The Accounting Concept Of Measurement And The Thin Line Between Representational Measurement Theory And The Classical Theory Of Measurement

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ABSTRACT

The purpose of this study is to discuss a possible way forward in accounting measurement. It also highlights the importance of understanding the lack of appreciation given by the accounting researchers to the distinction between representation measurement theory and the axioms of quantity on which the classical theory of measurement is based. For long, research in measurement theory has classified representational measurement as nothing but applications of the axioms of quantity. It was believed that there is in existence a single approach to measurement theory. However, recent studies in measurement theory have shown that there are two sides to measurement theory; one side at the interface with experimental science which is emphasized in representational measurement and the other side at the interface with quantitative theory which is emphasized in the classical measurement theory. Research in accounting measurement has concentrated on establishing a representational based accounting measurement theory. This has been done under the premise that no measurement theory exists in the discipline. Thus, this viewpoint neglects the concepts of classical measurement theory that already exists in the accounting discipline. Moreover, this created misunderstandings in accounting with regard to whether a theory of measurement exists in the discipline. This study highlights that the accounting concept of measurement was conceived under the principles of the classical measurement theory. Therefore this reason, it is suggested that research and improvements to the accounting measurement concept should be made in the light of the already existing principles of the classical theory of measurement in which the accounting concept of measurement was conceived.

Keywords: classical measurement theory; representational measurement; ontological; rationalism; empiricism

INTRODUCTION

In measurement literature, Scott and Suppes (1958) are credited with the conception of the modern principles of measurement. However, along with their conception also came, the confusion as to the distinction between the classical measurement theory and the modern principles of measurement. According to Michell and Ernst (1996:235), it has been reported that representational measurement theory (i.e. the modern principles of measurement) is nothing but applications of axioms of quantity. This viewpoint hides the fact that the modern principles of measurement and the axioms of quantity which form the basis of the classical measurement theory are not quite the same. The distinction lies in the fact that the former requires empirical evidence as proof of its applications while the latter is an essentially theoretical concept invoked to explain observations, but one not, itself, not always open to direct verification (Michell and Ernst, 1996). That is, there are two sides to measurement; one side at the interface with experimental science which is emphasized in representational measurement and the other side at the interface with quantitative theory which is emphasized in the classical theory of measurement.

Research in accounting measurement took the viewpoint that the modern principles of measurement are nothing but applications of the axioms of quantity. According to authors such as Vickrey (1970), Ijiri (1975), Orbach (1978), Willett (1987; 1988), Chambers (1997) and Musvoto (2008; 2011) accounting can only be a measurement discipline if an empirical attribute that is measurable can be found. This implies that measurement can only occur in accounting if the discipline becomes an empirical science. One of the most peculiar things in accounting studies on measurement is that nobody bothers to consider how the discipline came to be known as a measurement discipline in the absence of an underlying theory. Rather, everybody assumes that the absence of known foundation implies that they ought to be developed. According to authors such as Narens (2002) and Ryan *et al* (2002) all measurement processes must have an underlying theory of measurement. This viewpoint suggests the fact that in another epoch accounting must have complied with the principles of a certain theory that qualified it as a measurement discipline.

According to Michell and Ernst (1996) the principles measurement theory can be divided into two eras, that is, dividing the classical that stretched from Euclid and the modern that stretches to Luce *et al* 1990. If this is the case, it follows that, given that the principles of the modern measurement theory were conceptualized by Scott and Suppes (1958) and that double entry was conceptualized in the 15^{th} century (Power, 1996) then it may be argued that the accounting concept of measurement was conceived during the classical era. From the discussion in the paragraphs above, it is clear that research in accounting measurement never considered the role played by classical theory of measurement in the construction of the accounting concept of measurement. Moreover, it is clear that the studies did not appreciate the distinction between the classical and the modern era of measurement.

In the light of the discussion above, this study discusses the circumstances under which the accounting concept of measurement was conceived. It also distinguishes between the classical and the representational measurement theory and the possible way forward in solving the measurement problem in accounting. This study commences with the discussion of the possible role played by Pacioli in influencing the accounting concept of measurement in section 2. This is followed by a discussion of the influence of rationalism on the classical theory of measurement in section 3 and the influence of empiricism on the development of the modern principles of measurement in section 4. Section 5 discusses the mistakes, misconceptions in accounting about measurement theory and the possible way forward in accounting measurement. Conclusions and recommendations are discussed in section 6.

