Climate Change: A Comparison Of Market-Based Instruments From A South African Perspective

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ABSTRACT

This article aims to consider the relevancy of (i) cap-and-trade schemes and (ii) carbon tax schemes in a developing economy context. Even though both schemes have a common goal of reducing greenhouse gas emissions, they operate very differently, each with their own set of advantages and disadvantages. Sustainable developments comprise various elements categorised in three primary dimensions – environmental, economic and social. The objective of reducing greenhouse gases via the implementation of carbon tax or cap-and-trade schemes primarily addresses the environmental dimension of sustainable development. Notwithstanding the aforementioned, the impact of both schemes on the economically sustainable development, including industry competitiveness and growth, still has to be determined. In South Africa, the National Treasury made a decision to implement carbon tax as opposed to cap-and-trade schemes. In this article, the reasoning behind their decision in favour of carbon tax in the South African context is critically considered, firstly by evaluating the key characteristics between cap-and-trade and carbon tax schemes and secondly by considering the effectiveness hereof in the global context. It was found primary reason behind the favourable consideration of carbon tax was the fact the implementation thereof would be 'simpler' using the existing taxation systems, whereas cap-and-trade would require the implementation of sophisticated mechanisms that may not provide the optimum benefit in a developing economy context.

Keywords: Climate Change; Carbon Taxation; Cap-And-Trade Scheme; Greenhouse Gas Emissions; Sustainable Development

INTRODUCTION

Background

The issue of global warming in recent years has been at the forefront of not only the scientific community, but also of various governmental institutions (Ren & Lin, 2001). Many scientists are of the opinion that higher concentrations of greenhouse gas emissions, such as carbon dioxide and methane, can negatively affect our climate (Sathiendrakumar, 2003) and that if the atmospheric concentrations of these greenhouse gases continue to rise, the global climate will become increasingly warmer (Yusuf *et al.*, 2012; Ren & Lin, 2001). Shepherd (2012:1) is in agreement herewith when saying that the climate change currently being experienced is due to an increase in greenhouse gas emissions that arise from human activities, such as the burning of fossil fuels, agriculture and deforestation. Spectral calculations also confirm that water vapour accounts for approximately 87% of the greenhouse effect and a doubling of the current level of carbon dioxide emissions would result in a rise in global temperatures of 0.51°C without water feedback (Ollila, 2012). In South Africa, the level of carbon emissions per unit of economic output was nearly three times the average set by the Organisation for Economic Co-operation and Development (OECD) (Goldblatt & Davies, 2002).

Governments considering strategies for lowering carbon emissions ordinarily have two basic approaches to consider, namely i) a cap-and-trade scheme that reduces emissions by limiting the quantity of carbon dioxide that can be emitted and then allocating emissions permits that are tradable, or ii) introducing a carbon tax scheme that effectively raises the price of fossil fuels based on their carbon content (Anon, 2012). The *cap-and-trade* approach has its foundation in the United Nations Framework Convention on Climate Change (UNFCCC) that was established with the goal of reducing the concentration of greenhouse gases in the atmosphere, to which South Africa became a signatory in August 1997 (UNFCCC, 2004). In a cap-and-trade scheme, a governmental organisation typically issues *a license (or permit) to pollute* to major industries with the entity then being in position to trade these permits with another entity who might make 'equivalent' changes more cost effectively (Gilbertson & Reyes, 2009). This is the approach underlying most emission trading schemes with the underlying theory that the available supply of permits will be slowly reduced, so that the market retains its value while at the same time forcing a decrease in the overall level of greenhouse gas emissions (Gilbertson & Reyes 2009). On the other hand, *carbon tax* is in essence an excise tax on the producers of raw fossil fuels based on the relative carbon content of those fuels (OECD, 1997). The objective of carbon tax is therefore to control the problem of global warming caused by increasing concentrations of greenhouse gases, which then, *per se,* include carbon (Pearson & Smith, 1991). The impact of carbon tax is ordinarily determined by using the energy demand function that considers the price elasticity of energy (Yamaguchi, 2007). According to SBS (2012), carbon tax schemes have been implemented in many countries around the world, including Denmark, Finland, Ireland, the Netherlands, Norway, Slovenia, Sweden, Switzerland, the United Kingdom, Canada, India, Costa Rica and China.

