicestoCo	0.010	1.25	0.012	84.8	84.8
				aHydrocarbons / cTrans&comms / aTrans&comms / cServicestoCo / aServicestoCo	0.001	1.45	0.001	4.7	89.6
				aHydrocarbons / Cap / HH / cTrans&comms / aTrans&comms / cServicestoCo / aServicestoCo	0.000	1.78	0.001	3.9	93.5
				aHydrocarbons / cPW&PetroServ / aPW&PetroServ / cServicestoCo / aServicestoCo	0.000	1.31	0.000	2.6	96.1
				aHydrocarbons / Cap / HH / cShops / aShops / cServicestoCo / aServicestoCo	0.000	1.63	0.000	0.8	96.9
				aHydrocarbons / Cap / HH / cShops / aShops / cTrans&comms / aTrans&comms / cServicestoCo / aServicestoCo	0	1.79	0.000	0.4	97.3
				aHydrocarbons / Lab / HH / cTrans&comms / aTrans&comms / cServicestoCo / aServicestoCo	0	1.78	0	0.3	97.6
				aHydrocarbons / cShops / aShops / cServicestoCo / aServicestoCo	0	1.35	0	0.3	97.8
				aHydrocarbons / Cap / HH / cAgri / aAgri / cServicestoCo / aServicestoCo	0	1.76	0	0.2	98.0
				aHydrocarbons / cPW&PetroServ / aPW&PetroServ / cTrans&comms / aTrans&comms / cServicestoCo / aServicestoCo	0	1.52	0	0.1	98.2

Table II.4: Continued

Case	Origin	Dest.	Global infl.	Path	Direct infl.	Path mult.	Total infl.	Prop. (in %)	Accum. Prop.
				aHydrocarbons / cShops / aShops / cTrans&comms / aTrans&comms / cServicestoCo / aServicestoCo	0	1.56	0	0.1	98.3
				aHydrocarbons / Cap / HH / cAgroFood / aAgroFood / cServicestoCo / aServicestoCo	0	1.84	0	0.1	98.4
				aHydrocarbons / Cap / HH / cHotels&Restaur / aHotels&Restaur / cServicestoCo / aServicestoCo	0	1.63	0	0.1	98.6
				aHydrocarbons / Cap / HH / cAgroFood / aAgroFood / cAgri / aAgri / cServicestoCo / aServicestoCo	0	1.97	0	0.1	98.7
				aHydrocarbons / Lab / HH / cTrans&comms / aTrans&comms / cServicestoCo / aServicestoCo	0	1.78	0	0.3	98.9
				aHydrocarbons / cShops / aShops / cServicestoCo / aServicestoCo	0	1.35	0	0.3	99.2
				aHydrocarbons / Cap / HH / cAgri / aAgri / cServicestoCo / aServicestoCo	0	1.76	0	0.2	99.4
				aHydrocarbons / cPW&PetroServ / aPW&PetroServ / cTrans&comms / aTrans&comms / cServicestoCo / aServicestoCo	0	1.52	0	0.1	99.6
				aHydrocarbons / cShops / aShops / cTrans&comms / aTrans&comms / cServicestoCo / aServicestoCo	0	1.56	0	0.1	99.7
				aHydrocarbons / Cap / HH / cAgroFood / aAgroFood / cServicestoCo / aServicestoCo	0	1.84	0	0.1	99.8
				aHydrocarbons / Cap / HH / cHotels&Restaur / aHotels&Restaur / cServicestoCo / aServicestoCo	0	1.63	0	0.1	99.9
				aHydrocarbons / Cap / HH / cAgroFood / aAgroFood / cAgri / aAgri / cServicestoCo / aServicestoCo	0	1.97	0	0.1	100.0
VIII	aHydrocarbons	aServicestoHH	0.01	aHydrocarbons / Cap / HH / cServicestoHH / aServicestoHH	0.005	1.61	0.009	74.3	74.3
				aHydrocarbons / Lab / HH / cServicestoHH / aServicestoHH	0.000	1.61	0.001	5.1	79.5
				aHydrocarbons / cTrans&comms / aTrans&comms / cServicestoHH / aServicestoHH	0.000	1.46	0.001	4.1	83.6
				aHydrocarbons / Cap / HH / cTrans&comms / aTrans&comms / cServicestoHH / aServicestoHH	0.000	1.77	0.000	3.3	86.9
				aHydrocarbons / cTrans&comms / aTrans&comms / Cap / HH / cServicestoHH / aServicestoHH	0.000	1.77	0.000	2.9	89.8
				aHydrocarbons / cTrans&comms / aTrans&comms / Lab / HH / cServicestoHH / aServicestoHH	0.000	1.77	0.000	1.3	91.1
				aHydrocarbons / cShops / aShops / Cap / HH / cServicestoHH / aServicestoHH	0.000	1.62	0.000	1.1	92.2
				aHydrocarbons / cServicestoCo / aServicestoCo / Lab / HH / cServicestoHH / aServicestoHH	0.000	1.62	0.000	0.8	93.0
				aHydrocarbons / cServicestoCo / aServicestoCo / Cap / HH / cServicestoHH / aServicestoHH	0	1.62	0.000	0.7	93.7
				aHydrocarbons / cPW&PetroServ / aPW&PetroServ / Lab / HH / cServicestoHH / aServicestoHH	0	1.68	0.000	0.7	94.3
				aHydrocarbons / cPW&PetroServ / aPW&PetroServ / Cap / HH / cServicestoHH / aServicestoHH	0	1.68	0.000	0.4	94.8

Table II.4: Continued

Case	Origin	Dest.	Global infl.	Path	Direct infl.	Path mult.	Total infl.	Prop. (in %)	Accum. Prop.
				aHydrocarbons / Cap / HH / cShops / aShops / cTrans&comms / aTrans&comms / cServicestoHH / aServicestoHH	0	1.78	0	0.3	95.1
				aHydrocarbons / Cap / Ent / HH / cServicestoHH / aServicestoHH	0	1.61	0	0.3	95.4
				aHydrocarbons / cShops / aShops / Lab / HH / cServicestoHH / aServicestoHH	0	1.62	0	0.3	95.7
				aHydrocarbons / Lab / HH / cTrans&comms / aTrans&comms / cServicestoHH / aServicestoHH	0	1.77	0	0.2	96.0
				aHydrocarbons / Cap / HH / cAgri / aAgri / cServicestoHH / aServicestoHH	0	1.74	0	0.2	96.2
				aHydrocarbons / cAgroFood / aAgroFood / Cap / HH / cServicestoHH / aServicestoHH	0	1.82	0	0.2	96.4
				aHydrocarbons / cW&Ener / aW&Ener / Cap / HH / cServicestoHH / aServicestoHH	0	1.64	0	0.2	96.6
				aHydrocarbons / cAgroFood / aAgroFood / cAgri / aAgri / Cap / HH / cServicestoHH / aServicestoHH	0	1.95	0	0.2	96.8
				aHydrocarbons / cBuild&civil / aBuild&civil / Lab / HH / cServicestoHH / aServicestoHH	0	1.61	0	0.1	96.9
				aHydrocarbons / cBuildingM / aBuildingM / Lab / HH / cServicestoHH / aServicestoHH	0	1.62	0	0.1	97.1
				aHydrocarbons / cW&Ener / aW&Ener / Lab / HH / cServicestoHH / aServicestoHH	0	1.64	0	0.1	97.2
				aHydrocarbons / cPW&PetroServ / aPW&PetroServ / cTrans&comms / aTrans&comms / cServicestoHH / aServicestoHH	0	1.53	0	0.1	97.3
				aHydrocarbons / cShops / aShops / cTrans&comms / aTrans&comms / cServicestoHH / aServicestoHH	0	1.56	0	0.1	97.4
				aHydrocarbons / Cap / HH / cAgroFood / aAgroFood / cAgri / aAgri / cServicestoHH / aServicestoHH	0	1.95	0	0.1	97.5
IX	aHydrocarbons	aHotels&Restaur	0.01	aHydrocarbons / Cap / HH / cHotels&Restaur / aHotels&Restaur	0.004	1.61	0.006	63.0	63.0
				aHydrocarbons / cTrans&comms / aTrans&comms / cHotels&Restaur / aHotels&Restaur	0.000	1.45	0.001	5.8	68.8
				aHydrocarbons / Cap / HH / cTrans&comms / aTrans&comms / cHotels&Restaur / aHotels&Restaur	0.000	1.77	0.000	4.8	73.6
				aHydrocarbons / cHotels&Restaur / aHotels&Restaur	0.000	1.25	0.000	4.5	78.1
				aHydrocarbons / Lab / HH / cHotels&Restaur / aHotels&Restaur	0.000	1.61	0.000	4.4	82.4
				aHydrocarbons / cTrans&comms / aTrans&comms / Cap / HH / cHotels&Restaur / aHotels&Restaur	0.000	1.77	0.000	2.5	84.9
				aHydrocarbons / Cap / HH / cShops / aShops / cHotels&Restaur / aHotels&Restaur	0.000	1.62	0.000	1.7	86.6
				aHydrocarbons / cTrans&comms / aTrans&comms / Lab / HH / cHotels&Restaur / aHotels&Restaur	0.000	1.77	0.000	1.1	87.7
				aHydrocarbons / cPW&PetroServ / aPW&PetroServ / cHotels&Restaur / aHotels&Restaur	0.000	1.31	0.000	1.0	88.6

Table II.4: Continued

Case	Origin	Dest.	Global infl.	Path	Direct infl.	Path mult.	Total infl.	Prop. (in %)	Accum. Prop.
				aHydrocarbons / cShops / aShops / Cap / HH / cHotels&Restaur / aHotels&Restaur	0.000	1.62	0.000	0.9	89.6
				aHydrocarbons / cServicestoCo / aServicestoCo / cHotels&Restaur / aHotels&Restaur	0	1.26	0.000	0.7	90.3
				aHydrocarbons / cServicestoCo / aServicestoCo / Lab / HH / cHotels&Restaur / aHotels&Restaur	0	1.63	0.000	0.6	90.9
				aHydrocarbons / cServicestoCo / aServicestoCo / Cap / HH / cHotels&Restaur / aHotels&Restaur	0	1.63	0.000	0.6	91.5
				aHydrocarbons / cPW&PetroServ / aPW&PetroServ / Lab / HH / cHotels&Restaur / aHotels&Restaur	0	1.69	0.000	0.6	92.0
				aHydrocarbons / cShops / aShops / cHotels&Restaur / aHotels&Restaur	0	1.35	0.000	0.6	92.6
				aHydrocarbons / Cap / HH / cAgri / aAgri / cHotels&Restaur / aHotels&Restaur	0	1.74	0.000	0.6	93.1
				aHydrocarbons / Cap / HH / cShops / aShops / cTrans&comms / aTrans&comms / cHotels&Restaur / aHotels&Restaur	0	1.78	0	0.5	93.6
				aHydrocarbons / cPW&PetroServ / aPW&PetroServ / Cap / HH / cHotels&Restaur / aHotels&Restaur	0	1.69	0	0.4	94.0
				aHydrocarbons / Lab / HH / cTrans&comms / aTrans&comms / cHotels&Restaur / aHotels&Restaur	0	1.77	0	0.3	94.3
				aHydrocarbons / Cap / Ent / HH / cHotels&Restaur / aHotels&Restaur	0	1.61	0	0.3	94.6
				aHydrocarbons / Cap / HH / cAgroFood / aAgroFood / cAgri / aAgri / cHotels&Restaur / aHotels&Restaur	0	1.96	0	0.3	94.9
				aHydrocarbons / cShops / aShops / Lab / HH / cHotels&Restaur / aHotels&Restaur	0	1.62	0	0.3	95.1
				aHydrocarbons / cAgroFood / aAgroFood / Cap / HH / cHotels&Restaur / aHotels&Restaur	0	1.82	0	0.2	95.3
				aHydrocarbons / cPW&PetroServ / aPW&PetroServ / cTrans&comms / aTrans&comms / cHotels&Restaur / aHotels&Restaur	0	1.52	0	0.2	95.5
				aHydrocarbons / cShops / aShops / cTrans&comms / aTrans&comms / cHotels&Restaur / aHotels&Restaur	0	1.56	0	0.2	95.6
				aHydrocarbons / cW&Ener / aW&Ener / Cap / HH / cHotels&Restaur / aHotels&Restaur	0	1.64	0	0.2	95.8
				aHydrocarbons / Cap / HH / cAgroFood / aAgroFood / cHotels&Restaur / aHotels&Restaur	0	1.82	0	0.2	96.0
				aHydrocarbons / cAgroFood / aAgroFood / cAgri / aAgri / Cap / HH / cHotels&Restaur / aHotels&Restaur	0	1.96	0	0.1	96.1

Table II.4: Continued

Case	Origin	Dest.	Global infl.	Path	Direct infl.	Path mult.	Total infl.	Prop. (in %)	Accum.. Prop.
				aHydrocarbons / Lab / HH / cShops / aShops / cHotels&Restaur / aHotels&Restaur	0	1.62	0	0.1	96.2
				aHydrocarbons / cBuild&civil / aBuild&civil / Lab / HH / cHotels&Restaur / aHotels&Restaur	0	1.61	0	0.1	96.3
				aHydrocarbons / cBuildingM / aBuildingM / Lab / HH / cHotels&Restaur / aHotels&Restaur	0	1.62	0	0.1	96.4
				aHydrocarbons / cW&Ener / aW&Ener / Lab / HH / cHotels&Restaur / aHotels&Restaur	0	1.64	0	0.1	96.5
X	aHydrocarbons	aMetalSteelMecelectric	0.01	aHydrocarbons / Cap / HH / cMetalSteelMecelectric / aMetalSteelMecelectric	0.002	1.65	0.003	39.8	39.8
				aHydrocarbons / cMetalSteelMecelectric / aMetalSteelMecelectric	0.002	1.27	0.002	30.4	70.2
				aHydrocarbons / cTrans&comms / aTrans&comms / cMetalSteelMecelectric / aMetalSteelMecelectric	0.000	1.48	0.000	4.9	75.1
				aHydrocarbons / Cap / HH / cTrans&comms / aTrans&comms / cMetalSteelMecelectric / aMetalSteelMecelectric	0.000	1.82	0.000	4.0	79.1
				aHydrocarbons / Lab / HH / cMetalSteelMecelectric / aMetalSteelMecelectric	0.000	1.65	0.000	2.8	81.9
				aHydrocarbons / cPW&PetroServ / aPW&PetroServ / cMetalSteelMecelectric / aMetalSteelMecelectric	0.000	1.33	0.000	2.4	84.2
				aHydrocarbons / cTrans&comms / aTrans&comms / Cap / HH / cMetalSteelMecelectric / aMetalSteelMecelectric	0.000	1.82	0.000	1.6	85.8
				aHydrocarbons / cBuild&civil / aBuild&civil / cMetalSteelMecelectric / aMetalSteelMecelectric	0.000	1.27	0.000	1.1	86.9
				aHydrocarbons / Cap / HH / cShops / aShops / cMetalSteelMecelectric / aMetalSteelMecelectric	0	1.66	0.000	1.1	88.0
				aHydrocarbons / Cap / HH / cServicestoHH / aServicestoHH / cMetalSteelMecelectric / aMetalSteelMecelectric	0	1.65	0.000	0.8	88.7
				aHydrocarbons / cTrans&comms / aTrans&comms / Lab / HH / cMetalSteelMecelectric / aMetalSteelMecelectric	0	1.82	0	0.7	89.4
				aHydrocarbons / cServicestoCo / aServicestoCo / cMetalSteelMecelectric / aMetalSteelMecelectric	0	1.28	0	0.7	90.1
				aHydrocarbons / cShops / aShops / Cap / HH / cMetalSteelMecelectric / aMetalSteelMecelectric	0	1.66	0	0.6	90.7
				aHydrocarbons / Cap / HH / cShops / aShops / cTrans&comms / aTrans&comms / cMetalSteelMecelectric / aMetalSteelMecelectric	0	1.82	0	0.4	91.1
				aHydrocarbons / cServicestoCo / aServicestoCo / Lab / HH / cMetalSteelMecelectric / aMetalSteelMecelectric	0	1.67	0	0.4	91.5
				aHydrocarbons / Cap / HH / cAgroFood / aAgroFood / cMetalSteelMecelectric / aMetalSteelMecelectric	0	1.87	0	0.4	91.9