PACIOLI AND THE ACCOUNTING CONCEPT OF MEASUREMENT

In contemporary accounting literature, Luca Pacioli of 1494 is often credited with the invention of double entry bookkeeping. However, according to authors such as Swertz (1987) and Miller and Napier (1993) double entry originated with capitalism. They argue that capitalism could not exist without double entry and as a result double entry originated with the origins of capitalism. The debate about the identity of the father of accounting is not considered important in this study. One of the highlights of this study is to understand the epoch in which accounting was born. Such an understanding would shed light on how accounting came to be known as a measurement discipline. According to Swertz (1987:24) Pacioli of 1494 was a mathematician during the time double entry bookkeeping was born. During this period the beliefs of mathematicians and scientists was embedded in rationalism. Heelan (1965:127) defines rationalism as "the tendency to equate the meaning of reality with what can be expressed conceptually, that is, with what can be defined". This means that everything that falls under a definition belongs to the same class and has identical attributes. It follows that since Pacioli was a mathematician (Power, 1996) and accounting was then expressed in numeric terms, then, it may be argued that accounting definitions followed the rationalist beliefs of its founding fathers. Rather, one would say an apple never falls far from its tree. This viewpoint is also evident in the beliefs of other scientists and mathematicians at the time when scientific views were based on rationalism. For example, Newton expressed the theory of proportions as follows (Mitchell and Ernst, 1996:241): "The ratio of one magnitude to another of the same kind (where the latter is understood as a unit) is expressed through an abstract (i.e., real positive) number"

This view point is evidenced by the concept of addition, subtraction and division in the accounting discipline. Numbers that represent monetary units in the financial statements can be divided to give a ratio. Since, in relation to the concept of double entry monetary units assigned to represent the elements of the financial statements can be added, subtracted or divided to give an abstract number then it can be inducted that the concept of double entry is based on the theory of proportions. Moreover authors such as Spinoza and Leibniz approach science and mathematics from a rationalistic perspective of finding the universal laws of nature from which the cosmos could be built up by pure deduction (Heelan, 1965:128). This viewpoint that incorporates the concept of pure deduction highlights that the world of a rationalist is deterministic. That is to say the world is deduced through hard and fast rules that order events which comprise the world. This view is consistent with the perspective in accounting research on measurement. For example, according to Staubus (1985) studies in accounting measurement have consisted of cataloguing methods of accounting measurement with the hope of deducing a universal law that can be used to explain the assignment of monetary units to accounting phenomena. It is clear from this that the world of the accounting discipline is perceived as deterministic. That is, it asserts that the aim of accounting as a social science is to discover the immutable, absolute normative essences of economic events. The addition of the monetary units representing the different elements of the financial statements implies that there is an underlying operation that dictates addition. For example, Measurement in accounting is defined as (IASB, 2009 Para 99): "the process of determining the monetary amounts at which the elements of the financial statements are to be recognized and carried in the statement of financial position and the statement of comprehensive income".

This definition has certain universality as it can be applied to an endless array of monetary assignments to economic events. That is, accounting measurement is possible in every environment where monetary assignments can take place. In fact there are no stipulated conditions pertain to the environment that restricts its use. Rationalistic tendencies are also reflected in the way this definition of measurement is applied in the preparation of the financial statements. According to the IASB (2009) financial statements are prepared for a specific period of time. This definition of measurement is applied uniformly throughout this time period. In relation to the application of definitions over time in rationalities systems Heelan (1965:127) states:

"Moreover, since a definition is always a synthesis of many elements (connected possibly in time), it follows that whatever falls under the definition is necessarily a system of elements ordered (in time) just as the definition requires; for it is the essence of the rationalist to be normative".

The highlights of this extract are consistent with the normative characteristics of the accounting concept of measurement. For example, the IASB (2009) framework for financial reporting prescribes that accounting measurement should take place under measurement bases such as historical cost, current cost, realizable value and present value. This indicates that the measurement bases are established measurement norms in the accounting discipline. For this reason, it may be argued that the accounting concept of measurement reflects rationalistic tendencies. In this section it has been argued since its inception to the present day the accounting concept of measurement has been based on rationalism. As is indicated in the sections that follow, it is this rationalistic viewpoint that has had an influence on the adoption of the classical theory of measurement in accounting.