Sustainable development

From the above it is evident that both cap-and-trade schemes and carbon tax schemes intended to effect reductions in greenhouse gas emissions in order to contribute to sustainable development. According to Mohammed (2011), sustainable development has been defined as that which is required to harmonise the fulfilment of human needs with the protection of the natural environment so that these needs can be met not only in the present, but also in the indefinite future. Sustainable development comprises various elements categorised into three primary dimensions, namely environmental, economic and social, which in essence is the so-called triple bottom line, which has been defined as the *balance* within the concept of sustainability (Cronje & Chenga, 2009; Anon, 2006; Newport *et al*., 2003):

- The *economic dimension* of sustainability is important as critical issues such as costs associated with environmental pollution, constraints on economic growth and the destruction of non-renewable resources are addressed by this area of sustainable development.
- With regard to *social sustainability*, it is suggested that the social dimension of sustainable development encompasses the transformation, and perpetual improvement of the livelihoods of human beings within a specific social context.
- In terms of *environmental sustainability,* clean air and water, reduced toxic emissions and reducing household waste as well as conserving natural resources are among the important environmental policy objectives that most OECD governments have been pursuing over the past thirty years.

The South African context

In terms of related carbon emission developments in South Africa, the National Treasury published a discussion document considering the economic merits for introducing a carbon tax in South Africa in December 2010 (National Treasury, 2010). This elicited 79 stakeholder responses, with a more detailed policy document containing the design of the carbon tax anticipated to be released in due course (WWF, 2012).

However, prior to this, on 1 September 2010, a carbon emission tax on the sale of new passenger motor vehicles in South Africa was implemented, which added a tax of R75 for every gram of carbon dioxide per kilometre it emits over the 120g/km (NAAMSA, 2011; Shirley, 2010). These vehicles are taxed on carbon dioxide emissions above 120g/km at a fixed rate of ZAR75 per g/km. Therefore, if a new passenger car emits 200g/km of carbon dioxide, it will be taxed on the 80g/km emitted above the 120g/km threshold. At the suggested flat rate of ZAR75 per g/km, such a vehicle will attract carbon tax of around ZAR 6 000 (Finnern, 2010). In terms of the industry's contribution to sustainable development in the region, it contributed approximately 7.5% to the country's GDP in 2008 (SAI, 2008a). Therefore, due to its importance to the South African economy, the impact of hereof is expected to be significant. The National Association of Automobile Manufacturers of South Africa (NAAMSA) suggested that carbon tax will inflate vehicle prices by as much as 2%, which may lower sales volumes and could negatively impact vehicle industry employment levels (Anon, 2010).

PROBLEM STATEMENT AND OBJECTIVES

Following from the above, the question may be asked as to the total impact of the implementation of carbon tax as an environmental policy, not only in the context of the South African vehicle industry, but also in the context of the broader economy. In light hereof, the primary research question under consideration could be formulated as follows:

- Is the carbon tax mechanism the most appropriate mechanism to reduce greenhouse gas emissions within the South African developing economy context, seen in the light of global experiences?

In consideration hereof, this paper aims to examine firstly the distinguishing natures of i) cap-and-trade schemes and ii) carbon tax schemes, and secondly to provide an evaluation of the decision made by the National Treasury to implement carbon tax in South Africa. The research is based on an analytical literature study research methodology and utilises a three-step approach in considering whether carbon tax is the most appropriate mechanism to reduce greenhouse gas emissions in South Africa. Firstly, the key distinguishing features between the carbon tax and cap-and-trade mechanisms are analysed, secondly, the effectiveness of these scheme are evaluated based on global experiences and thirdly an evaluation of the National Treasury's case for carbon tax is provided.

KEY FEATURES OF CAP-AND-TRADE AND CARBON TAX SCHEMES

Introduction

According to Goldblatt (2010a), the primary distinguishing features of cap-and-trade and carbon tax schemes are typically threefold, namely:

- In terms of carbon pricing, carbon tax offers some level of certainty as the price is fixed; whereas with a cap-and-trade approach, the carbon price is uncertain and is subject to market volatility.
- In terms of achieving quantitative limits of carbon emissions, the cap-and-trade approach appears to be able to accomplish this more effectively than carbon tax as emissions are capped and therefore provide some level of certainty of the environmental outcome.
- In terms of administrative costs, the carbon tax approach may be seen as a more efficient option as its implementation can be executed within the infrastructure of the existing tax administration, whereas the cap-and-trade approach may require the creation of a new institution to implement a trading scheme.