Table II.4: Continued

Case	Origin	Dest.	Global infl.	Path	Direct infl.	Path mult.	Total infl.	Prop. (in %)	Accum. Prop.
				aHydrocarbons / cBuildingM / aBuildingM / cMetalSteelMecelectric / aMetalSteelMecelectric	0	1.28	0	0.4	92.3
				aHydrocarbons / cServicestoCo / aServicestoCo / Cap / HH / cMetalSteelMecelectric / aMetalSteelMecelectric	0	1.67	0	0.4	92.7
				aHydrocarbons / cPW&PetroServ / aPW&PetroServ / Lab / HH / cMetalSteelMecelectric / aMetalSteelMecelectric	0	1.73	0	0.4	93.0
				aHydrocarbons / cShops / aShops / cMetalSteelMecelectric / aMetalSteelMecelectric	0	1.38	0	0.4	93.4
				aHydrocarbons / Cap / HH / cW&Ener / aW&Ener / cMetalSteelMecelectric / aMetalSteelMecelectric	0	1.68	0	0.3	93.7
				aHydrocarbons / Lab / HH / cTrans&comms / aTrans&comms / cMetalSteelMecelectric / aMetalSteelMecelectric	0	1.82	0	0.3	94.0
				aHydrocarbons / Cap / HH / cBuild&civil / aBuild&civil / cMetalSteelMecelectric / aMetalSteelMecelectric	0	1.65	0	0.3	94.2
				aHydrocarbons / cPW&PetroServ / aPW&PetroServ / Cap / HH / cMetalSteelMecelectric / aMetalSteelMecelectric	0	1.73	0	0.2	94.5
				aHydrocarbons / Cap / HH / cAgri / aAgri / cMetalSteelMecelectric / aMetalSteelMecelectric	0	1.79	0	0.2	94.7
				aHydrocarbons / cW&Ener / aW&Ener / cMetalSteelMecelectric / aMetalSteelMecelectric	0	1.31	0	0.2	94.9
				aHydrocarbons / Cap / HH / cChemRubberPlastic / aChemRubberPlastic / cMetalSteelMecelectric / aMetalSteelMecelectric	0	1.72	0	0.2	95.1
				aHydrocarbons / Cap / Ent / HH / cMetalSteelMecelectric / aMetalSteelMecelectric	0	1.65	0	0.2	95.2
				aHydrocarbons / cShops / aShops / Lab / HH / cMetalSteelMecelectric / aMetalSteelMecelectric	0	1.66	0	0.2	95.4
				aHydrocarbons / cPW&PetroServ / aPW&PetroServ / cTrans&comms / aTrans&comms / cMetalSteelMecelectric / aMetalSteelMecelectric	0	1.55	0	0.1	95.5
				aHydrocarbons / cShops / aShops / cTrans&comms / aTrans&comms / cMetalSteelMecelectric / aMetalSteelMecelectric	0	1.59	0	0.1	95.7
				aHydrocarbons / cAgroFood / aAgroFood / Cap / HH / cMetalSteelMecelectric / aMetalSteelMecelectric	0	1.87	0	0.1	95.8
				aHydrocarbons / cW&Ener / aW&Ener / Cap / HH / cMetalSteelMecelectric / aMetalSteelMecelectric	0	1.68	0	0.1	95.9
				aHydrocarbons / Cap / HH / cAgroFood / aAgroFood / cAgri / aAgri / cMetalSteelMecelectric / aMetalSteelMecelectric	0	2.0054	0	0.1	96.0

Table II.4: Continued

Case	Origin	Dest.	Global infl.	Path	Direct infl.	Path mult.	Total infl.	Prop. (in %)	Accum. Prop.
XI	aHydrocarbons	aTextiles	0.018	aHydrocarbons / Cap / HH / cTextiles / aTextiles	0.003	1.89	0.005	77.9	77.9
				aHydrocarbons / Lab / HH / cTextiles / aTextiles	0.000	1.89	0.000	5.4	83.3
				aHydrocarbons / cTrans&comms / aTrans&comms / Cap / HH / cTextiles / aTextiles	0.000	2.08	0.000	3.0	86.4
				aHydrocarbons / cTextiles / aTextiles	0.000	1.46	0.000	2.9	89.3
				aHydrocarbons / cTrans&comms / aTrans&comms / Lab / HH / cTextiles / aTextiles	0.000	2.08	8.59E-05	1.4	90.6
				aHydrocarbons / cShops / aShops / Cap / HH / cTextiles / aTextiles	0.000	1.91	7.38E-05	1.2	91.8
				aHydrocarbons / cServicestoCo / aServicestoCo / Lab / HH / cTextiles / aTextiles	0.000	1.91	5.03E-05	0.8	92.6
				aHydrocarbons / cServicestoCo / aServicestoCo / Cap / HH / cTextiles / aTextiles	0.000	1.91	4.41E-05	0.7	93.3
				aHydrocarbons / cPW&PetroServ / aPW&PetroServ / Lab / HH / cTextiles / aTextiles	0.000	1.98	4.41E-05	0.7	94.0
				aHydrocarbons / cPW&PetroServ / aPW&PetroServ / Cap / HH / cTextiles / aTextiles	0.000	1.98	2.84E-05	0.4	94.5
				aHydrocarbons / Cap / Ent / HH / cTextiles / aTextiles	0.000	1.90	2.21E-05	0.3	94.8
				aHydrocarbons / cShops / aShops / Lab / HH / cTextiles / aTextiles	0.000	1.91	1.96E-05	0.3	95.1
				aHydrocarbons / cTrans&comms / aTrans&comms / cTextiles / aTextiles	0.000	1.70	1.51E-05	0.2	95.4
				aHydrocarbons / cAgroFood / aAgroFood / Cap / HH / cTextiles / aTextiles	0.000	2.14	1.47E-05	0.2	95.6
				aHydrocarbons / cPW&PetroServ / aPW&PetroServ / cTextiles / aTextiles	0.000	1.53	1.38E-05	0.2	95.8
				aHydrocarbons / cW&Ener / aW&Ener / Cap / HH / cTextiles / aTextiles	0.000	1.93	1.29E-05	0.2	96.0
				aHydrocarbons / Cap / HH / cTrans&comms / aTrans&comms / cTextiles / aTextiles	0.000	2.08	1.24E-05	0.2	96.2
				aHydrocarbons / cAgroFood / aAgroFood / cAgri / aAgri / Cap / HH / cTextiles / aTextiles	0.000	2.30	1.12E-05	0.2	96.4
				aHydrocarbons / cBuild&civil / aBuild&civil / Lab / HH / cTextiles / aTextiles	0.000	1.90	9.10E-06	0.1	96.5
				aHydrocarbons / cBuildingM / aBuildingM / Lab / HH / cTextiles / aTextiles	0.000	1.91	8.92E-06	0.1	96.7
				aHydrocarbons / cW&Ener / aW&Ener / Lab / HH / cTextiles / aTextiles	0.000	1.93	8.16E-06	0.1	96.8
				aHydrocarbons / Cap / HH / cServicestoHH / aServicestoHH / cTextiles / aTextiles	0.000	1.89	7.97E-06	0.1	96.9

Table II.4: Continued

Case	Origin	Dest.	Global infl.	Path	Direct infl.	Path mult.	Total infl.	Prop. (in %)	Accum. Prop.
				aHydrocarbons / Cap / HH / cShops / aShops / cTextiles / aTextiles	3.88E-06	1.91	7.41E-06	0.1	97.0
				aHydrocarbons / Cap / HH / cWoodcorkpaper / aWoodcorkpaper / cTextiles / aTextiles	3.37E-06	2.01	6.77E-06	0.1	97.2
				aHydrocarbons / cPW&PetroServ / aPW&PetroServ / cTrans&comms / aTrans&comms / Cap / HH / cTextiles / aTextiles	2.60E-06	2.18	5.68E-06	0.1	97.2
				aHydrocarbons / cBuildingM / aBuildingM / Cap / HH / cTextiles / aTextiles	2.96E-06	1.91	5.65E-06	0.1	97.3
				aHydrocarbons / cTrans&comms / aTrans&comms / cAgri / aAgri / Cap / HH / cTextiles / aTextiles	2.40E-06	2.26	5.42E-06	0.1	97.4
				aHydrocarbons / cBuild&civil / aBuild&civil / cTextiles / aTextiles	3.66E-06	1.46	5.35E-06	0.1	97.5
				aHydrocarbons / cBuild&civil / aBuild&civil / Cap / HH / cTextiles / aTextiles	2.81E-06	1.90	5.33E-06	0.1	97.6
				aHydrocarbons / cShops / aShops / cTrans&comms / aTrans&comms / Cap / HH / cTextiles / aTextiles	2.50E-06	2.09	5.23E-06	0.1	97.7
				aHydrocarbons / cHydrocarbons / HH / cTextiles / aTextiles	2.57E-06	1.89	4.87E-06	0.1	97.7
				aHydrocarbons / cMetalSteelMecelectric / aMetalSteelMecelectric / Lab / HH / cTextiles / aTextiles	2.41E-06	1.95	4.68E-06	0.1	97.8
				aHydrocarbons / Cap / HH / cLeather&Shoes / aLeather&Shoes / cTextiles / aTextiles	2.08E-06	2.24	4.64E-06	0.1	97.9
				aHydrocarbons / Cap / HH / cChemRubberPlastic / aChemRubberPlastic / cTextiles / aTextiles	2.28E-06	1.98	4.51E-06	0.1	98.0
				aHydrocarbons / cAgroFood / aAgroFood / Lab / HH / cTextiles / aTextiles	2.10E-06	2.14	4.50E-06	0.1	98.0
				aHydrocarbons / cTrans&comms / aTrans&comms / cShops / aShops / Cap / HH / cTextiles / aTextiles	2.12E-06	2.09	4.44E-06	0.1	98.1
				aHydrocarbons / cAgroFood / aAgroFood / cAgri / aAgri / Lab / HH / cTextiles / aTextiles	1.48E-06	2.30	3.40E-06	0.1	98.2
				aHydrocarbons / Cap / HH / cAgroFood / aAgroFood / cWoodcorkpaper / aWoodcorkpaper / cTextiles / aTextiles	1.44E-06	2.27	3.26E-06	0.1	98.2
				aHydrocarbons / cWoodcorkpaper / aWoodcorkpaper / cTextiles / aTextiles	2.01E-06	1.55	3.11E-06	0.0	98.3
				aHydrocarbons / cTrans&comms / aTrans&comms / cServicestoCo / aServicestoCo / Lab / HH / cTextiles / aTextiles	1.26E-06	2.10	2.65E-06	0.0	98.3
				aHydrocarbons / cPW&PetroServ / aPW&PetroServ / cShops / aShops / Cap / HH / cTextiles / aTextiles	1.27E-06	2.00	2.55E-06	0.0	98.3
				aHydrocarbons / cPW&PetroServ / aPW&PetroServ / cTrans&comms / aTrans&comms / Lab / HH / cTextiles / aTextiles	1.16E-06	2.18	2.54E-06	0.0	98.4

Table II.4: Continued

Case	Origin	Dest.	Global infl.	Path	Direct infl.	Path mult.	Total infl.	Prop. (in %)	Accum. Prop.
				aHydrocarbons / cShops / aShops / cTextiles / aTextiles	1.53E-06	1.58	2.42E-06	0.0	98.4
				aHydrocarbons / cShops / aShops / cTrans&comms / aTrans&comms / Lab / HH / cTextiles / aTextiles	1.12E-06	2.09	2.34E-06	0.0	98.5
				aHydrocarbons / cTrans&comms / aTrans&comms / cServicestoCo / aServicestoCo / Cap / HH / cTextiles / aTextiles	1.10E-06	2.10	2.32E-06	0.0	98.5
				aHydrocarbons / cTrans&comms / aTrans&comms / cServicestoHH / aServicestoHH / Cap / HH / cTextiles / aTextiles	1.08E-06	2.08	2.26E-06	0.0	98.5
				aHydrocarbons / cMetalSteelMecelectric / aMetalSteelMecelectric / Cap / HH / cTextiles / aTextiles	1.06E-06	1.95	2.06E-06	0.0	98.6
				aHydrocarbons / cTrans&comms / aTrans&comms / cHotels&Restaur / aHotels&Restaur / Cap / HH / cTextiles / aTextiles	9.54E-07	2.09	1.99E-06	0.0	98.6
				aHydrocarbons / cServicestoCo / aServicestoCo / cW&Ener / aW&Ener / Cap / HH / cTextiles / aTextiles	9.77E-07	1.95	1.91E-06	0.0	98.6
				aHydrocarbons / cTrans&comms / aTrans&comms / cAgri / aAgri / Lab / HH / cTextiles / aTextiles	7.33E-07	2.26	1.65E-06	0.0	98.7
				aHydrocarbons / cHotels&Restaur / aHotels&Restaur / Cap / HH / cTextiles / aTextiles	8.61E-07	1.90	1.63E-06	0.0	98.7
				aHydrocarbons / Cap / HH / cAgroFood / aAgroFood / cTextiles / aTextiles	7.23E-07	2.14	1.55E-06	0.0	98.7
				aHydrocarbons / cPW&PetroServ / aPW&PetroServ / cServicestoCo / aServicestoCo / Lab / HH / cTextiles / aTextiles	7.60E-07	2.00	1.52E-06	0.0	98.7
				aHydrocarbons / cPW&PetroServ / aPW&PetroServ / cAgri / aAgri / Cap / HH / cTextiles / aTextiles	6.85E-07	2.15	1.47E-06	0.0	98.8
				aHydrocarbons / cServicestoCo / aServicestoCo / cTextiles / aTextiles	9.63E-07	1.48	1.42E-06	0.0	98.8
				aHydrocarbons / cPW&PetroServ / aPW&PetroServ / cServicestoCo / aServicestoCo / Cap / HH / cTextiles / aTextiles	6.66E-07	2.00	1.34E-06	0.0	98.8
				aHydrocarbons / cAgroFood / aAgroFood / cShops / aShops / Cap / HH / cTextiles / aTextiles	5.99E-07	2.16	1.29E-06	0.0	98.8
				aHydrocarbons / Cap / HH / cShops / aShops / cTrans&comms / aTrans&comms / cTextiles / aTextiles	6.07E-07	2.09	1.27E-06	0.0	98.8
				aHydrocarbons / Cap / HH / cBuild&civil / aBuild&civil / cTextiles / aTextiles	6.66E-07	1.90	1.26E-06	0.0	98.9
				aHydrocarbons / cServicestoCo / aServicestoCo / cW&Ener / aW&Ener / Lab / HH / cTextiles / aTextiles	6.18E-07	1.95	1.21E-06	0.0	98.9
				aHydrocarbons / cTrans&comms / aTrans&comms / cShops / aShops / Lab / HH / cTextiles / aTextiles	5.63E-07	2.09	1.18E-06	0.0	98.9