RATIONALISM AND THE CLASSICAL THEORY OF MEASUREMENT

In the previous section it has been pointed out that rationalism is the tendency to equate meaning of reality with what can expressed conceptually, that is, with what can be defined. It follows that within the confines of this viewpoint, everything that is capable of being defined or expressed conceptually is considered to be real. For this reason, it may be argued that under this perspective there is a great diversity of what constitutes the proper criterion of knowledge for the discernment of what is real under the definition or conception. Furthermore, one may suggest that no extra proof of the existence of reality is required in this case, but compliance with the conception or with the definition. This viewpoint provides a startling similarity to the principles of the classical theory of measurement. According to Michell and Ernst (1992:236) the classical theory axiomatizes the classical concept of quantity in such a way that ratios of magnitudes could be expressed as positive real numbers. They argue that it is concerned with an absolute, continuous quantity, which is an essentially theoretical concept invoked to explain observations, but one not, itself, open to direct verification. That is, if in proposing a theory, a scientist takes a certain set of attributes to be quantitative, then it is usually quantity in the classical sense that is presumed. This indicates that the proposed theory creates a norm for whatever falls under the definition. In this case, no empirical testing is necessary to find out whether the hypothesis that the phenomenon proposed is really quantitative as intimated by the proposed theory.

It is important to note that equating reality with what can be expressed conceptually or can be defined is key to the existence of the classical theory of measurement. According to Michell and Ernst (1992:236) the classical theory of measurement is not intended to be an account of how measurement is attained in practice, rather, the key theorem is that for each ratio of magnitudes there exists a positive real number. Furthermore, they also argue that this perspective of measurement ensures the measurability of the magnitudes of a continuous quantity. In this case, following rationalistic tendencies it is not necessary to ask the kind of structure that an attribute or a phenomenon must have in order to be measurable under the classical theory of measurement. In relation to the accounting discipline there is an obvious conceptual link between the accounting concept of measurement and the classical theory of measurement.

According to the IASB (2009) measurement in accounting is attained when monetary units are assigned to the value of an economic event that meets the definition of an element of the financial statements. Value in this case, is a theoretical concept whose empirical testability is not necessary for measurement to occur in the accounting discipline. Any monetary unit assignment that can be conceptualized under the accounting definition of measurement qualifies as a measurement in the discipline. The question about how the assignment of monetary units to the value of an element of the financial statements can be defined via observation and experiment is not necessary. The only important aspect is that the assignment of monetary units can be conceptualized under the accounting concept of measurement. In accounting, it is supposed that the structure of value is that of an absolute quantity that can be represented by the real line. Thus, it is clear that the concept of measurement in accounting is based on the theory of measurable magnitudes. The theory of measurable magnitudes is based on a set of facts called the axioms of quantity. Michell and Ernst (1992:238) specify the facts upon which the theory of measurable (absolute) quantities is based as follows:

1. Given any two magnitudes, **a** and **b,** one and only one of the following is true: **a** is identical to **b** (**a** = **b**, **b** = **a**), **a** is greater than **b** and **b** is less than **a** (**a** > **b**, **b** < **a**), or inversely **b** is greater than **a** and **a** is less than **b** (**b** > **a**, **a** < **b**).
2. For every magnitude there exists one that is less.
3. For every ordered pair of (not necessarily distinct) magnitude, **a** and **b**, their sum, **a** + **b**, is well defined.
4. **a** + **b** is greater than **a** and greater than **b**.
5. If **a** < **b**, then there exists **x** and **y** such that **a** + **x** = **b** and **y** + **a** = **b**.
6. It is always true that (**a** + **b**) + **c** = **a** + (**b** +**c**).
7. Whenever all magnitudes are divided into classes such that each magnitude belongs to one and only one class, neither class is empty, and any magnitude in the first class is less than each magnitude in the second class, there exists a magnitude **z** such that ever **z**' < **z** is in the first class and every **z**" > **z** belongs to the second class