The distinctive characteristics of these two approaches are discussed in more detail below.

Cap-and-trade schemes

The foundation of the cap-and-trade methodology originated with C Boyden Gray who talked about cleaning up the environment by letting people buy and sell *rights to pollute* (Smithsonian, 2009). This concept was initially termed *emissions trading*, but was subsequently changed to *cap and trade*. In a cap-and-trade scheme, quantitative limits are set on the time path for greenhouse gas emissions of different countries with these countries then administering these limits in their own fashion. These schemes typically allow for the transfer of emission allowances between the different countries under the Kyoto Protocol (Noordhaus, 2007). With regard to cap- and-trade schemes in South Africa, it should be noted that South Africa signed the protocol in 2002, and even though it has no commitment to cap emissions, it is involved in *Clean Development Mechanism* (CDM) projects (DEAT 2010). Some of the key (negative) characteristics of cap-and-trade schemes include the following:

- There may be initial over-allocation permits to governments or companies resulting in no required behavioural change by companies regarding carbon emissions (Gilbertson & Reyes, 2009).
- In some instances, producers may be able to transfer abatement costs to consumers and increase its prices without consideration of the true purposes of the scheme (Gilbertson & Reyes, 2009).
- There are major administrative complexities related to cap-and-trade schemes together with uncertainties with regard to the actual economic costs to business (National Treasury, 2010).

A further issue is the concept of carbon leakage, which is said to occur when there is an increase in greenhouse gas emissions in one country as a result of emission reductions in another country that has stricter climate change policies (CLC, 2010). The results of studies conducted on the effects of the Kyoto Protocol have shown carbon leakage to be in the range of 5 to 20% using static *Computable General Equilibrium* models, which differs from the opinion of researchers who say, in practice, carbon leakage is not substantial due to transport costs and local market conditions (Barker *et al.*, 2007). The principles of the cap-and-trade approach, however, have indicated some positive aspects, including the following:

- Trade schemes implemented in air pollution programmes in the United States reported a strong positive effect on reducing emissions (Tietenburg, 2003).
- The performance of cap-and-trade schemes in the field of improving environmental sustainability was assessed using a simulation model at the University of Saskatchewan, where it was revealed that it decreased carbon dioxide emissions and increased environmental and economic sustainability (Belcher *et al*., 2003).

Carbon tax

Carbon tax, which was first introduced in Europe in the early 1990s, has been widely advocated as a means for reducing such emissions to address anthropogenic climate change (Clarke, 2011). In principle, carbon taxes are levied at the same specific rate on all emissions, irrespective of their source. Since carbon emissions have a proportional relationship to fossil fuel usage, this could be charged directly on emissions of fossil fuels such petrol, gas and coal (IMF, 2008). In addition to the advantages of price certainty and lower administrative costs, carbon tax offers the advantage of economy-wide application in terms of coverage in comparison to cap-and-trade schemes that ordinarily only cover high emitters in the initial phases (Goldblatt, 2010a). Another advantage is that pricing systems such as carbon tax are less susceptible to corruption than quantity type systems, with this being demonstrated frequently at international trade interventions when quotas are compared to tariffs (Noordhaus, 2007). A further significant advantage, according to Pope and Owen (2009), is the suggestion that it would provide a more stable revenue base over time. They propose (within the Australian context) that it may generate around A$11.5 billion per annum, subject to various treasury assumptions (Pope & Owen, 2009).

In terms of disadvantages, carbon tax schemes do not ensure quantifiable, emission reductions (National Treasury, 2010). This assumption is supported by the simulation model developed at the University of Saskatchewan, which revealed that carbon tax had no significant effect on carbon dioxide emissions or environmental sustainability, but may rather decrease economic sustainability (Belcher *et al*., 2003). Another possible significant disadvantage is the pricing of carbon. The social cost of carbon has been defined as the monetary damage done by emitting one more ton of carbon at some point in time. Using quantitative modelling, a marginal cost of £100 per ton of carbon has been noted in the United Kingdom (Pearce, 2003). Ideally, the carbon tax price should be priced to cover the marginal cost per ton of carbon, with the resultant question then being whether the carbon tax price accurately reflects the monetary damage caused by an additional ton of carbon?