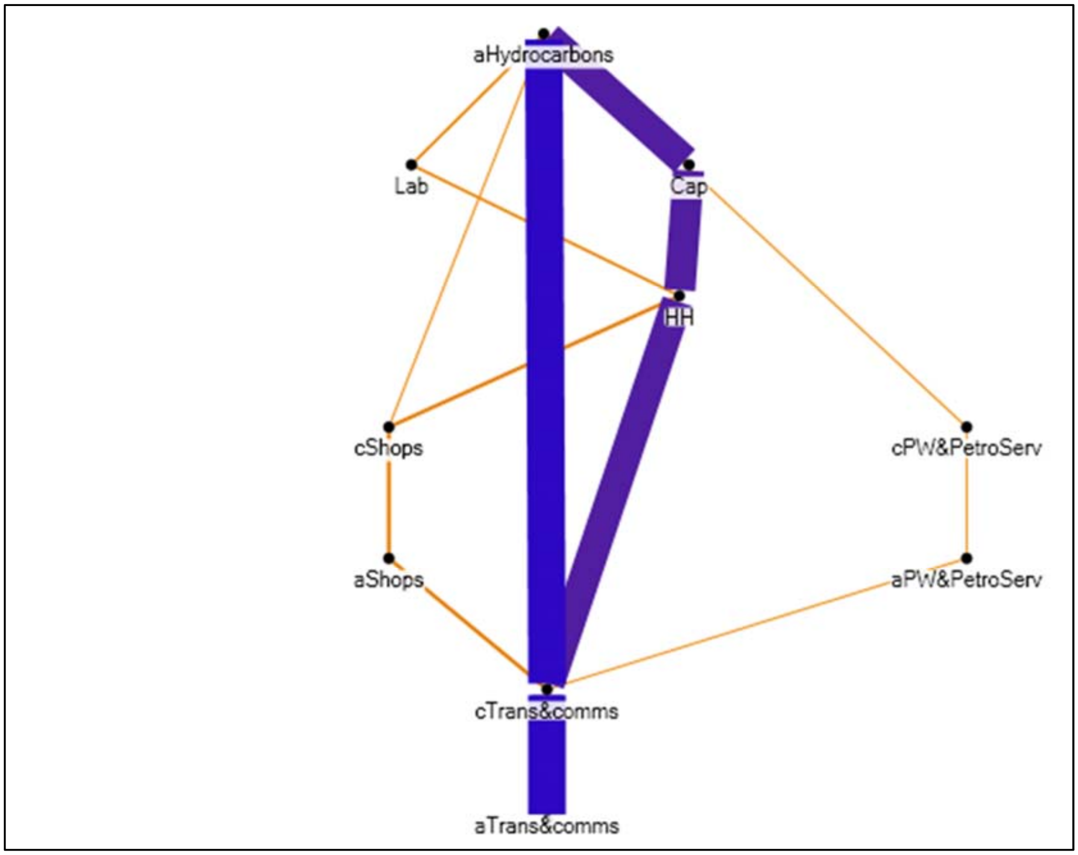
Table II.4: Continued

Case	Origin	Dest.	Global infl.	Path	Direct infl.	Path mult.	Total infl.	Prop. (in %)	Accum. Prop.
				aHydrocarbons / cBuild&civil / aBuild&civil / cShops / aShops / Cap / HH / cTextiles / aTextiles	6.00E-07	1.91	1.15E-06	0.0	98.9
				aHydrocarbons / cTrans&comms / aTrans&comms / cWoodcorkpaper / aWoodcorkpaper / cTextiles / aTextiles	6.08E-07	1.81	1.10E-06	0.0	98.9
				aHydrocarbons / cChemRubberPlastic / aChemRubberPlastic / Lab / HH / cTextiles / aTextiles	5.35E-07	1.98	1.06E-06	0.0	98.9
				aHydrocarbons / cTrans&comms / aTrans&comms / cHotels&Restaur / aHotels&Restaur / Lab / HH / cTextiles / aTextiles	5.06E-07	2.09	1.06E-06	0.0	99.0
				aHydrocarbons / cTrans&comms / aTrans&comms / cServicestoHH / aServicestoHH / Lab / HH / cTextiles / aTextiles	4.90E-07	2.08	1.02E-06	0.0	99.0
				aHydrocarbons / cWoodcorkpaper / aWoodcorkpaper / Lab / HH / cTextiles / aTextiles	5.07E-07	2.01	1.02E-06	0.0	99.0
				aHydrocarbons / Cap / HH / cAgri / aAgri / cTextiles / aTextiles	4.40E-07	2.05	9.03E-07	0.0	99.0
				aHydrocarbons / Cap / HH / cTrans&comms / aTrans&comms / cWoodcorkpaper / aWoodcorkpaper / cTextiles / aTextiles	4.08E-07	2.21	9.00E-07	0.0	99.0
				aHydrocarbons / cHotels&Restaur / aHotels&Restaur / Lab / HH / cTextiles / aTextiles	4.57E-07	1.90	8.67E-07	0.0	99.0
				aHydrocarbons / cTrans&comms / aTrans&comms / Cap / Ent / HH / cTextiles / aTextiles	4.14E-07	2.09	8.64E-07	0.0	99.1
				aHydrocarbons / Lab / HH / cTrans&comms / aTrans&comms / cTextiles / aTextiles	4.11E-07	2.08	8.57E-07	0.0	99.1
				aHydrocarbons / cChemRubberPlastic / aChemRubberPlastic / cTextiles / aTextiles	5.39E-07	1.53	8.24E-07	0.0	99.1
				aHydrocarbons / cTrans&comms / aTrans&comms / cW&Ener / aW&Ener / Cap / HH / cTextiles / aTextiles	3.79E-07	2.13	8.07E-07	0.0	99.1
				aHydrocarbons / Cap / HH / cShops / aShops / cWoodcorkpaper / aWoodcorkpaper / cTextiles / aTextiles	3.80E-07	2.02	7.68E-07	0.0	99.1
				aHydrocarbons / cServicestoCo / aServicestoCo / cWoodcorkpaper / aWoodcorkpaper / cTextiles / aTextiles	4.76E-07	1.56	7.45E-07	0.0	99.1

Table II.4: Continued

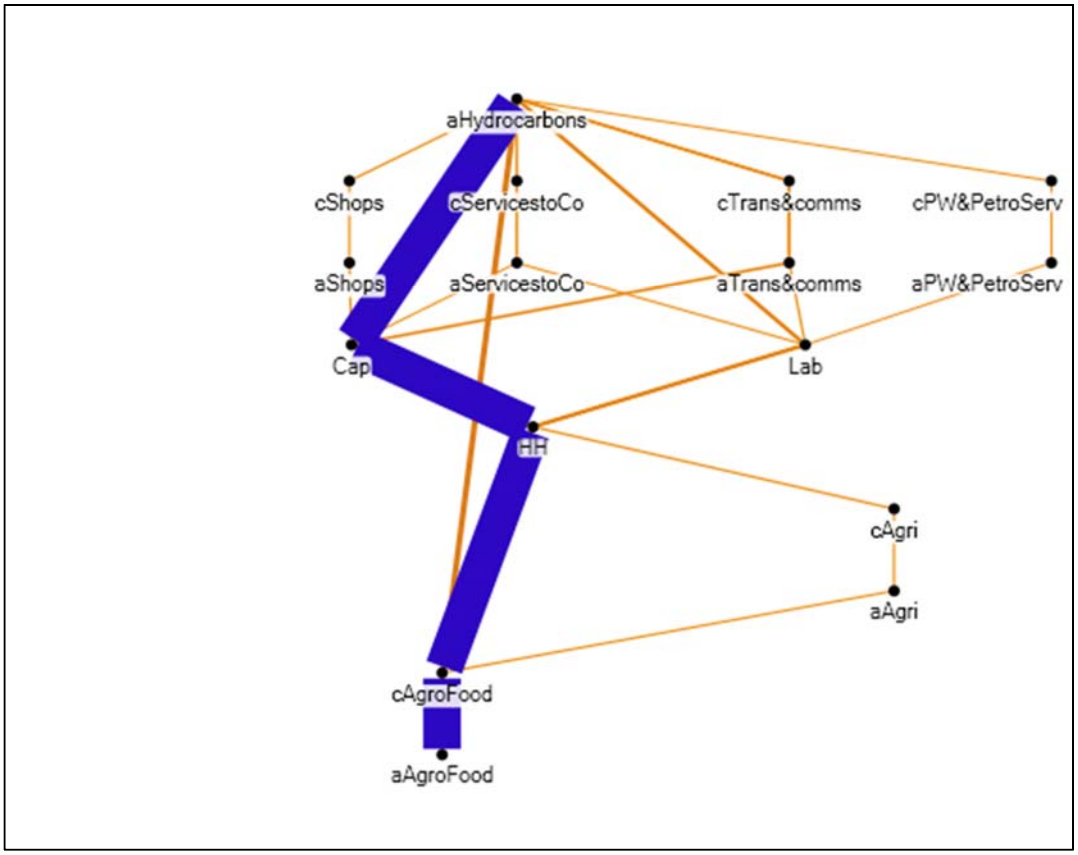
Case	Origin	Dest.	Global infl.	Path	Direct infl.	Path mult.	Total infl.	Prop. (in %)	Accum. Prop.
				aHydrocarbons / cChemRubberPlastic / aChemRubberPlastic / Cap / HH / cTextiles / aTextiles	3.73E-07	1.98	7.38E-07	0.0	99.1
				aHydrocarbons / cTrans&comms / aTrans&comms / cMetalSteelMecelectric / aMetalSteelMecelectric / Lab / HH / cTextiles / aTextiles	3.31E-07	2.14	7.08E-07	0.0	99.1
				aHydrocarbons / cMetalSteelMecelectric / aMetalSteelMecelectric / cShops / aShops / Cap / HH / cTextiles / aTextiles	3.55E-07	1.96	6.97E-07	0.0	99.1
				aHydrocarbons / Cap / HH / cMetalSteelMecelectric / aMetalSteelMecelectric / cTextiles / aTextiles	3.52E-07	1.95	6.85E-07	0.0	99.2
				aHydrocarbons / cServicestoCo / aServicestoCo / cShops / aShops / Cap / HH / cTextiles / aTextiles	3.54E-07	1.93	6.82E-07	0.0	99.2
				aHydrocarbons / cPW&PetroServ / aPW&PetroServ / cAgroFood / aAgroFood / Cap / HH / cTextiles / aTextiles	3.02E-07	2.24	6.77E-07	0.0	99.2
				aHydrocarbons / cPW&PetroServ / aPW&PetroServ / cShops / aShops / Lab / HH / cTextiles / aTextiles	3.38E-07	2.00	6.76E-07	0.0	99.2
				aHydrocarbons / cServicestoCo / aServicestoCo / cTrans&comms / aTrans&comms / Cap / HH / cTextiles / aTextiles	3.15E-07	2.10	6.63E-07	0.0	99.2
				aHydrocarbons / cBuildingM / aBuildingM / cTextiles / aTextiles	4.50E-07	1.47	6.63E-07	0.0	99.2

Figure II.1: Production Activities – Case I



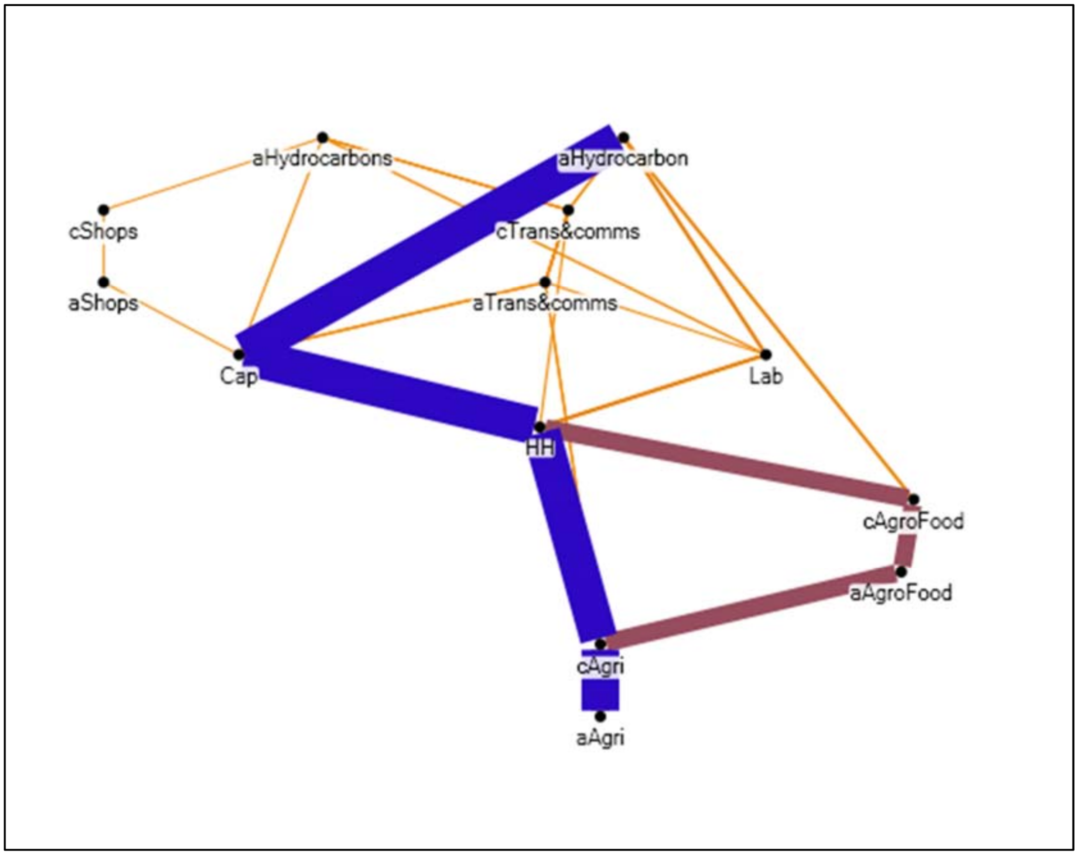
Note: Figure created using the weighted graph scheme of NodeXL. Paths depicted explain 93% of the accounting multiplier.

Figure II.2: Production Activities – Case II



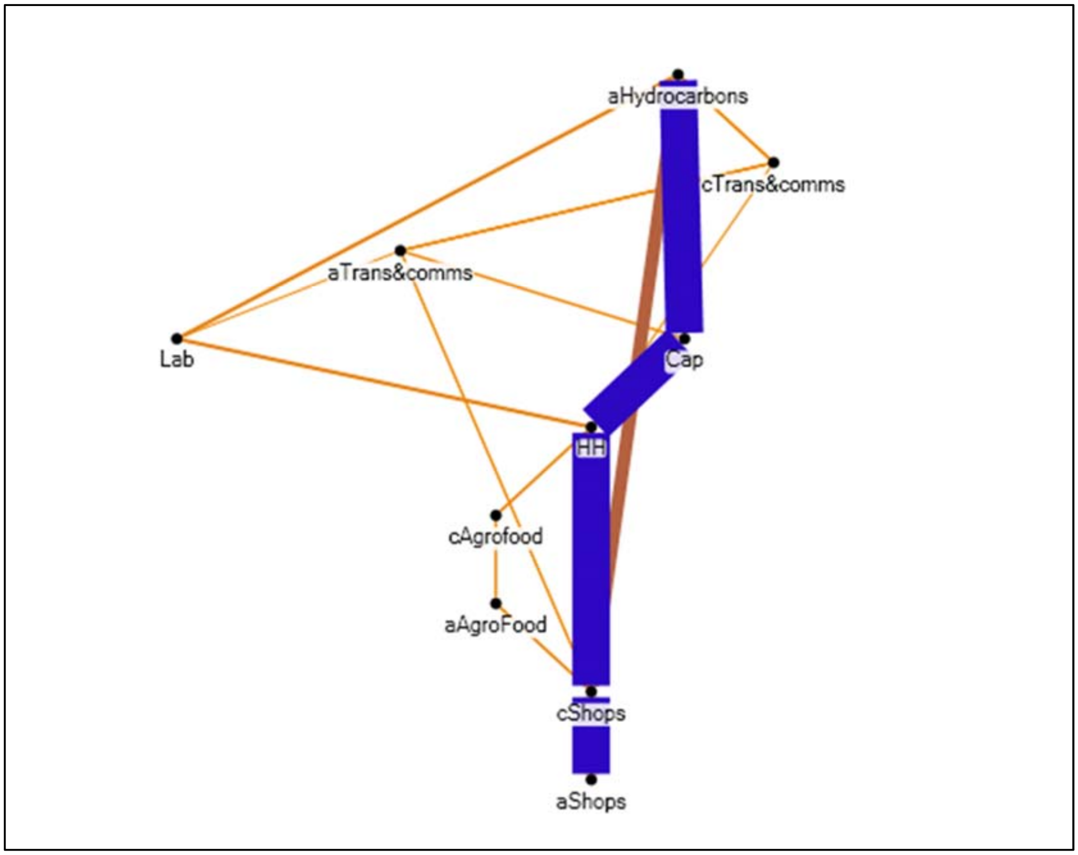
Note: Figure created using the weighted graph scheme of NodeXL. Paths depicted explain 95% of the accounting multiplier.

Figure II.3: Production Activities – Case III



Note: Figure created using the weighted graph scheme of NodeXL. Paths depicted explain 90% of the accounting multiplier.