From the axioms above it is clear that the concept of rationalism implies a deterministic world. For example, from the axioms above, suppose magnitude **a < b,** and **b** is less than **c,** then from axiom **5,** magnitudes **x** and **y** exist such that **a** + **x** = **b**, and **b** + **y** = **c**. It follows from this that (**a** + **x)** + **y** = **c** and, so, according to axiom **6, a + (x + y) = c** and consequently from axiom **4, a < c.** Clearly, from **a** < **b** and **b** < **c** it can be concluded that **a** < **c**. In this case, it is clear that whatever falls under the definition of a measurable magnitude is necessarily a system of attributes ordered just as the definition requires. Heelan (1965) points out that the true ontological knowledge of a rationalist definition is characterised by universality (in all possible universes) and necessity (in temporal evolution). This means that a rationalist definition must be applicable to all things that fall under its definition in all contexts and that its application must be a necessary one in relation to a context at a specific point in time. That is, in this case, it must be necessary at a specific point in time for a measurable magnitude to be definable under the axioms of quantity. Thus, the axioms of quantity serve as a causal theory that explains the immutable, absolute essences of measurable magnitudes. According to Musvoto (2011) the structure of monetary units can be represented on the real line. This means that the structure of monetary units has properties that are compatible with the axioms of arithmetic. It is important to note that the arithmetic of integers is based on facts which are not able to be proved. In other words these facts are not empirically testable. For example, the formula for the addition of integers is only a description of the procedure of addition not the proof of addition. Michell and Ernst (1992:238) state it as follows:

"It says the number understood as the sum of **a** and **b** + 1 (the number following **b**) follows **a** + **b** in the number sequence. Consequently, this formula requires that **a** + 1, **a** +2, **a** +3, **a** +4, …, **a** + **c** be consecutive, and thus that the number **a** + **c** may be found by beginning at **a** + 1 (the successor of **a**) and taking each number consecutively until one has counted from 1 to **c**"

The excerpt above clearly highlights that given any magnitude, **z**, there is one that is greater, since, for example, **z** + **z** > **z**. In mathematics it is an obvious concept that cannot be proved. It may be suggested that one knows that this process can always be carried out. This rule is presupposed in the accounting discipline where monetary units are considered to be bound by the axioms of arithmetic. For example, according to the IASB (2009) monetary units representing the values of different assets under the same classification can be added or subtracted in the same way the arithmetic axiom of addition on real numbers is carried out in the absence of proof. In this case, the only necessary condition is its ability to be defined and conceptualized. It may be suggested that this view point is taken for granted and has become a procedure that is normative with regard to dealing with items under the same classification in the financial statements in order to find the total figure.

Furthermore, the extract implies that arithmetic contains the presupposition that the addition of positive real numbers is associative. That is, for example, given three elements of the financial statements, **a**, **b**, and **c,** it is true that **(a + b) + c = a + (b + c)**. Moreover, no proof is required of compliance with this axiom of arithmetic in the financial statements except that the definition of the economic event must fall under the definition of a measurable magnitude under the classical theory of measurement. Hence, it is considered a theoretical concept invoked to explain observations, but one not, itself, open to direct verification.

EMPIRICISM AND THE MODERN PRINCIPLES OF MEASUREMENT

The conversion of science from a rationalistic perspective to an empiricist perspective gave rise to the need to identify reality with both conceptualization or definition with empirical validity. According to Heelan (1965:131) the empiricist revolution started with Heisenberg's great insight of 1925 that a "physical reality must earn its title by being observable" after over three hundred years of unrestrained rationalism. This indicates that modern scientists could no longer accept as real anything that can be defined. Thus, it is also clear that more is needed to identify reality that could be conceptualized or defined. It is also clear that rationalism allowed alternative conceptualizations or definitions of reality to thrive leading to ambiguity and vagueness in identifying reality. Moreover, Heelan (1965:131), also states: "*To be then is to be an object given in perception*". This means that judgments about reality must be supported by empirical evidence. This creates defined boundaries on the meaning of reality as consistent characteristics or manifestations will always be associated with it. That is, the meaning of reality cannot be equated only with what can be conceptualized or defined but also with empirical evidence. In this case, it is necessary to specify the criterion of reality. This provides a precise definition and meaning of reality.