EVALUATION OF THE EFFECTIVENESS OF SUCH SCHEMES

Cap-and-trade schemes

In terms of cap and trade, the European Union Environmental Trading Scheme (EU ETS) is the world's largest emissions permit market to date and is organised into distinctive periods referred to as 'phases', with *Phase I* between 2005 and 2007 and *Phase II* between 2008 and 2012 (Hintermann, 2012). In terms of the effectiveness hereof in reducing greenhouse gas emissions, a sample study of 2101 European firms subject to the EU ETS revealed that it led to reductions in emissions in both phases (Abrell *et al.*, 2011).

In respect of Phase I, an analysis of carbon dioxide emissions by countries subject to the EU ETS (Table 1 below) found an overall net increase of 1.88% in GHG emissions, with 11 out of the 24 countries recording decreases in their carbon emissions.

Table 1: Phase I: Emissions of EU ETS countries (tons of carbon)

Country	2005	2006	2007	% change
Austria	33,372,826	32 382 804	31 751 165	-4.86
Belgium	55,363,223	54 775 314	52 795 318	-4.64
Cyprus	5,078,866	5 259 273	5 396 164	6.25
Czech Republic	82,454,618	83 624 953	87 834 758	6.52
Germany	474,990,760	478 016 581	487 004 055	2.53
Denmark	26,475,718	34 199 588	29 407 355	11.07
Estonia	12,621,817	12 109 278	15 329 931	21.46
Spain	183,626,981	179 711 225	186 495 894	1.56
Finland	33,099,625	44 621 411	42 541 327	28.53
France	131,263,787	126 979 048	126 634 806	-3.53
Greece	71,267,736	69 965 145	72 717 006	2.03
Hungary	26,161,627	25 845 891	26 835 478	2.58
Ireland	22,441,000	21 705 328	21 246 117	-5.32
Italy	225,989,357	227 439 408	226 368 773	0.17
Lithuania	6,603,869	6 516 911	5 998 744	-9.16
Luxembourg	2,603,349	2 712 972	2 567 231	-1.39
Latvia	2,854,481	2 940 680	2 849 203	-0.18
Netherlands	80,351,288	76 701 184	79 874 658	-0.59
Poland	203,149,562	209 616 285	209 601 993	3.18
Portugal	36,425,915	33 083 871	31 183 076	-14.39
Sweden	19,381,623	19 884 147	15 348 209	-20.81
Slovenia	8,720,548	8 842 181	9 048 633	3.76
Slovakia	25,231,767	25 543 239	24 516 830	-2.83
United Kingdom	242,513,099	251 159 840	256 581 160	5.80
Total	2,012,043,453	2 033 636 557	2 049 927 884	1.88

Source: Anon (2008b)

In respect of Phase II (Table 2 below), all the countries reported reductions in carbon emissions, with an overall reduction of 7.2%

From a review of the above tables it is clear that the EU ETS was more effective in Phase II than in Phase I. It is, however, argued that Phase I not only established a carbon price for material sectors of economic activity in Europe, but also established the necessary trading infrastructure (Convery *et al.*, 2008). Furthermore, during Phase I, the permits allocated were also found to be consistently higher than the actual verified emissions taking place in the EU ETS countries (Gilbertson & Reyes, 2009).

Table 2: Phase II: Emissions of EU ETS countries (tons of carbon)