Figure II.4: Production Activities – Case IV

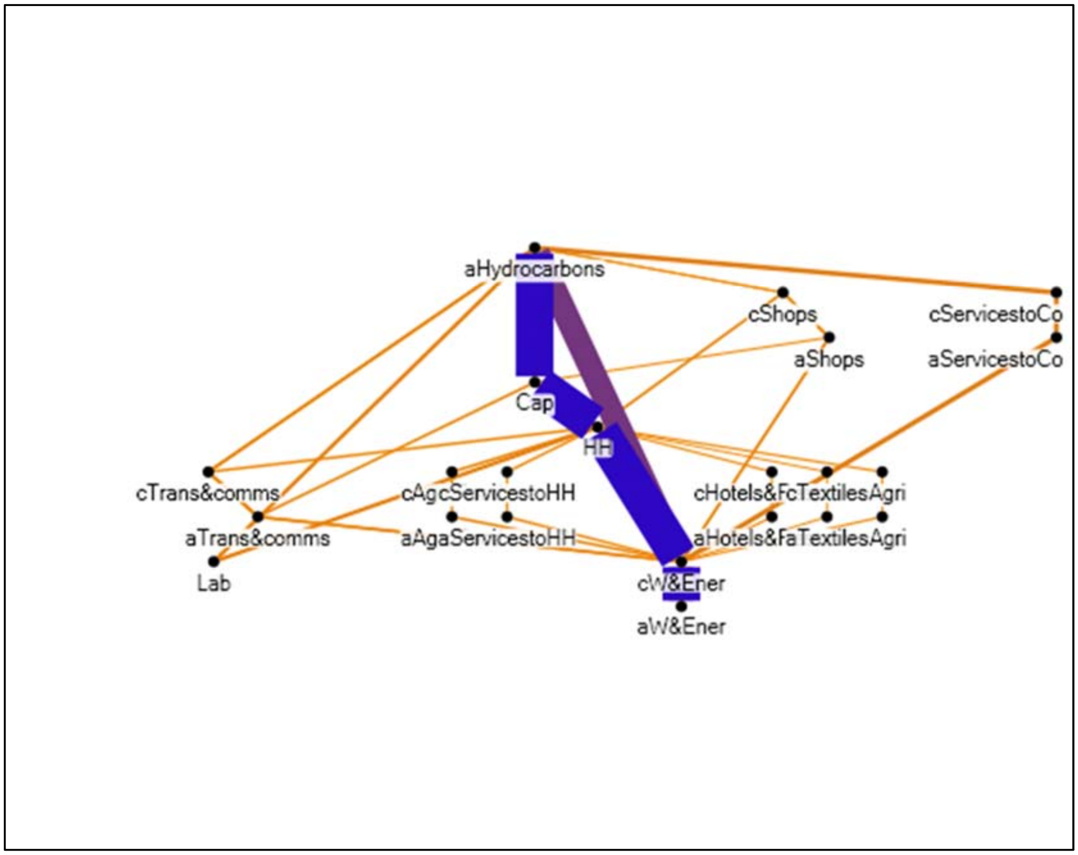


Note: Figure created using the weighted graph scheme of NodeXL. Paths depicted explain 90% of the accounting multiplier.

Figure II.5: Production Activities – Case V

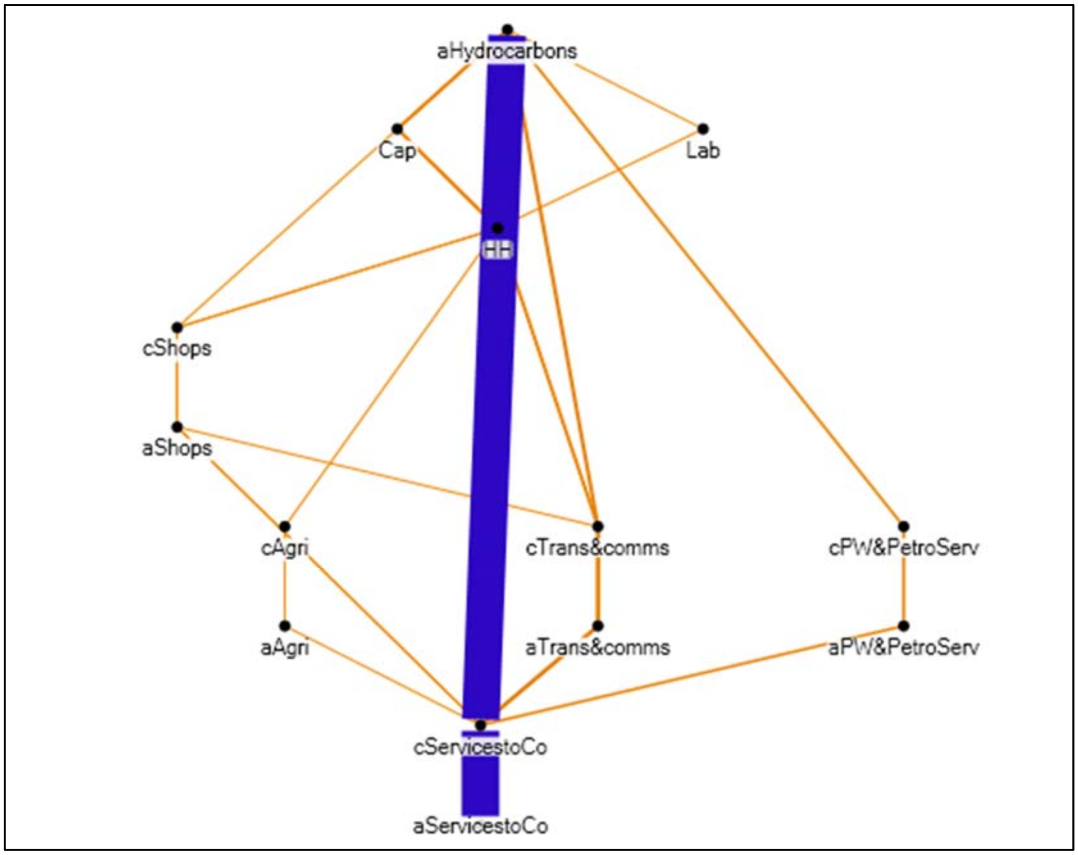
Note: Figure created using the weighted graph scheme of NodeXL. Paths depicted explain 90% of the accounting multiplier.

Figure II.6: Production Activities – Case VI



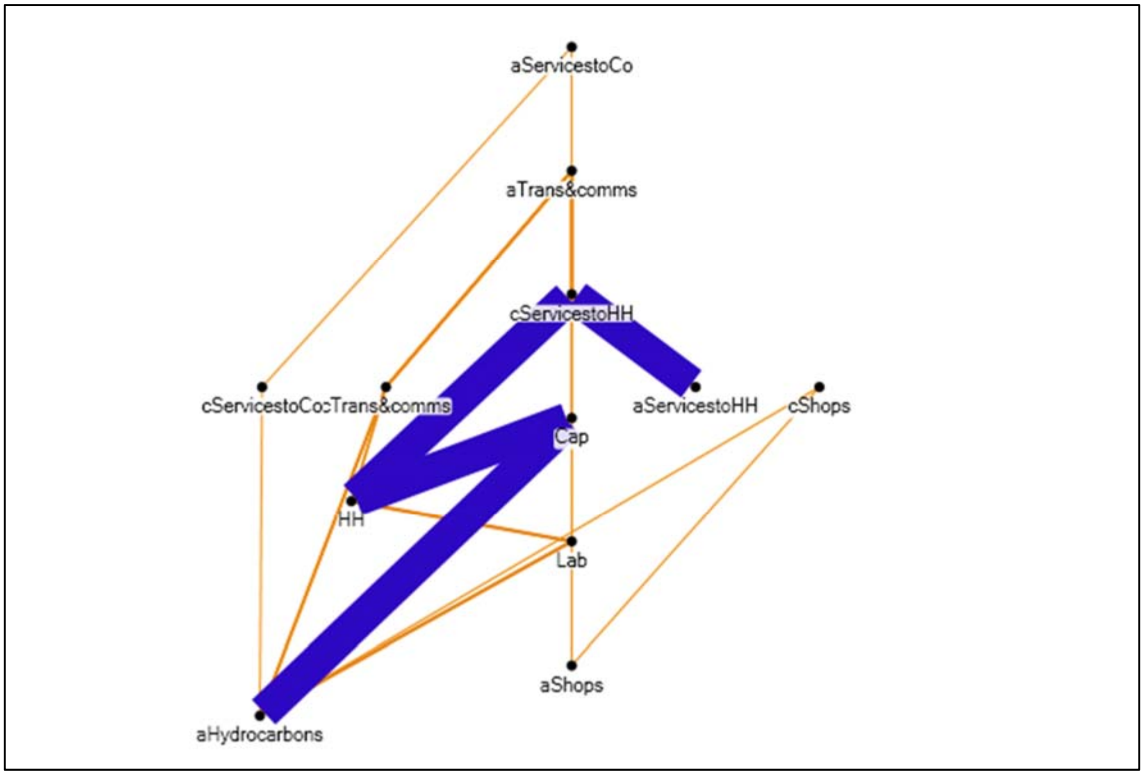
Note: Figure created using the weighted graph scheme of NodeXL. Paths depicted explain 99% of the accounting multiplier.

Figure II.7: Production Activities – Case VII



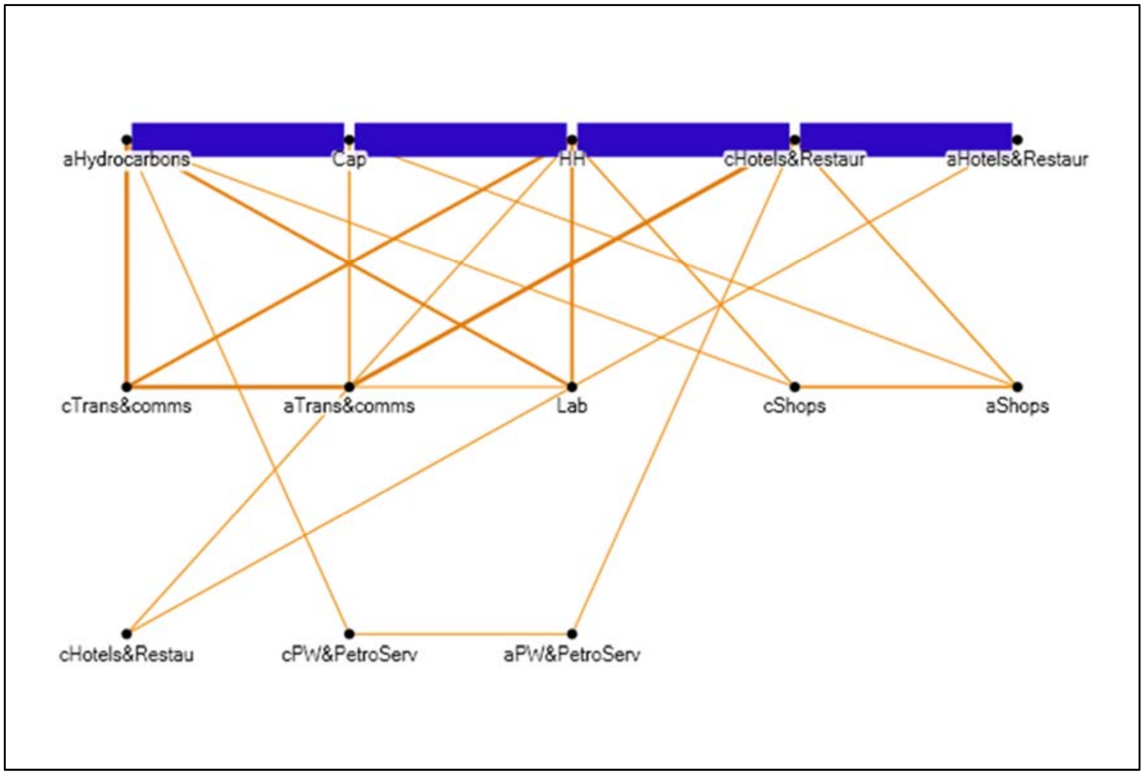
Note: Figure created using the weighted graph scheme of NodeXL. Paths depicted explain 98% of the accounting multiplier.

Figure II.8: Production Activities – Case VIII



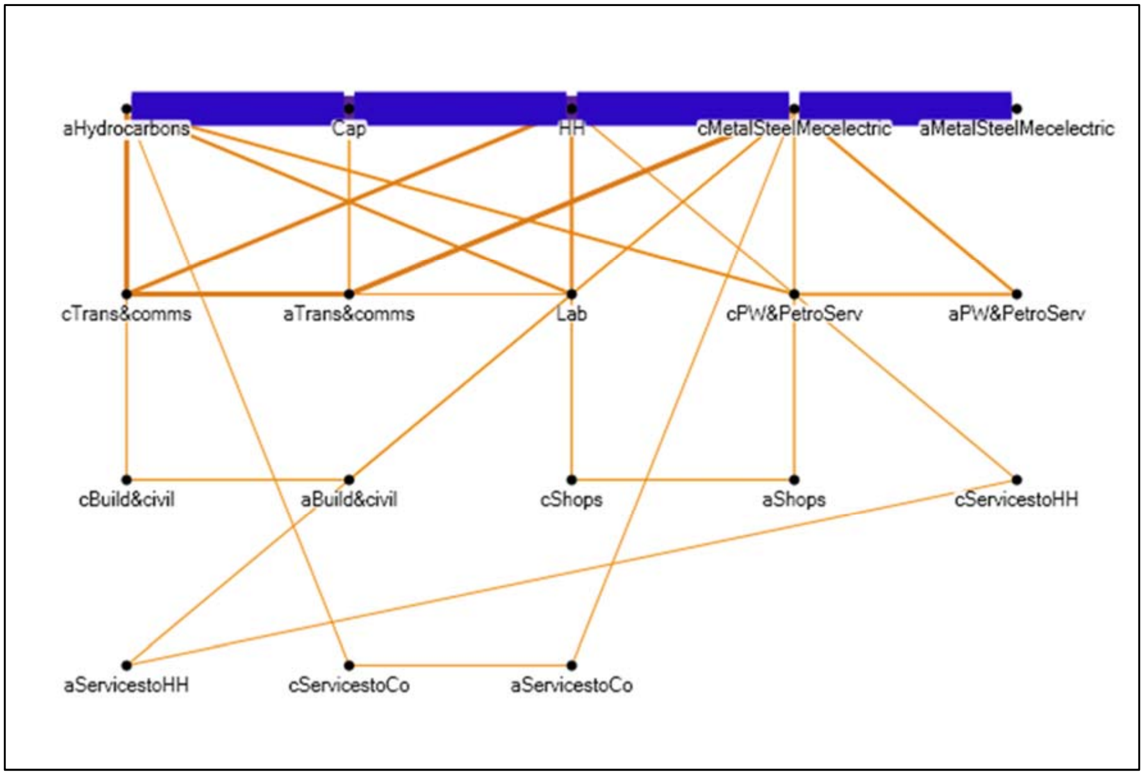
Note: Figure created using the weighted graph scheme of NodeXL. Paths depicted explain 93% of the accounting multiplier.

Figure II.9: Production Activities – Case IX



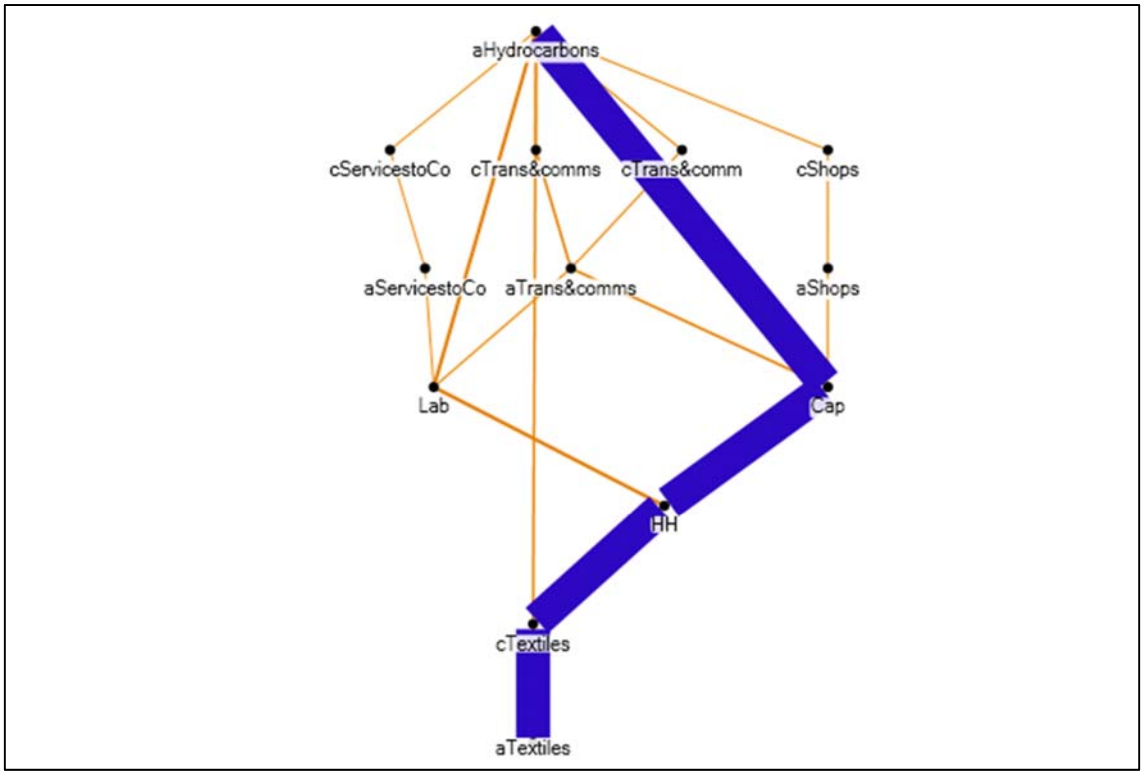
Note: Figure created using the weighted graph scheme of NodeXL. Paths depicted explain 90% of the accounting multiplier.