The conversion of science from rationalism to empiricism also sparked a revolution in measurement sciences. A precise definition of the word "measurement lacked before the development of the modern principles of measurement by Scott and Suppes (1958). As Orbach (1978) notes the definition of measurement arbitrarily depended upon a particular author defining the word. This means that the meaning and criterion of reality depended upon a particular author. This limited the universal applicability of the concept of measurement. Campbell (1952) also reflects the strong link between rationalist theory of measurable magnitudes and the era of the classical theory of measurement by pointing out that in measurement it is necessary that the measurement structure be so defined as to satisfy the axioms of additivity. In this case, it may be argued that measurement only took place if the reality conceptualized is believed to possess a structure that can be represented on the real line. This is the viewpoint that is currently prevalent in the accounting discipline. For example, the IASB (2009) recognizes as measurements only the assignment of monetary units to economic events that meet the definition of an element of the financial statements. With regard to the assignment of monetary units to economic events, Musvoto (2011) notes that the structure of monetary units can be represented on the real line implying that monetary units represent a possible underlying measurable magnitude. But, the author also argues that the underlying structure "value" is not empirically testable. If this is the case, one can conclude that the accounting discipline is still locked in the rationalist theory of measurable magnitudes in which the empirical validity of the phenomenon being measured is not important. However, with the conversion of science from rationalism to empiricism there was need to convert measurement theory to suit the empiricist tendencies of the new era. This view is reflected by Scott and Suppes (1958:116) when they remarked:

"A primary aim of measurement is to provide a means of convenient computation. Practical control or prediction of empirical phenomena requires that unified, widely applicable methods of analyzing important relationships between the phenomena be developed. Imbedding the discovered relations in various numerical relational systems is the most important such unifying method that has yet been found ".

This extracts highlights that the use of an abstract structure to represent a phenomenon may vary from place but, the underlying phenomenon must not be changed by the abstract structure used to represent it. In this case, this invariance of the underlying phenomenon allows a theory of its measurement to be created. It is important to note that invariant properties of a phenomenon can only be discovered through empirical testing. As a result, it would be necessary to conduct empirical tests of the underlying phenomenon before measurement can commence. Similarly, Caws (1959: 5) supports this empiricist view of measurement when he defines measurement "as the assignment of particular mathematical characteristics to conceptual entities in such a way as to permit an unambiguous mathematical description of every situation involving the entity and the arrangement of all occurrences of it be in a quasi-serial order". This extract asserts the need for the identity of the properties of the underlying structure to be dichotomous. An unambiguous description of every situation involving an entity requires that its properties be given empirical identities. Such an identity would help in the confirmation of whether or not an assignment is representative. According to Mock (1976:15), an assignment is representative "if predefined relationships among the assigned numbers represent equivalent relationships that exist among the measured attributes".

It is clear from this extract that under the empiricism perspective all measurements must consist of a mapping from one algebraic structure onto another. That is the domain of the measurement function as well as the value of a measurement function must be specified. In relation to the accounting discipline, the IASB (2009) describes accounting measurement as the assignment of monetary units to the elements of the financial statements.

MISTAKES, MISCONCEPTIONS AND THE WAY FORWARD IN ACCOUNTING MEASUREMENT

There have been several suggestions on making the accounting concept of measurement compatible with the modern principles of measurement. These suggestions were based on the premise that the accounting discipline is still in its infancy as a measurement discipline and as a result, all these studies started creating and prescribing foundations of accounting measurement from level zero. The methodological approach in the studies treated accounting as a newly born discipline that needs measurement foundations so that it can take its place alongside empirical sciences. However, these suggestions failed to realize and appreciate that accounting already had foundations of measurement and has been in existence for centuries. It already had foundations of measurement that were based on the beliefs of the rationalist era; beliefs that are different from the current empiricist era dominated by the modern principles of measurement. For instance, Ijiri (1965) after claiming that the accounting discipline lacked foundations of measurement, according to the modern principles of measurement, introduced the value allocation rule of measurement to the accounting discipline. According to Ijiri (1965) the value allocation rule advocates that the adding of values allocated to outgoing resources produces a meaningful value for the decrease in resources resulting from an exchange. This viewpoint highlights the lack of understanding of the development of the principles of measurement. In this case, the value allocation rule places empiricism on the level of the business operations, that is, on the actual carrying out of the transfer of resources. It does not place empiricism in the empirical relational structure of the intrinsic attributes of the outgoing resources. Since the IASB (2009) highlights that value or cost is the property of the elements of the financial statements that should be measured in order to achieve recognition in the financial statements, it follows that both the meaning and the criterion of reality should be identified with the subject's empirical intuition about value or cost. The value allocation rule says nothing about the empirical validity of adding the values allocated to outgoing resources. It is necessary to give the addition operation on value a qualitative interpretation that ensures that the resulting total has an empirical interpretation.