Country	2008	2009	% change
Austria	68 232 000	62 313 000	-8.67
Belgium	104 865 000	103 593 000	-1.21
Cyprus	8 555 000	8 199 000	-4.16
Czech Republic	116 952 000	108 121 000	-7.55
Germany	786 652 000	734 599 000	-6.62
Denmark	46 850 000	45 698 000	-2.46
Estonia	18 383 000	15 951 000	-13.23
Spain	329 286 000	288 230 000	-12.47
Finland	56 083 000	53 568 000	-4.48
France	376 993 000	363 356 000	-3.62
Greece	97 817 000	94 917 000	-2.96
Hungary	54 653 000	48 676 000	-10.94
Ireland	43 406 000	41 642 000	-4.06
Italy	447 367 000	400 836 000	-10.40
Lithuania	15 130 000	12 838 000	-15.15
Luxembourg	10 660 000	10 143 000	-4.85
Latvia	7 591 000	6 652 000	-12.37
Netherlands	173 845 000	169 650 000	-2.41
Poland	316 059 000	298 905 000	-5.43
Portugal	58 357 000	57 400 000	-1.64
Sweden	49 105 000	43 744 000	-10.92
Slovenia	17 158 000	15 291 000	-10.88
Slovakia	37 557 000	33 890 000	-9.76
United Kingdom	522 247 000	474 579 000	-9.13
Total	3 763 803 000	3 492 791 000	-7.20

Source: UN (2011)

Carbon tax

Various studies around the world have been conducted using simulations to determine the estimated impact of carbon tax on greenhouse gas emissions, such as the following:

- In a study estimating the impact of carbon tax on greenhouse gas emissions in Nepal using an energy system model, it was confirmed that the introduction of carbon tax would result in an estimated reduction of 12% under certain conditions (Shakya *et al.*, 2012).
- A study estimating the effect of policy instruments such as carbon tax in Austria on the passenger motor vehicles confirmed that policy measures may demonstrate an effective reduction in GHG emissions (Kloess & Muller, 2011).
- In terms of the actual effectiveness of the tax in reducing greenhouse gases, studies conducted in Norway, one of the first countries to introduce carbon tax in 1991, revealed that carbon emissions increased by 19% from 1990 to 1999 as opposed to a GDP growth of 35% in the same period, which pointed to an overall reduction in average emission per unit GDP of 12% (Bruvoll & Larson, 2004).
- In Sweden, an ex-post evaluation of the implementation of carbon tax for the years 1992 to 1995 shows mixed results of the effect of the carbon tax on carbon emissions according to different industries affected by the tax, and also revealed that even though the services sector, household and transport sectors reported no change in emission levels, there was a positive effect on carbon emission levels (Bohlin, 1998).
- In both the Netherlands and Denmark, tax exemptions were provided for the manufacturing industry and related energy intensive industries, and this reduced the mitigating effects of carbon tax in these countries (Lin & Li, 2012).
- Carbon tax on passenger motor vehicles was introduced in Ireland in 2008, and a study estimating the effect of the tax on greenhouse gas emissions revealed that it should result in a decline in greenhouse gas emissions of 0.2milllions tons of carbon by 2015 (Hennessy & Toll, 2011).

- An analysis of the implementation of a potential carbon tax in Washington using a Carbon Tax Analysis Model revealed that a carbon tax at US$30 per metric ton of carbon dioxide lowers GHG emissions by 8.4% (Keibun, 2011).

Effects of cap-and-trade and carbon tax on industry

In terms of the economic effect of cap-and-trade schemes on profit, employment and value added, a firm-based study of the EU ETS revealed that in Phase I and the beginning of Phase II, the EU ETS did not materially affect profits, employment and value added (Abrell *et al.*, 2011). An interim analysis of Phase I of the EU ETS confirms that the first phase had little impact on industry competitiveness (Convery *et al.*, 2008). Table 3 below summarises the GDP per capita information (adjusted for current prices) for each EU ETS country in the period 2005 to 2009. With the exception of the United Kingdom, all countries reported a real increase in economic growth during the period, with the aggregate economic output growing in real terms by 21%. This mitigates any argument that cap-and-trade schemes will result in decreased profits and growth for companies and industries alike.

Table 3: EU ETS countries: GDP per capita (US dollars at current prices)