Figure II.10: Production Activities – Case X



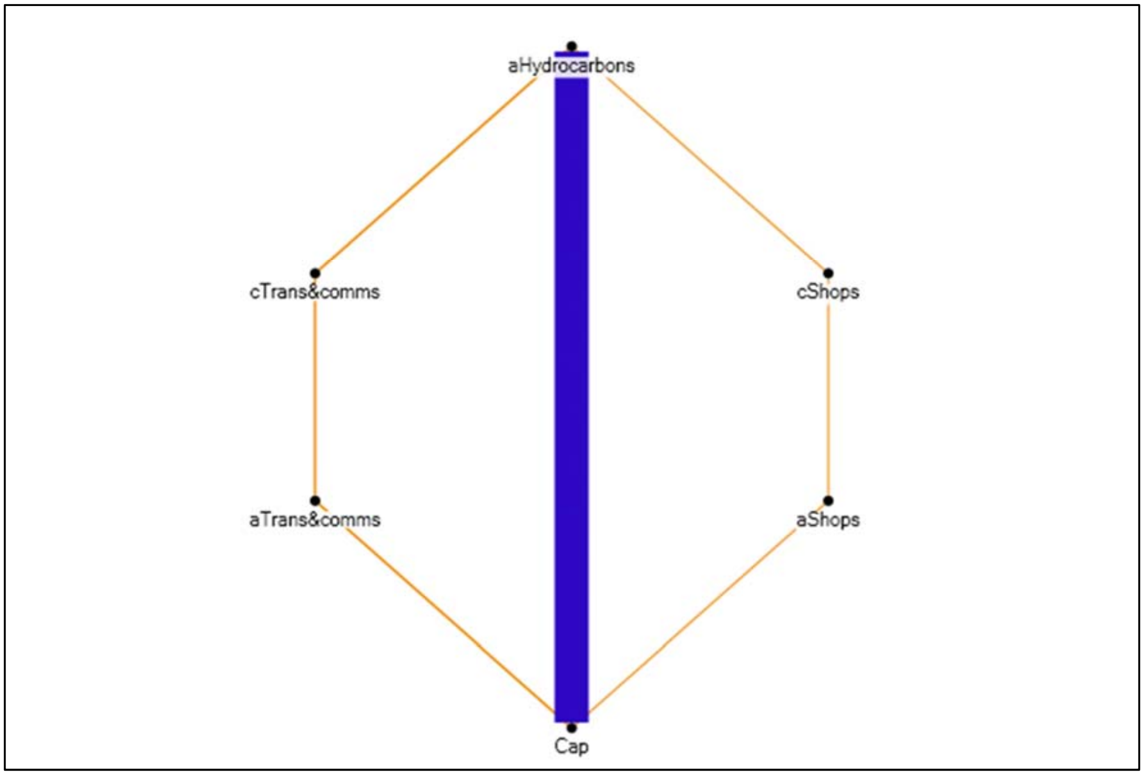
Note: Figure created using the weighted graph scheme of NodeXL. Paths depicted explain 90% of the accounting multiplier.

Figure II.11: Production Activities – Case XI



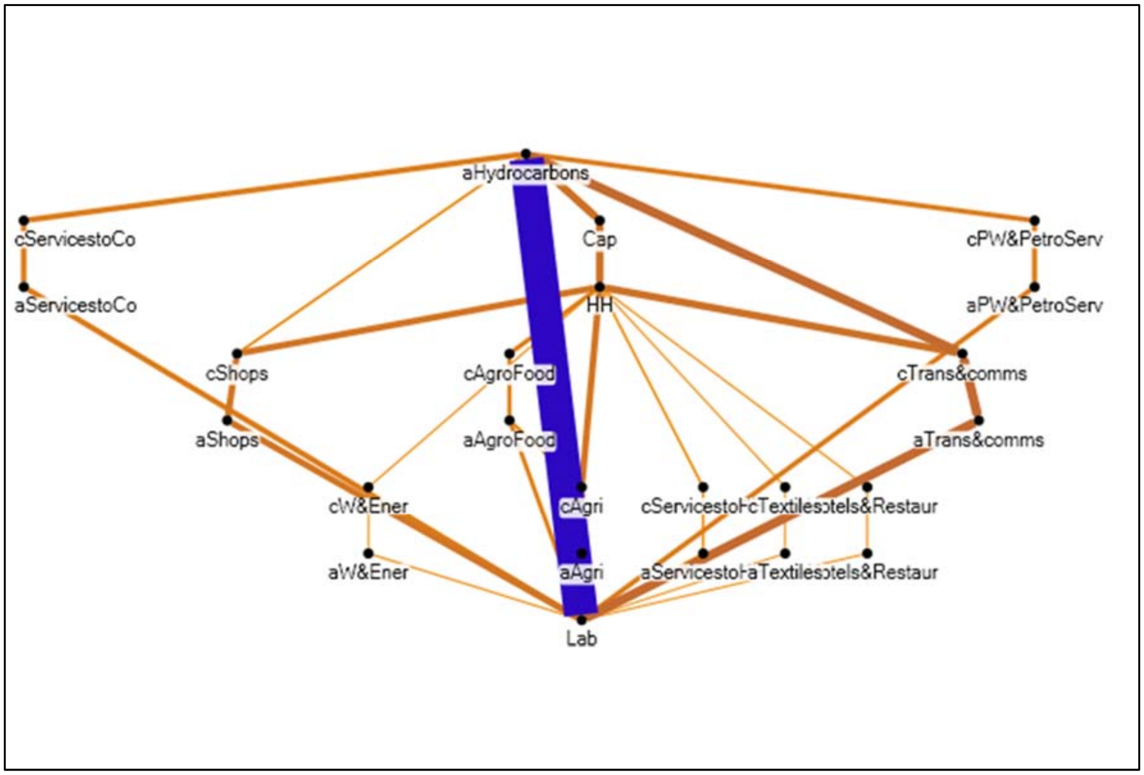
Note: Figure created using the weighted graph scheme of NodeXL. Paths depicted explain 93% of the accounting multiplier.

Figure II.12: Factors – Case I (Capital)



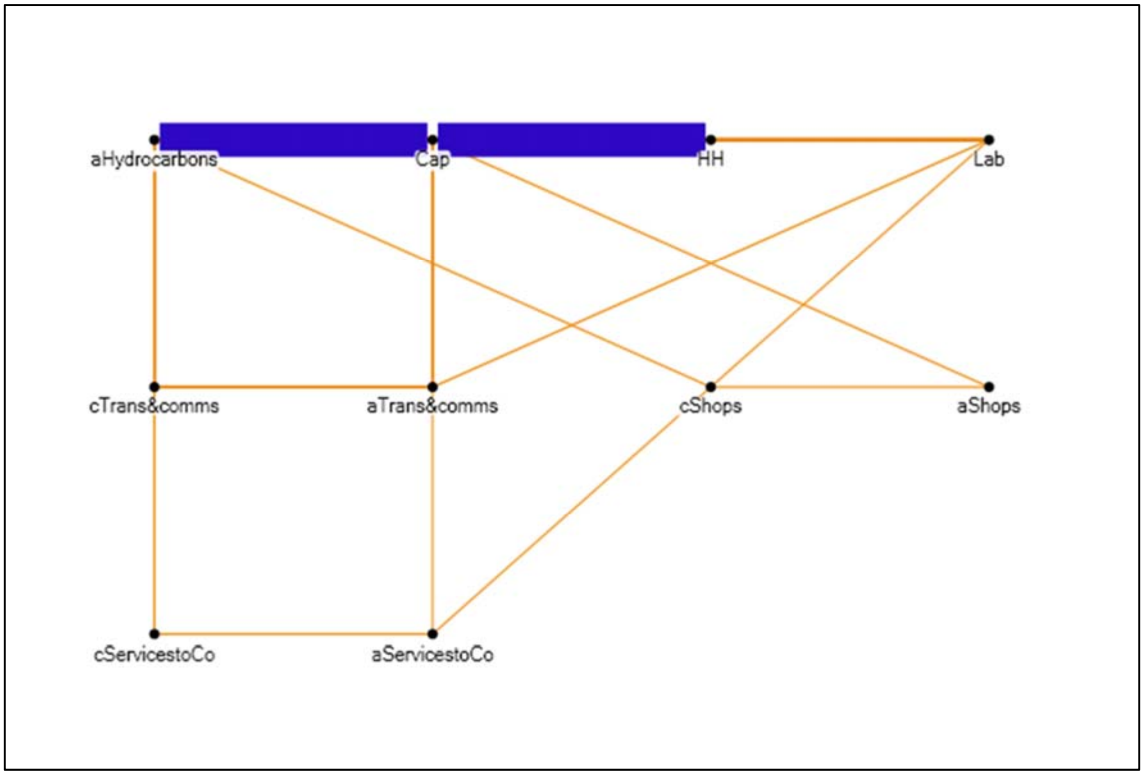
Note: Figure created using the weighted graph scheme of NodeXL. Paths depicted explain 95% of the accounting multiplier.

Figure II.13: Factors – Case II (Labour)



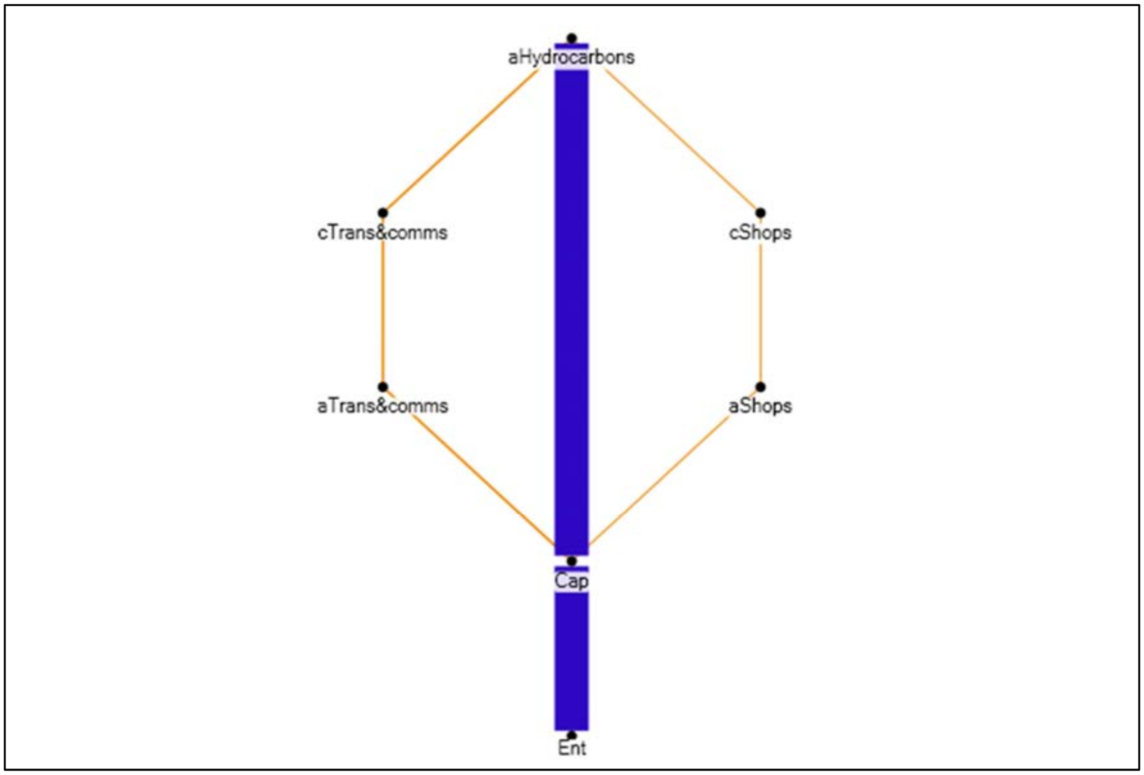
Note: Figure created using the weighted graph scheme of NodeXL. Paths depicted explain 85% of the accounting multiplier.

Figure II.14: Institutions – Case I (Households)



Note: Figure created using the weighted graph scheme of NodeXL. Paths depicted explain 95% of the accounting multiplier.

Figure II.15: Institutions – Case II (Enterprises)



Note: Figure created using the weighted graph scheme of NodeXL. Paths depicted explain 94% of the accounting multiplier.

Appendix III: Chad

This appendix lays the foundation for the analysis in Chapter 5. Tables III.1 summarises the macro structure of the Chad SAM used for the multiplier and SPA analysis in Chapter 5. Table III.2 and III.3 give the SAM account (activities and commodities) abbreviations and their corresponding names. Table III.4 provides the detailed results from the SPA performed in Chapter 5. Figure III.1 to III.13 are a graphical representation of the SPA results from Chapter 5.

Table III.1: Macro Social Accounting Matrix for Chad (2000)

Receipts \ Payments	Activities	Commodities	Land	Capital	Labour	Enterprises	Households	Government	Capital account	Rest of the world	Residual	Total
Activities		1 578.6									0.2	**1 578.8**
Commodities	623.0	185.7				207.5	676.4	77.6	221.1	197.0	-385.9	**1 802.4**
Land	80.0										0.1	**80.1**
Capital	293.6										0.1	**293.7**
Labour	580.5										-0.3	**580.2**
Enterprises			35.6	204.9				0.9				**241.4**
Households			44.5	51.0	580.2		66.4	12.0	14.4	4.6	0.2	**773.3**
Government	1.7	38.1		8.3		14.0	23.8			24.6	-0.4	**110.1**
Capital account						19.9	6.7	10.7		198.2		**235.5**
Rest of the world				29.5				8.9			386.0	**424.4**
Residual												
Total	**1 578.8**	**1 802.4**	**80.1**	**293.7**	**580.2**	**241.4**	**773.3**	**110.1**	**235.5**	**424.4**	**0.0**	**6 119.9**

Note: *Subgroups for the factors, capital and labour, have been aggregated into the capital and labour factors respectively. Furthermore, subgroups for households and the capital account (savings and investment) have also been aggregated into the repsective household and capital accounts.*

Table III.2: Chad SAM accounts: Activities

Account Number	Code	Description
1	a_ag	Non-Cotton Agriculture
2	a_agcot	Cotton Agriculture
3	a_live	Livestock
4	a_fish	Forestry, Fishing, (Non-Oil) Mining
5	a_man	Non-Cotton, Non-Oil Formal Manufacturing
6	a_cot	Cotton Fiber Manufacturing
7	a_dev	Oil Field Development
8	a_con	Informal Manufacturing
9	a_inf	Construction and Public Works
10	a_serv	Services
11	a_gov	Public Administration

Table III.3: Chad SAM accounts: Commodities

Account Number	Code	Description
1	c_ag	Non-Cotton Agriculture
2	c_agcot	Cotton Agriculture
3	c_live	Livestock
4	c_fish	Forestry, Fishing, (Non-Oil) Mining
5	c_man	Non-Cotton, Non-Oil Formal Manufacturing
6	c_cot	Cotton Fiber Manufacturing
7	c_dev	Oil Field Development
8	c_con	Informal Manufacturing
9	c_inf	Construction and Public Works
10	c_serv	Services
11	c_gov	Public Administration

Table III.4: SPA for selected activites: Chad (CASE I TO XIII)