According to Luce *et al* (1971) a set of axiom leading to fundamental measurement may be regarded as a set of qualitative (that is, non-numerical) empirical laws. This means that the meaning of an axiom must be grounded in its criterion of reality. It follows that axioms that facilitate the measurement of an empirical relational structure must give an indication of what reality is like. That is, they should give true and objective information about the empirical relational structure not being merely conceptual. For this reason, with respect to the value allocation rule, it is necessary to have axioms about the addition of values of outgoing resources that are a set of empirical laws. Vickrey (1970) also claims to notice the lack of a measurement theory in accounting, and in this vein he questions the status of accounting as a measurement discipline and concludes that accounting can only be a measurement discipline if an extensive property is found. It can be inferred from this that the author believes that the accounting concept of measurement is not based on an additive property. But, in section 2 it has been noted that the accounting concept of measurement is based on the axioms of quantity that form the basis of the classical theory of measurement. In this case, it can be argued that the author is oblivious to the fact that accounting already has foundations of measurement but, an interface between the classical theory of measurement and the modern principles of measurement is needed. According to Michell and Ernst (1996:236) there are two sides to measurement theory: one side (emphasized in the modern era) at the interface with experimental science, the other side (emphasized in the classical) at the interface with quantitative theory. However, some accounting studies (e.g., Ijiri, 1967, 1975; Orbach, 1978; Willet, 1987, 1988; Walker and Jones, 2003 & Musvoto, 2011) have concentrated on the applications of modern measurement theory to accounting neglecting the already existing principles of the classical theory of measurement in accounting. It may be argued that this has somewhat caused the accounting concept of measurement to be misunderstood.

In section 2, it has been argued that the accounting concept of value or cost measurement is based on quantitative theory. It has also been pointed out in section 2 that quantitative theory is an essentially theoretical concept that is invoked to explain observations, but one not, itself, open to direct verification. If this is the case, it may be argued that in order to transform this theoretical concept in accounting to conform to the modern experimental science one needs to consider the kind of structure cost or value must have in order to be empirically testable. That is, if one wishes to experimentally test the hypothesis that cost or value are continuous quantities consideration of observable structures having continuous structures would be relevant if the experimenter took the extra step to support the quantitative theory by linking the hypothesized quantities (cost or value) to observable structures.

The failure to appreciate this has also led to the misunderstanding of the accounting concept of measurement. For example, Willet (1987, 1988, and 1992) consistently searches and aims to construct foundations of accounting measurement under the presumption that no measurement currently takes place in the accounting discipline apart from the measurement of monetary units. Willet (1987, 1988, and 1992) proposes the development of accounting measurement theory using the transaction theory. This theory did not focus on bridging the gap between the hypothesized belief that value is a continuous quantity and the observable structures of that sort. Rather, the modern principles of measurement are used to interpret the accounting definition of measurement stated by the IASB (2009 Para 99), as "*Measurement is the process of determining the monetary amounts at which the elements of the financial statements are to be recognized and carried in the balance sheet and income statement"* as a contribution to the accounting theory of extensive measurement. In this case, value is believed to be measured extensively via a directly observable concatenation operation on monetary units. Clearly, this is a shift from the essentially theoretical concept of quantity that form the basis of the classical theory of measurement on which the accounting concept of measurement is based. As a result, one has to appreciate that the account of measurement theory given in the accounting discipline is not intended to be an account of how measurement is attained in practice, as is intimated by the modern principles of measurement. The question that fascinates Willet (1987, 1988, 1992) and other accounting measurement theorists such as Vickrey (1970), Orbach (1978) and Chambers (1997) through the use of modern measurement theory is how measurable empirical structures of economic events can be defined in the financial statements through observation and experiment. But, the accounting discipline shows little interest in this. As reflected in the definition of accounting measurement above, the question that interests the IASB (2009) is that; in hypothesizing that the value or cost of an element of the financial statements is a measurable continuous quantity, what kind of structure must it have so that ratios of their magnitudes can be expressed on the real line. In this case, using the classical theory of measurement the hypothesis that value or cost has a structure that matches monetary units is not intended to be empirically testable. Although, Willet (1987, 1988, 1992), Ryan *et al* (2002) and Musvoto (2008, 2011) draw attention to the lack of empirically testability of the relationship between value and monetary units the representing structure, they mistakenly attributes this to the lack of foundations of measurement in the accounting discipline. Their arguments fail to recognize that there are two sides to measurement theory, as Michell and Ernst (1996: 236) states: "one side (emphasized in the modern era) at the interface with experimental science, the other side (emphasized in the classical) at the interface with quantitative theory". It is clear that the concentration by accounting measurement theorists on using the modern principles of measurement to develop the accounting measurement theory has in a way contributed to the neglect of the connection between accounting measurement theory and the quantitative theory. Evidently, there is an obvious link between translations of the ratio scale structures of monetary units and the theory of ratios of magnitudes.