Country	2005	2006	2007	2008	2009	% change
Austria	37 048	39 278	45 133	49 650	45 614	23
Belgium	36 225	38 167	43 586	47 822	44 356	22
Cyprus	22 298	23 876	27 686	31 693	29 277	31
Czech Republic	12 726	14 463	17 499	21 723	18 789	48
Denmark	47 546	50 412	56 941	62 115	55 915	18
Estonia	10 330	12 506	16 375	17 773	14 337	39
Finland	37 302	39 460	46 523	51 153	45 062	21
France	34 002	35 669	40 586	44 245	40 773	20
Germany	33 514	35 169	40 281	43 937	40 029	19
Greece	21 468	23 357	27 088	30 216	28 411	32
Hungary	10 937	11 181	13 553	15 390	12 660	16
Ireland	48 888	52 922	60 578	60 570	50 564	3
Italy	30 299	31 539	35 569	38 344	35 041	16
Latvia	6 913	8 658	12 557	14 729	11 433	65
Lithuania	7 641	8 900	11 636	14 153	11 075	45
Luxembourg	82 370	91 395	107 863	118 673	104 384	27
Netherlands	39 157	41 378	47 591	52 766	47 915	22
Poland	7 963	8 949	11 132	13 852	11 256	41
Portugal	18 132	19 008	21 846	23 689	21 976	21
Slovakia	8 844	10 290	13 803	17 348	16 026	81
Slovenia	17 840	19 406	23 507	27 058	24 235	36
Spain	26 044	28 052	32 327	35 306	32 080	23
Sweden	41 042	43 899	50 485	52 632	43 347	6
United Kingdom	37 881	40 381	46 191	43 022	35 220	-7
Total	676 410	728 315	850 336	927 859	819 775	21

Source: UN (2012)

The effect of carbon tax on certain industries has also been subject to empirical research.

- In a study of energy intensive industries, 21 OECD countries between 1992 and 2008 revealed that carbon tax had a positive influence on the international competitiveness of energy intensive industries in export countries (Zhao, 2011). An important point to note is that carbon tax has important implications in terms of global competitiveness of economies and even though global competitiveness may not be reduced over the long term by higher energy prices, the short-term effects of a carbon tax may be serious for certain industries (Zhang & Baranzini, 2004).
- In Sweden, the implementation of carbon tax has had no effect in terms of economic efficiencies in the transport, household and service sectors; however, carbon tax accounted for $1,6 billion of government revenue in 1995 (Bohlin, 1998).

- The implementation of excise tax on passenger motor vehicles (based on emission levels rather than engine size) in Ireland is expected to result in a decrease in fiscal revenue by up to half a billion euro in 2025 (Hennessy & Toll, 2011).

AN EVALUATION OF NATIONAL TREASURY'S CASE FOR CARBON TAX

Considering the above, within the South African context, it was not disputed that cap-and-trade schemes could achieve the same objectives as carbon taxes. National Treasury did, however, argue that cap-and-trade schemes brought specific challenges to the South African context. These include the i) credibility of emission caps, the allocation of permits and the need for a competitive market to facilitate trading, ii) price uncertainty, iii) the need for new financial regulations and administrative capacity, iv) tax implications, as well as v) the non-transparency of distributional incidence (National Treasury, 2010).

- Firstly, with regard to the credibility of emission caps and the allocation of permits, the EU ETS permit allocations in first phase were greater than verified emissions, which were due to using emission projections before verifiable emissions data became available (Gilbertson & Reyes 2009). It was argued that if a cap-and-trade scheme is to work in South Africa, it will be critical for caps to be based on verified emissions data. The emissions data in Table 2, for the second phase of the EU ETS, indeed confirms the effectiveness of credible caps in reducing carbon emissions.
- Secondly, with regard to price uncertainty, this is definitely a valid challenge as seen in EU ETS, where prices have moved significantly in response to new information regarding the allocation of allowances (Goldblatt, 2010b). The market structure in which permits are traded are equally important, as in South Africa there is a high concentration of emissions in the energy and fossils fuels sector that will create a challenge to the design of an emissions trading scheme in terms of addressing market power as well as ensuring trading liquidity (Goldblatt, 2010b).
- Thirdly, in terms of the administration of an emission trading scheme, most installations in EU ETS chose between a *method of calculation* or *continuous measurement*, with the former being the practical choice (Brohe, 2010). Each member state in the EU ETS is also required to keep a national registry to ensure accurate accounting of all allowances under the Kyoto Protocol (Brohe, 2010). It is clear that any emissions trading scheme in South Africa will require additional administrative resources for both the government and firms alike.
- Fourthly, the tax implications of cap-and-trade can be complicated, especially in the EU ETS, where there has been extensive grandfathering of emission rights (allocating them without charge) (IMF, 2008). Some experts argue that the grandfathered rights should be recorded as tax expenditure as a minimum, opening the issue up for public debate (IMF, 2008). This will present a valid challenge for South African Revenue Service (SARS) and NT if an emissions trading system were to be implemented in South Africa.
- Fifthly, in respect of the challenge of distributional incidence, a study examining the welfare effect of emissions trading under oligopolistic trading conditions found that refunding 10% of the emission trading proceeds resulted in optimal welfare improvements where such proceeds are reinvested in renewable energy sources (Traber & Kemfert, 2010). In South Africa, the structure of the energy sector market is oligopolistic (National Treasury, 2010), and provided the proceeds from emissions trading are invested in renewable energy, the challenge may be addressed effectively.