Case	Origin	Dest.	Global infl.	Path	Direct infl.	Path mult.	Total infl.	Prop. (in %)	Accum. Prop.
I	a_dev	a_serv	5.17	a_dev / c_serv / a_serv	0.438	5.77	2.524	48.8	48.8
				a_dev / c_man / c_serv / a_serv	0.082	8.55	0.698	13.5	62.3
				a_dev / f_capital / h_ent / c_serv / a_serv	0.051	5.87	0.301	5.8	68.1
				a_dev / c_con / a_con / c_man / c_serv / a_serv	0.027	8.64	0.237	4.6	72.7
				a_dev / c_con / a_con / c_serv / a_serv	0.040	5.84	0.233	4.5	77.2
				a_dev / c_con / a_con / f_capital / h_ent / c_serv / a_serv	0.017	5.95	0.102	2.0	79.2
				a_dev / c_man / a_man / f_capital / h_ent / c_serv / a_serv	0.009	8.62	0.075	1.4	80.7
				a_dev / c_man / a_man / c_live / a_live / f_labour / households / c_serv / a_serv	0.005	13.67	0.070	1.4	82.0
				a_dev / c_con / a_con / c_fish / c_serv / a_serv	0.009	6.30	0.059	1.1	83.2
				a_dev / f_labour / households / c_serv / a_serv	0.005	10.86	0.054	1.0	84.2
II	a_dev	a_man	1.90	a_dev / c_man / a_man	0.121	4.20	0.508	26.8	26.8
				a_dev / c_serv / a_serv / c_man / a_man	0.050	8.55	0.430	22.6	49.4
				a_dev / c_serv / a_serv / f_labour / households / c_man / a_man	0.014	13.67	0.196	10.3	59.7
				a_dev / c_con / a_con / c_man / a_man	0.041	4.26	0.174	9.1	68.9
				a_dev / c_serv / a_serv / f_capital / households / c_man / a_man	0.004	13.67	0.054	2.9	71.7
				a_dev / f_capital / h_ent / c_serv / a_serv / c_man / a_man	0.006	8.62	0.051	2.7	74.4
				a_dev / c_con / a_con / c_serv / a_serv / c_man / a_man	0.005	8.64	0.040	2.1	76.5
				a_dev / f_labour / households / c_man / a_man	0.005	8.58	0.040	2.1	78.6
				a_dev / c_serv / a_serv / f_labour / households / c_inf / a_inf / c_man / a_man	0.002	15.17	0.035	1.8	80.4
				a_dev / c_con / a_con / c_fish / a_fish / f_labour / households / c_man / a_man	0.004	8.96	0.035	1.8	82.2
				a_dev / c_con / a_con / f_labour / households / c_man / a_man	0.004	8.66	0.032	1.7	83.9
				a_dev / f_capital / households / c_man / a_man	0.002	11.57	0.025	1.3	85.2
				a_dev / f_capital / h_ent / c_serv / a_serv / f_labour / households / c_man / a_man	0.002	13.67	0.023	1.2	86.4
				a_dev / c_serv / a_serv / c_ag / a_ag / f_labour / households / c_man / a_man	0.002	14.45	0.023	1.2	87.6

Table III.4: Continued

Case	Origin	Dest.	Global infl.	Path	Direct infl.	Path mult.	Total infl.	Prop. (in %)	Accum. Prop.
III	a_dev	a_ag	1.21	a_dev / c_serv / a_serv / f_labour / households / c_ag / a_ag	0.022	11.49	0.255	21.1	21.1
				a_dev / c_serv / a_serv / c_ag / a_ag	0.015	8.38	0.125	10.4	31.5
				a_dev / c_serv / a_serv / f_capital / households / c_ag / a_ag	0.006	11.49	0.071	5.9	37.3
				a_dev / c_man / a_man / c_live / a_live / f_labour / households / c_ag / a_ag	0.007	9.23	0.068	5.6	42.9
				a_dev / c_man / c_serv / a_serv / f_labour / households / c_ag / a_ag	0.004	14.45	0.060	5.0	47.9
				a_dev / c_serv / a_serv / c_man / a_man / c_live / a_live / f_labour / households / c_ag / a_ag	0.003	14.45	0.044	3.7	51.5
				a_dev / f_labour / households / c_ag / a_ag	0.007	5.94	0.042	3.5	55.0
				a_dev / c_con / a_con / c_fish / a_fish / f_labour / households / c_ag / a_ag	0.006	6.22	0.037	3.1	58.1
				a_dev / c_con / a_con / f_labour / households / c_ag / a_ag	0.006	6.01	0.034	2.8	60.9
				a_dev / c_man / c_serv / a_serv / c_ag / a_ag	0.003	11.78	0.033	2.7	63.6
				a_dev / f_capital / h_ent / c_serv / a_serv / f_labour / households / c_ag / a_ag	0.003	11.49	0.030	2.5	66.1
				a_dev / f_capital / households / c_ag / a_ag	0.003	8.57	0.028	2.3	68.5
				a_dev / c_con / a_con / c_serv / a_serv / f_labour / households / c_ag / a_ag	0.002	11.60	0.024	1.9	70.4
				a_dev / c_con / a_con / c_man / a_man / c_live / a_live / f_labour / households / c_ag / a_ag	0.002	9.32	0.023	1.9	72.3
				a_dev / c_man / a_man / c_ag / a_ag	0.003	6.70	0.021	1.7	74.0
				a_dev / c_con / a_con / c_man / c_serv / a_serv / f_labour / households / c_ag / a_ag	0.001	14.58	0.020	1.7	75.7
				a_dev / c_man / c_serv / a_serv / f_capital / households / c_ag / a_ag	0.001	14.45	0.017	1.4	77.1
				a_dev / c_man / a_man / c_live / a_live / f_land / households / c_ag / a_ag	0.002	9.23	0.016	1.3	78.4
				a_dev / c_serv / a_serv / c_man / a_man / c_ag / a_ag	0.001	11.78	0.015	1.2	79.6
				a_dev / f_capital / h_ent / c_serv / a_serv / c_ag / a_ag	0.002	8.49	0.015	1.2	80.9

Table III.4: Continued

Case	Origin	Dest.	Global infl.	Path	Direct infl.	Path mult.	Total infl.	Prop. (in %)	Accum. Prop.
IV	a_dev	a_live	0.97	a_dev / c_man / a_man / c_live / a_live	0.052	4.48	0.231	23.9	23.9
				a_dev / c_serv / a_serv / c_man / a_man / c_live / a_live	0.021	8.94	0.192	19.9	43.8
				a_dev / c_serv / a_serv / f_labour / households / c_man / a_man / c_live / a_live	0.006	13.67	0.084	8.7	52.5
				a_dev / c_con / a_con / c_man / a_man / c_live / a_live	0.017	4.54	0.079	8.2	60.6
				a_dev / c_serv / a_serv / f_labour / households / c_live / a_live	0.003	11.01	0.031	3.2	63.8
				a_dev / c_serv / a_serv / f_capital / households / c_man / a_man / c_live / a_live	0.002	13.67	0.023	2.4	66.2
				a_dev / f_capital / h_ent / c_serv / a_serv / c_man / a_man / c_live / a_live	0.003	9.01	0.023	2.3	68.5
				a_dev / c_con / a_con / c_serv / a_serv / c_man / a_man / c_live / a_live	0.002	9.03	0.018	1.8	70.4
				a_dev / f_labour / households / c_man / a_man / c_live / a_live	0.002	8.58	0.017	1.7	72.1
				a_dev / c_serv / a_serv / f_labour / households / c_inf / a_inf / c_man / a_man / c_live / a_live	0.001	15.17	0.015	1.6	73.7
				a_dev / c_con / a_con / c_fish / a_fish / f_labour / households / c_man / a_man / c_live / a_live	0.002	8.96	0.015	1.5	75.2
				a_dev / c_con / a_con / f_labour / households / c_man / a_man / c_live / a_live	0.002	8.67	0.014	1.4	76.6
				a_dev / f_capital / households / c_man / a_man / c_live / a_live	0.001	11.57	0.011	1.1	77.7
				a_dev / f_capital / h_ent / c_serv / a_serv / f_labour / households / c_man / a_man / c_live / a_live	0.001	13.67	0.010	1.0	78.7
V	a_dev	a_inf	0.59	a_dev / c_serv / a_serv / f_labour / households / c_inf / a_inf	0.013	12.05	0.155	26.4	26.4
				a_dev / c_serv / a_serv / f_capital / households / c_inf / a_inf	0.004	12.05	0.043	7.3	33.7
				a_dev / c_man / a_man / c_live / a_live / f_labour / households / c_inf / a_inf	0.004	9.53	0.040	6.9	40.6
				a_dev / c_man / c_serv / a_serv / f_labour / households / c_inf / a_inf	0.002	15.17	0.036	6.2	46.8
				a_dev / c_serv / a_serv / c_man / a_man / c_live / a_live / f_labour / households / c_inf / a_inf	0.002	15.17	0.027	4.6	51.3
				a_dev / f_labour / households / c_inf / a_inf	0.004	6.07	0.025	4.3	55.6
				a_dev / c_con / a_con / c_fish / a_fish / f_labour / households / c_inf / a_inf	0.003	6.36	0.022	3.7	59.3
				a_dev / c_con / a_con / f_labour / households / c_inf / a_inf	0.003	6.14	0.020	3.4	62.7

Table III.4: Continued

Case	Origin	Dest.	Global infl.	Path	Direct infl.	Path mult.	Total infl.	Prop. (in %)	Accum. Prop.
				a_dev / f_capital / h_ent / c_serv / a_serv / f_labour / households / c_inf / a_inf	0.002	12.05	0.018	3.1	65.8
				a_dev / c_serv / a_serv / c_ag / a_ag / f_labour / households / c_inf / a_inf	0.001	12.75	0.018	3.0	68.9
				a_dev / f_capital / households / c_inf / a_inf	0.002	8.83	0.017	2.9	71.7
				a_dev / c_con / a_con / c_serv / a_serv / f_labour / households / c_inf / a_inf	0.001	12.16	0.014	2.4	74.2
				a_dev / c_con / a_con / c_man / a_man / c_live / a_live / f_labour / households / c_inf / a_inf	0.001	9.62	0.014	2.3	76.5
				a_dev / c_con / a_con / c_man / c_serv / a_serv / f_labour / households / c_inf / a_inf	0.001	15.30	0.012	2.1	78.6
				a_dev / c_man / c_serv / a_serv / f_capital / households / c_inf / a_inf	0.001	15.17	0.010	1.7	80.3
				a_dev / c_man / a_man / c_live / a_live / f_land / households / c_inf / a_inf	0.001	9.55	0.010	1.6	82.0
				a_dev / c_serv / a_serv / c_man / a_man / c_live / a_live / f_land / households / c_inf / a_inf	0.000	15.17	0.006	1.1	83.0
				a_dev / c_con / a_con / f_capital / h_ent / c_serv / a_serv / f_labour / households / c_inf / a_inf	0.001	12.16	0.006	1.0	84.1
VI	a_dev	a_con	0.25	a_dev / c_con / a_con	0.213	1.05	0.223	88.4	88.4
				a_dev / c_serv / a_serv / c_con / a_con	0.001	5.84	0.006	2.2	90.6
				a_dev / c_serv / a_serv / f_labour / households / c_con / a_con	0.000	10.96	0.005	2.0	92.5
VII	a_dev	a_fish	0.17	a_dev / c_con / a_con / c_fish / a_fish	0.034	1.28	0.043	25.0	25.0
				a_dev / c_serv / a_serv / f_labour / households / c_fish / a_fish	0.002	11.21	0.028	16.1	41.1
				a_dev / c_serv / a_serv / c_fish / a_fish	0.002	6.22	0.009	5.4	46.5
				a_dev / c_serv / a_serv / f_capital / households / c_fish / a_fish	0.001	11.21	0.008	4.5	51.0
				a_dev / c_man / a_man / c_live / a_live / f_labour / households / c_fish / a_fish	0.001	8.88	0.007	4.2	55.3
				a_dev / c_man / c_serv / a_serv / f_labour / households / c_fish / a_fish	0.000	14.11	0.007	3.8	59.0
				a_dev / c_serv / a_serv / c_man / a_man / c_live / a_live / f_labour / households / c_fish / a_fish	0.000	14.11	0.005	2.8	61.8

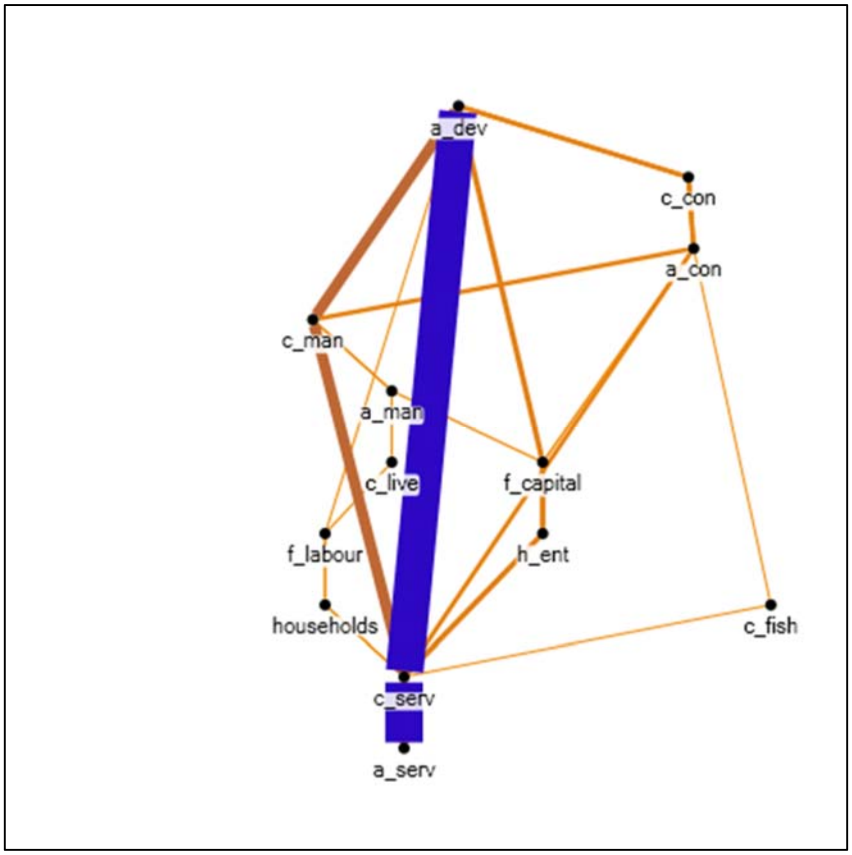
Table III.4: Continued

Case	Origin	Dest.	Global infl.	Path	Direct infl.	Path mult.	Total infl.	Prop. (in %)	Accum. Prop.
				a_dev / f_labour / households / c_fish / a_fish	0.001	5.66	0.005	2.6	64.5
				a_dev / c_con / a_con / f_labour / households / c_fish / a_fish	0.001	5.73	0.004	2.1	66.6
				a_dev / f_capital / h_ent / c_serv / a_serv / f_labour / households / c_fish / a_fish	0.000	11.21	0.003	1.9	68.4
				a_dev / c_serv / a_serv / c_ag / a_ag / f_labour / households / c_fish / a_fish	0.000	11.86	0.003	1.9	70.3
				a_dev / f_capital / households / c_fish / a_fish	0.000	8.23	0.003	1.8	72.1
				a_dev / c_man / c_serv / a_serv / c_fish / a_fish	0.000	9.15	0.003	1.5	73.5
				a_dev / c_con / a_con / c_serv / a_serv / f_labour / households / c_fish / a_fish	0.000	11.31	0.003	1.5	75.0
				a_dev / c_con / a_con / c_man / a_man / c_live / a_live / f_labour / households / c_fish / a_fish	0.000	8.96	0.002	1.4	76.5
				a_dev / c_con / a_con / c_man / c_serv / a_serv / f_labour / households / c_fish / a_fish	0.000	14.23	0.002	1.3	77.8
				a_dev / c_man / c_serv / a_serv / f_capital / households / c_fish / a_fish	0.000	14.11	0.002	1.1	78.8
				a_dev / c_man / a_man / c_live / a_live / f_land / households / c_fish / a_fish	0.000	8.90	0.002	1.0	79.8
VIII	a_dev	a_gov	0.02	a_dev / c_serv / a_serv / f_labour / households / c_gov / a_gov	0.000	10.86	0.004	23.0	23.0
				a_dev / c_serv / a_serv / f_capital / households / c_gov / a_gov	0.000	10.86	0.001	6.4	29.4
				a_dev / c_man / a_man / c_live / a_live / f_labour / households / c_gov / a_gov	0.000	8.59	0.001	6.0	35.4
				a_dev / c_man / c_serv / a_serv / f_labour / households / c_gov / a_gov	0.000	13.68	0.001	5.4	40.8
				a_dev / c_serv / a_serv / c_gov / a_gov	0.000	5.79	0.001	5.1	45.9
				a_dev / c_serv / a_serv / c_man / a_man / c_live / a_live / f_labour / households / c_gov / a_gov	0.000	13.68	0.001	4.0	49.9
				a_dev / f_labour / households / c_gov / a_gov	0.000	5.47	0.001	3.7	53.6
				a_dev / c_con / a_con / c_fish / a_fish / f_labour / households / c_gov / a_gov	0.000	5.73	0.001	3.3	56.9
				a_dev / c_con / a_con / f_labour / households / c_gov / a_gov	0.000	5.54	0.001	3.0	59.8
				a_dev / f_capital / h_ent / c_serv / a_serv / f_labour / households / c_gov / a_gov	0.000	10.86	0.000	2.7	62.5
				a_dev / c_serv / a_serv / c_ag / a_ag / f_labour / households / c_gov / a_gov	0.000	11.50	0.000	2.6	65.2