However, there is also another respect in which the accounting concept of measurement, perhaps, may have been misinterpreted. It is not clear from the discussion in this paper exactly what the accounting discipline's view of measurement is. On one hand it may be argued that the view of measurement in accounting is a representational one. As noted above, the IASB (2009) refers to measurement in accounting as the assignment of monetary units to the elements of the financial statements. According to Musvoto (2008:147), the ratio scale character of monetary units measurement is based on the numerical representation of monetary unit intervals so that the value associated with the concatenation of adjacent intervals is the sum of values associated with those intervals. This means that the hypothesis that monetary units can be represented on the real line is empirically testable. Luce *et al* (1971) highlight that representational measurement takes place once the representation and uniqueness theorem have been proved. That is to say, measurement takes place once a scale of measurement has been specified. For this reason it may be argued that the measurement view in accounting is a representational one. However, given that the IASB (2009) points out that cost or value are the objects of measurement in accounting, then it is necessary to specify the relationship between monetary units as the representing structure and cost or value in order for the measurement view in accounting to be a representational one. Otherwise, it is necessary to do away with all suggestions in the accounting literature that point to phenomena other than monetary units as the objects of measurement if a representational measurement view is to be achieved. Further, it would be necessary to ensure that monetary units assigned to the different elements of the financial statements are measured under identical conditions.

On the other hand, given that the IASB (2009) specifies cost or value as the objects of measurement and monetary units as the representing structure in the absence of specified axioms that specify the relationship between monetary units and cost or value then, it may be argued that the measurement view in accounting is a classical one. As noted above, monetary units are a continuous quantity such that ratios of magnitudes of monetary units can be expressed as positive real numbers. If this the case, it follows that the absence of axioms that specify the relationship between cost or value and monetary units implies that the hypothesis that cost or value can be represented by monetary units is not empirically testable. According to Michell and Ernst (1996) such hypotheses are not meant to be empirically testable under the axioms of quantity, rather they are based on the viewpoint that if in proposing as theory, a scientist takes a certain set of attributes to be quantitative, then it usually quantity in the sense of the classical measurement theory that is presumed. Clearly, it may be argued that the accounting discipline (IASB, 2009) in proposing that value is a continuous quantity in the absence of any requisition of empirical testability, it intended to invoke an essentially theoretical concept invoked to explain economic phenomena which itself is not open to direct verification. Therefore, it follows that under the axioms of quantity if scientist intends to develop an empirically based theory of accounting measurement considerations should be made of observable structures of value that can be represented by monetary units. This discussion highlights that the suggestion by authors such as Musvoto (2011), Walker and Jones (2003), Chambers (1997), Willet (1987, 1988) and Ijiri (1975) that there is no comprehensive theory accounting measurement is possibly without basis. In the light of this discussion, it just depends on whether one wishes to have the classical or representational view of accounting measurement.

CONCLUSIONS AND RECOMMENDATIONS

A theory of measurement is fundamental to every measurement discipline. Accounting has been regarded as a measurement discipline that lacks a theory of measurement. Contrary this belief however, this study has highlighted that accounting is a discipline that does have foundations of measurement. It has been argued that the accounting concept of measurement was developed based on the foundations of the classical theory of measurement. The misinterpretation by accountants of the classical theory of measurement has resulted in a frantic search for an accounting theory of measurement that is based on the modern principles of measurement. Accountants believe that representational measurement is nothing but applications of the axioms of quantity. For this reason they believe that all purported measurement must be empirically testable. But, there are two sides to measurement: one side (emphasized in the modern era) at the interface with experimental science, the other side (emphasized in the classical) at the interface with quantitative theory.

In the light of the above, it is recommended that improvements to the accounting theory of measurement should take into account the fact that it is currently based on the classical theory of measurement. Hence, attempts should focus on finding the empirical identity of the axioms of value.

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