The effects of carbon tax on the competitiveness of industries are positive, and in addition, the carbon tax also increases fiscal revenue, although when replacing another tax, the results may be adverse to the fiscus. The effect of cap-and-trade schemes over the long term on industry is positive, with most EU ETS countries still experiencing positive GDP per capita growth at current prices over a five-year period of the EU ETS.

CONCLUSION

The objective of this article was to consider the effect of cap-and-trade and carbon tax schemes on sustainable development and to use this information in assessing the National Treasury's decision to implement carbon tax in South Africa. In determining the impact of cap-and-trade and carbon tax on sustainable development, the distinguishing features between both instruments were highlighted. The primary difference is that carbon tax is a pricing instrument offering certainty about price but uncertainty about the quantity of emission reductions, whereas a cap-and-trade scheme is a quantity instrument, offering certainty about the quantity of emission reduced but uncertainty about the carbon price.

The studies evaluating the effect of carbon tax on greenhouse gas reduction confirm that the tax has the overall effect of reducing greenhouse gases. These results were obtained from both models predicting the impact of carbon tax on greenhouse gases as well as post-ex results of introducing a carbon tax. In respect of emissions trading, the first phase of the EU ETS showed no decrease in carbon emissions, which was primarily due to permit allocation being based on estimates of carbon emissions rather than verified emissions. However, the second phase of the EU ETS showed a material decline in carbon emissions with caps being based on verified emissions. On a whole, the impact of both market-based instruments on environmental and economically sustainable development is positive. The National Treasury's reasons for not implementing cap-and-trade schemes were explained on the basis of a list of factors that were considered challenging within a South African context. These challenges included the credibility of emission cap, the allocation of permits, the need for a competitive market to facilitate trading, price uncertainty, tax implications, the need for new financial regulations and administrative capacity as well as the non-transparency of distributional incidence.

The significant challenges from a South African context remain a competitive market for trading, price uncertainty, tax implications and administrative capacity. The welfare effect may be positive provided the South African government reinvests proceeds from emissions trading in renewable energy. The credibility of the emission cap and allocation of permits can be addressed by using verifiable emissions as a basis for determining the quantitative limits of carbon emissions and allocating permits based on verifiable emissions rather than grandfathering permits. The decision by the Treasury on a whole is considered rational and acceptable from an economic and environmental perspective.

LIMITATIONS AND FUTURE RESEARCH

A key limitation of the study is that it does not produce any new empirical insights nor does it necessarily validate any existing empirical insights. Notwithstanding this limitation, the article contribution can be seen in it contrasting evaluation of cap-and-trade schemes as opposed to carbon tax schemes, especially in the context of a developing economy such as South Africa. Although the study has led to theoretical insights regarding the relationship of carbon tax and cap-and-trade schemes on greenhouse gas emissions and economic growth, an empirical study will be necessary to validate the theoretical conclusions arrived at in the study. As far as future research opportunities regarding the impact of carbon tax and cap-and-trade schemes on economic and environmental sustainability, the following may be considered. The third phase of the EU ETS started in 2012 and should end in 2020. The level of allocated permits in the third phase is expected to be even smaller than in the second phase. The impact of a shortfall in permit allocations on carbon leakage, which occurs when there is an increase in carbon dioxide in one country as a result of an emissions reduction by a second country with a strict climate policy could be significant. The ability of multi-national companies operating in countries with stringent climate change policies to shift production processes to other countries with less stringent climate change policies and thereby nullify any emission reductions should be considered in determining the true effectiveness of the EU ETS in the third phase.

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