Table III.4: Continued

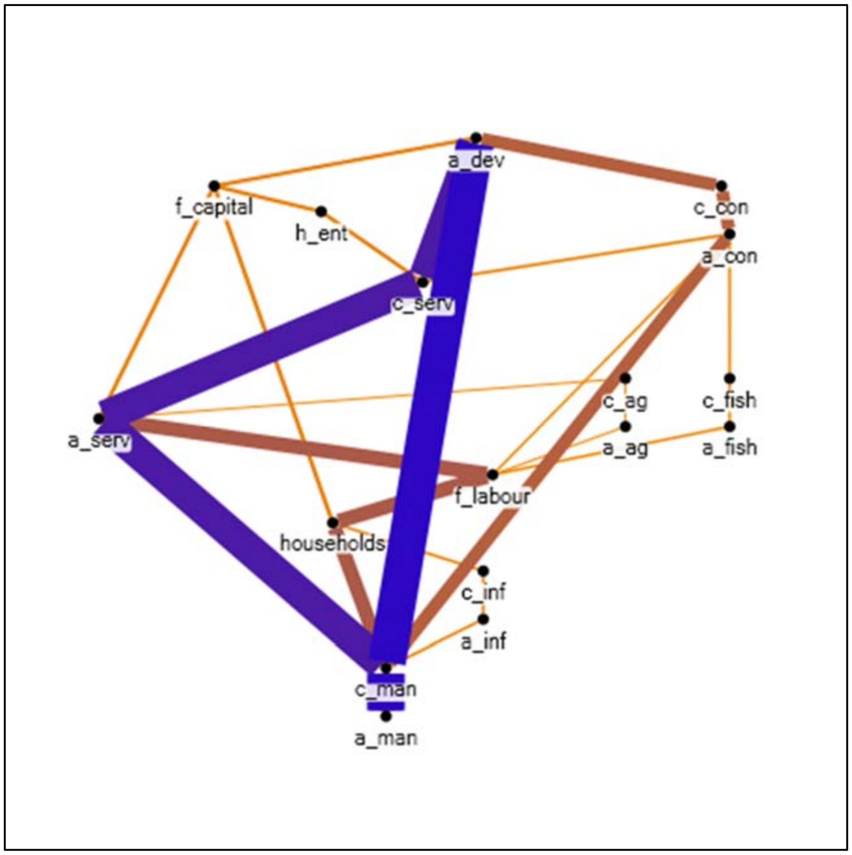
Case	Origin	Dest.	Global infl.	Path	Direct infl.	Path mult.	Total infl.	Prop. (in %)	Accum. Prop.
				a_dev / f_capital / households / c_gov / a_gov	5.76E-05	7.96	0.000	2.5	67.7
				a_dev / c_con / a_con / c_serv / a_serv / f_labour / households / c_gov / a_gov	3.54E-05	10.97	0.000	2.1	69.8
				a_dev / c_con / a_con / c_gov / a_gov	0.000363	1.07	0.000	2.1	71.9
				a_dev / c_con / a_con / c_man / a_man / c_live / a_live / f_labour / households / c_gov / a_gov	4.31E-05	8.67	0.000	2.0	74.0
				a_dev / c_con / a_con / c_man / c_serv / a_serv / f_labour / households / c_gov / a_gov	2.43E-05	13.79	0.000	1.8	75.8
				a_dev / c_man / c_serv / a_serv / f_capital / households / c_gov / a_gov	2.01E-05	13.68	0.000	1.5	77.3
				a_dev / c_man / a_man / c_live / a_live / f_land / households / c_gov / a_gov	3.04E-05	8.61	0.000	1.4	78.7
				a_dev / c_man / c_serv / a_serv / c_gov / a_gov	3.00E-05	8.57	0.000	1.4	80.1

Figure III.1: Production activities – Case I



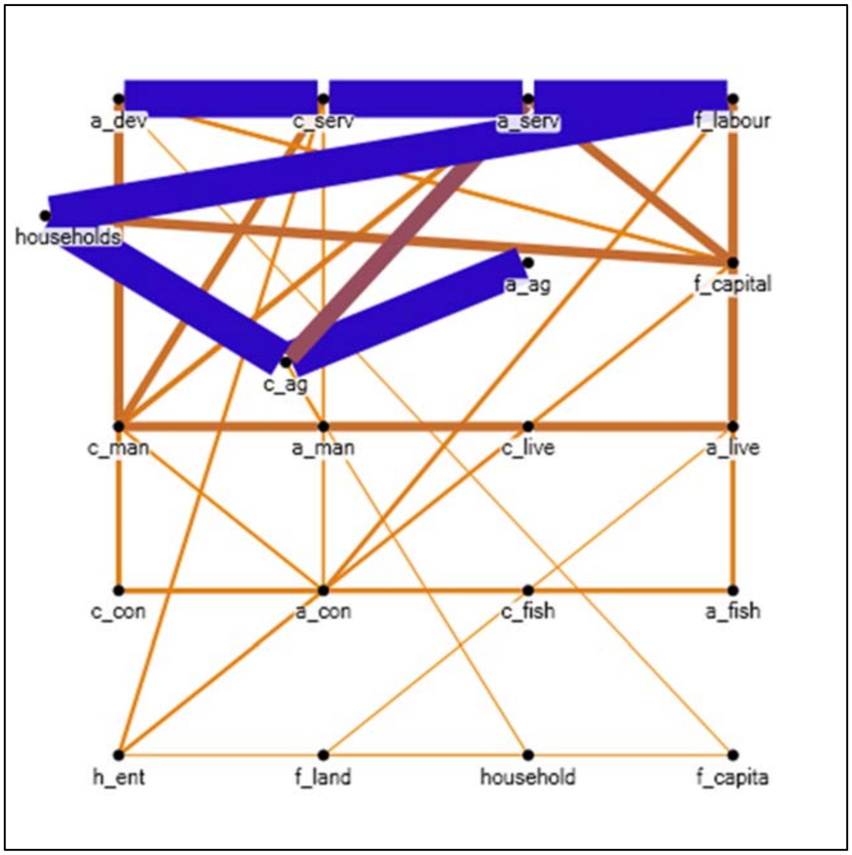
Note: Figure created using the weighted graph scheme of NodeXL. Paths depicted explain 84% of the accounting multiplier.

Figure III.2: Production activities – Case II



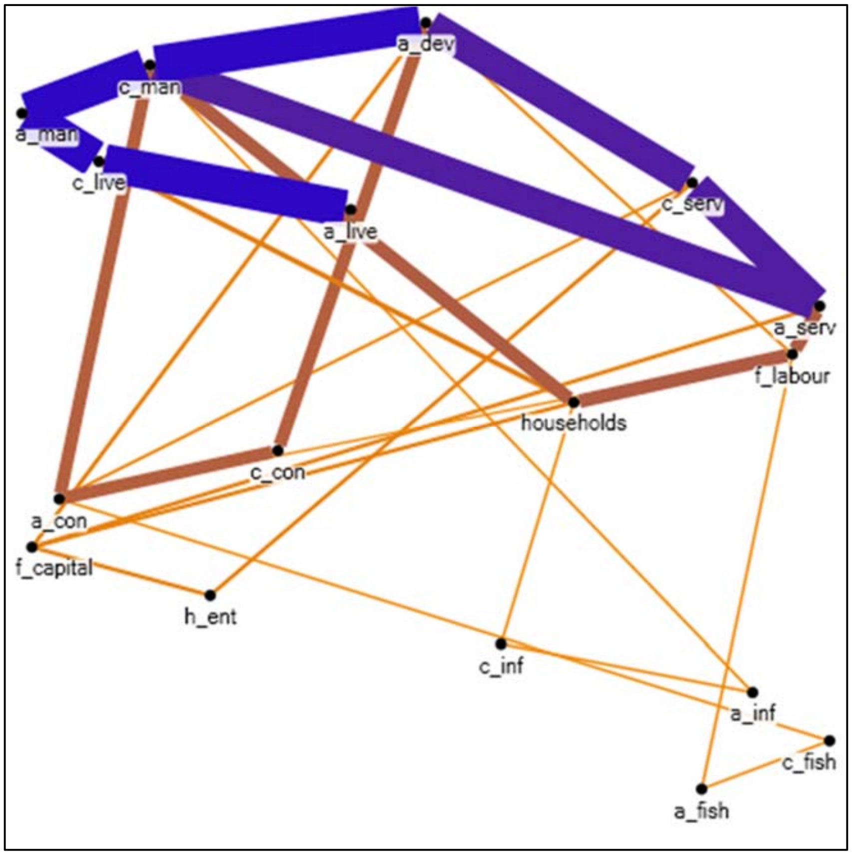
Note: Figure created using the weighted graph scheme of NodeXL. Paths depicted explain 87% of the accounting multiplier.

Figure III.3: Production activities – Case III



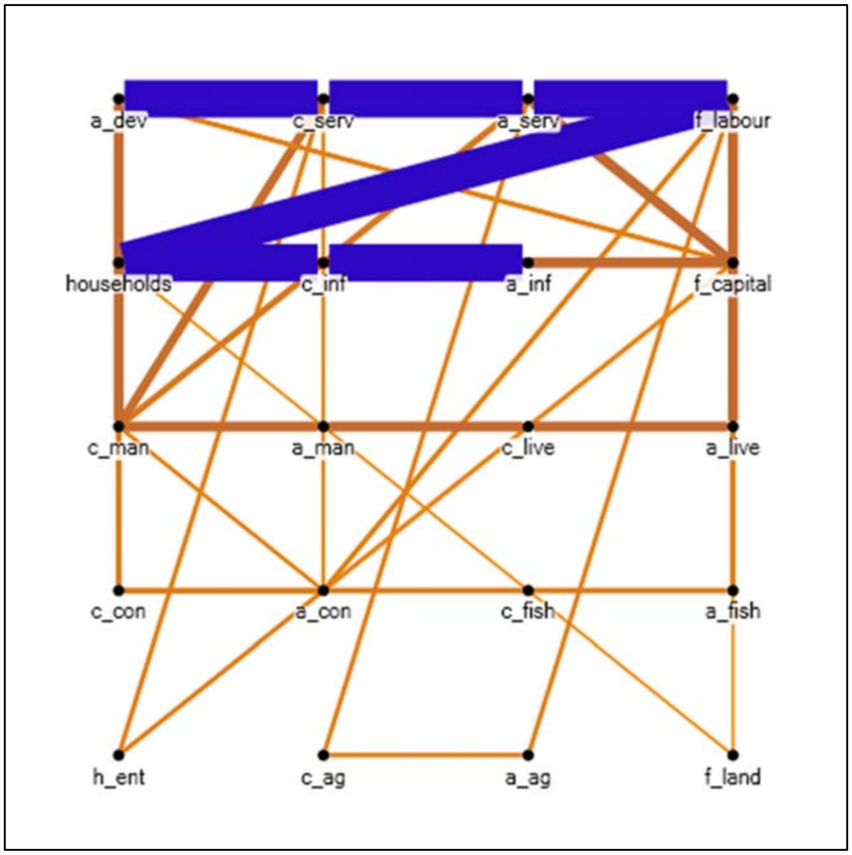
Note: Figure created using the weighted graph scheme of NodeXL. Paths depicted explain 80% of the accounting multiplier.

Figure III.4: Production activities – Case IV



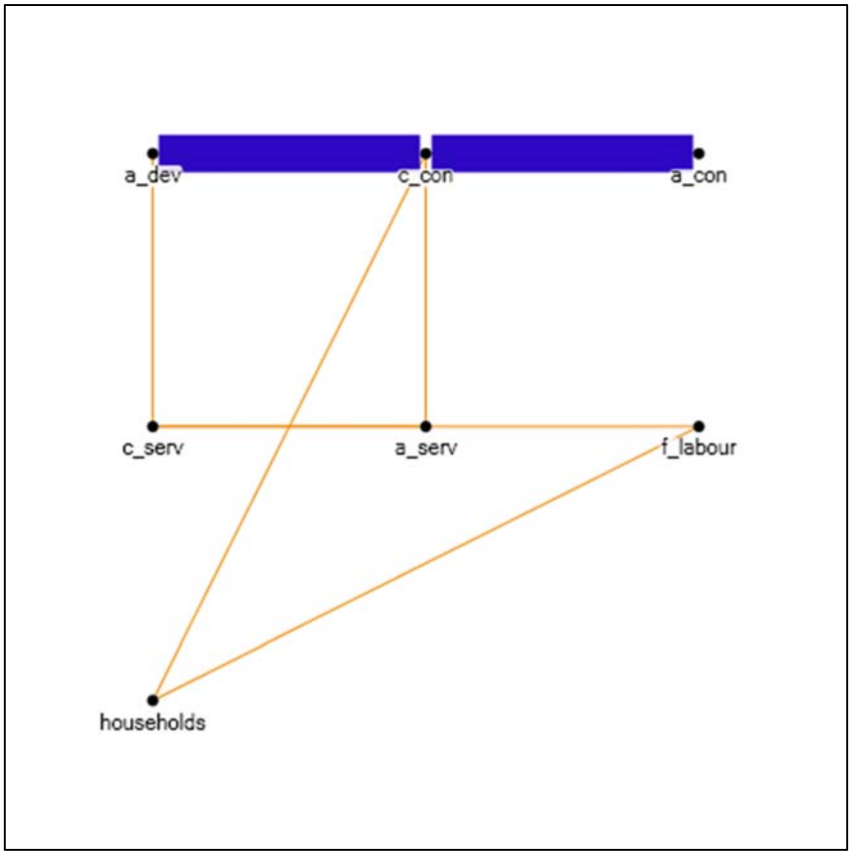
Note: Figure created using the weighted graph scheme of NodeXL. Paths depicted explain 79% of the accounting multiplier.

Figure III.5: Production activities – Case V



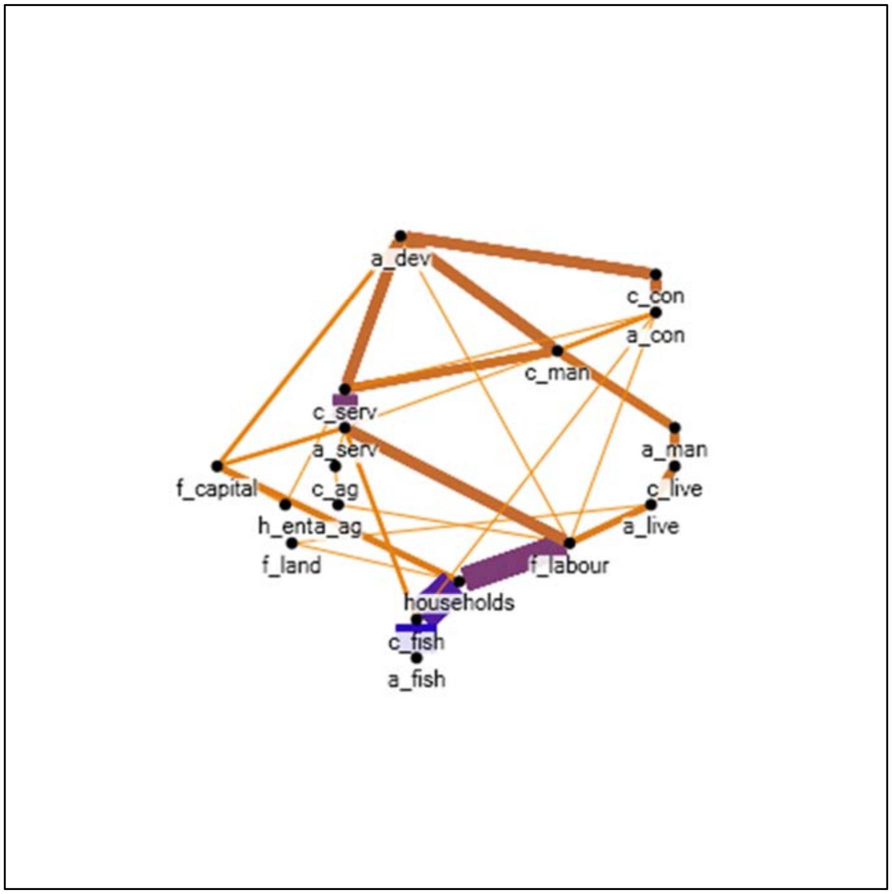
Note: Figure created using the weighted graph scheme of NodeXL. Paths depicted explain 84% of the accounting multiplier.

Figure III.6: Production activities – Case VI



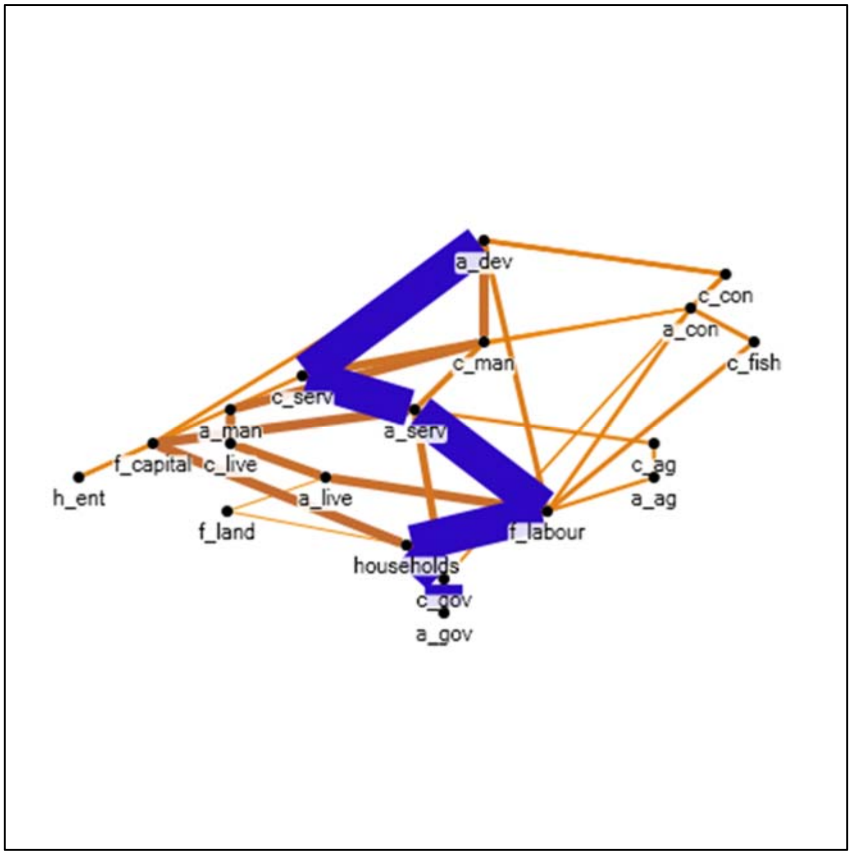
Note: Figure created using the weighted graph scheme of NodeXL. Paths depicted explain 93% of the accounting multiplier.

Figure III.7: Production activities – Case VII



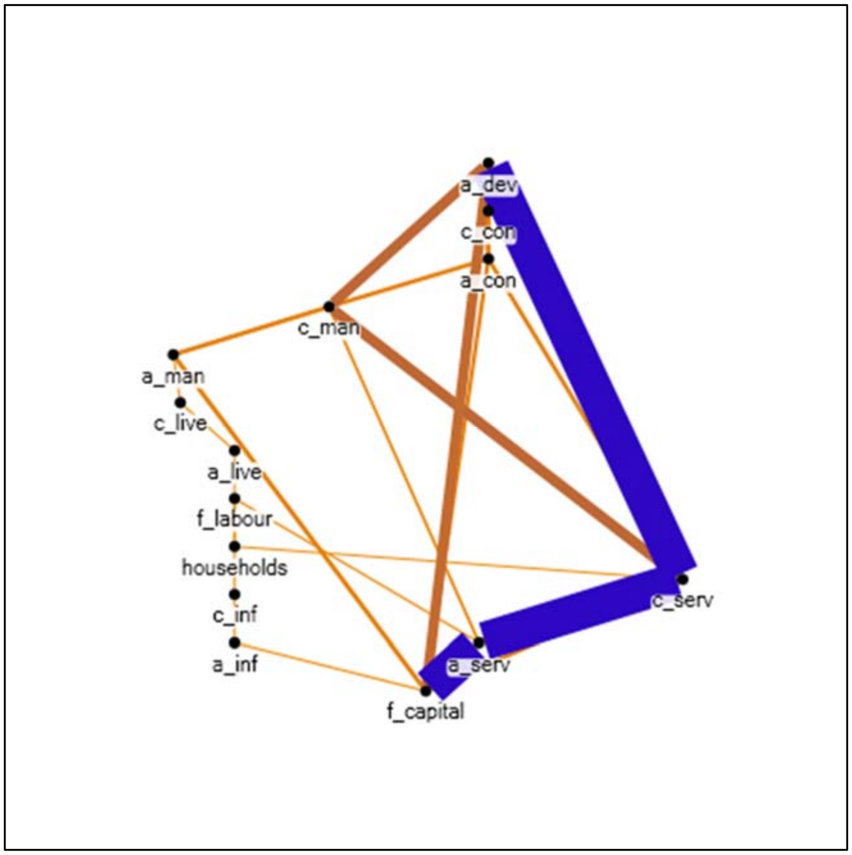
Note: Figure created using the weighted graph scheme of NodeXL. Paths depicted explain 80% of the accounting multiplier.

Figure III.8: Production activities – Case VIII



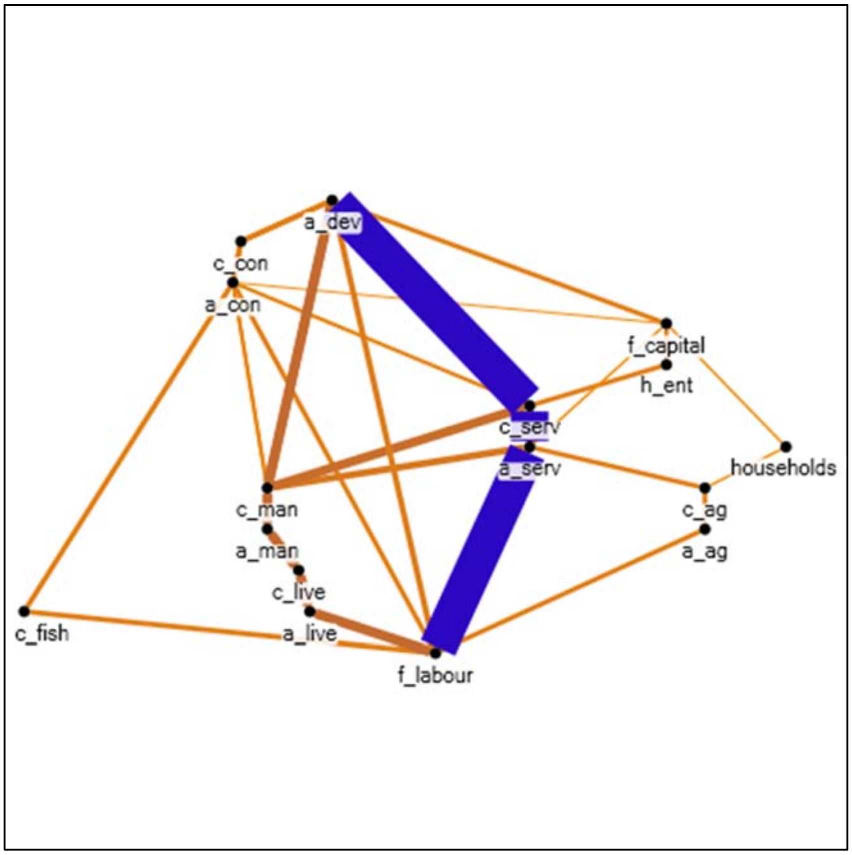
Note: Figure created using the weighted graph scheme of NodeXL. Paths depicted explain 80% of the accounting multiplier.

Figure III.9: Factors – Case I (Capital)



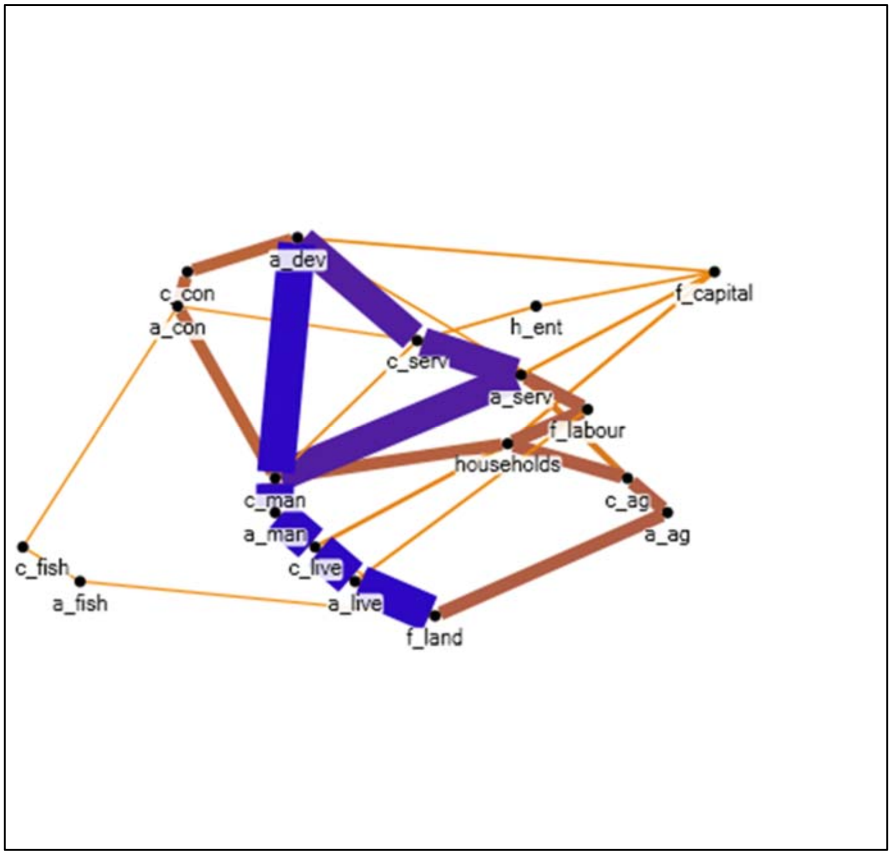
Note: Figure created using the weighted graph scheme of NodeXL. Paths depicted explain 82% of the accounting multiplier.

Figure III.10: Factors – Case II (Labour)



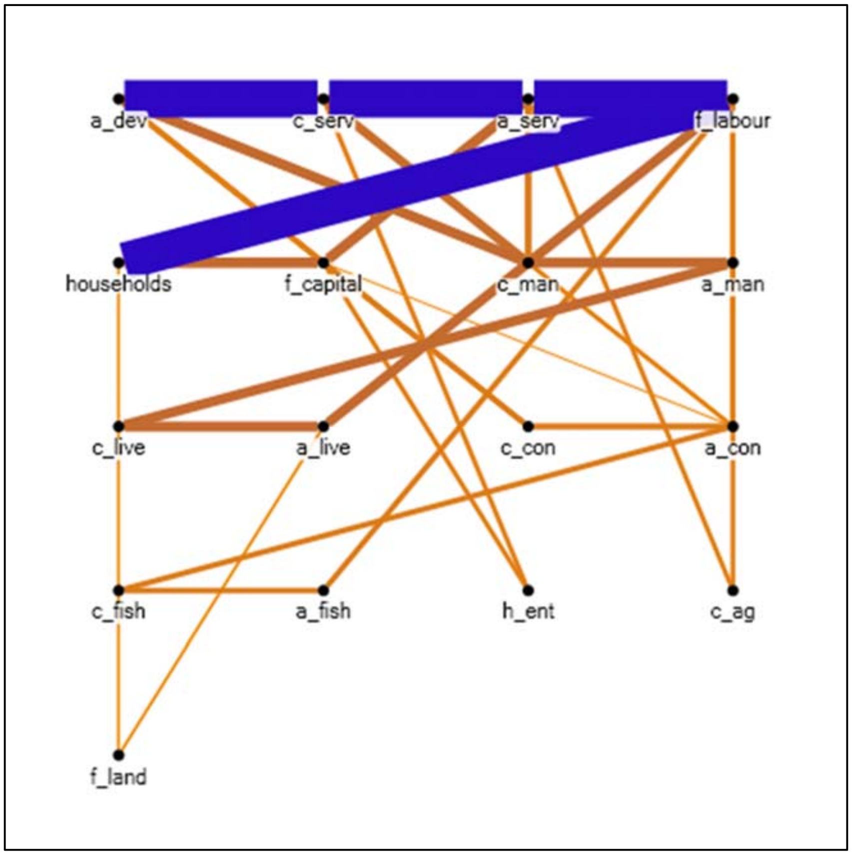
Note: Figure created using the weighted graph scheme of NodeXL. Paths depicted explain 80% of the accounting multiplier.

Figure III.11: Factors – Case III (Land)



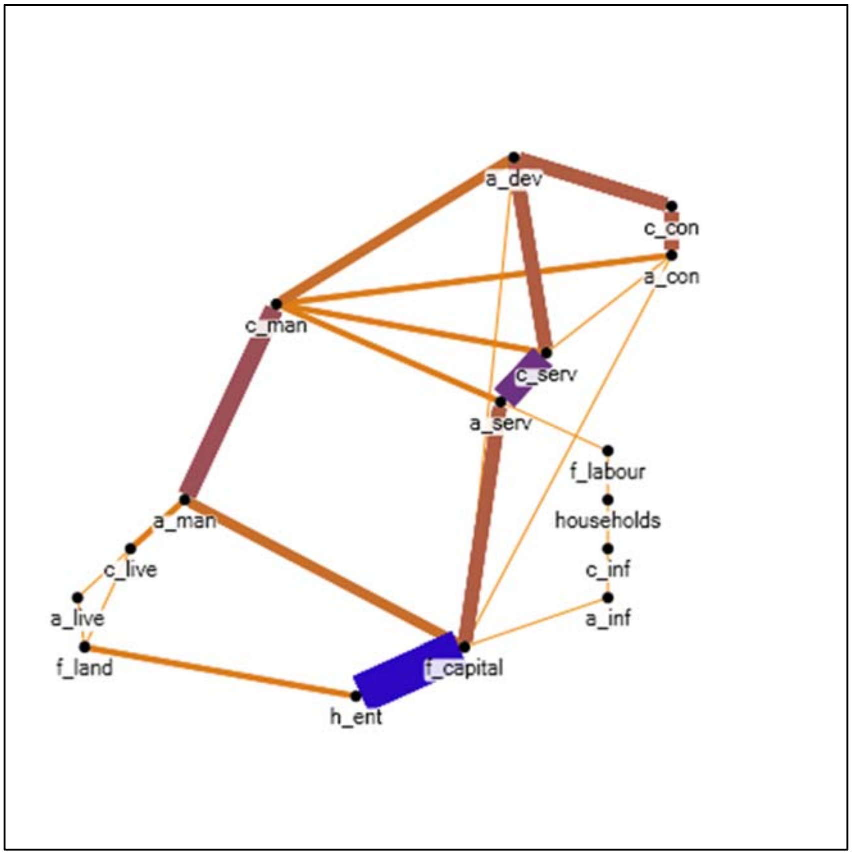
Note: Figure created using the weighted graph scheme of NodeXL. Paths depicted explain 66% of the accounting multiplier.

Figure III.12: Institutions – Case I (Households)



Note: Figure created using the weighted graph scheme of NodeXL. Paths depicted explain 84% of the accounting multiplier.

Figure III.13: Institutions – Case II (Enterprises)



Note: Figure created using the weighted graph scheme of NodeXL. Paths depicted explain 77% of the accounting multiplier.