A COMPARATIVE ANALYSIS OF THE DIVISIA INDEX AND THE SIMPLE SUM MONETARY AGGREGATES FOR SOUTH AFRICA.

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ABSTRACT

The effectiveness of monetary policy in achieving its macroeconomic objectives such as price stability and economic growth depend on the monetary policy tools that are implemented by the Central Bank. Monetary aggregates are one of the tools that have been used as indicators of economic activity and as intermediate targets to achieve these economic objectives. Until recently, monetary aggregates have been questioned and criticised on their usefulness in monetary policy. This has been attributed to the economic, financial and technological developments that have distorted the relationship between monetary aggregates and major macroeconomic variables.

This study investigates the relevance of monetary aggregation by comparing the traditional simple sum and Divisia index monetary aggregates which was constructed for the first time for South Africa using the Tornquist-Theil method. The Polynomial Distributed Lag model is employed to compare the performance of these monetary aggregates using their relationship with inflation and manufacturing index. Furthermore, the aggregates are compared in terms of their controllability and information content.

Overall, the study found a very strong relationship between inflation and all the monetary aggregates. However, more specifically the results suggested that the Divisia indices are superior to the simple sum in terms of predicting inflation. The evidence further suggests that the Divisia aggregates provide higher information about inflation than the simple sum aggregates. Regarding the controllability of the monetary aggregates, the findings suggest that the monetary authorities can hardly control the monetary aggregates using monetary base. Finally, the relationship between manufacturing index and all the monetary aggregates was very weak.

Key words: *Monetary aggregation, Divisia index, Simple sum, Inflation and Money*

JEL Classification: E5, E52

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ABBREVIATIONS

SM……………..Simple sum
DM…………….Divisia Index
GSM…………...Growth rate of simple sum
GDM…………..Growth rate of Divisia Index
NCD……………Negotiable certificate of deposit
SARB…………..South African Reserve Bank
VES…………….Variable elasticity of substitution
CE……………...Currency equivalent
PDL……………Polynomial distributed lag
SVAR………….Structural vector autoregressions
SE………………Standard error

CHAPTER ONE:
INTRODUCTION

1.1 BACKGROUND INFORMATION

Money is a fundamental aspect of any thriving economic system, such that both the macroeconomic analysis and the effectiveness of monetary policy are based on the stability of the demand for money function and a stable relationship between money and nominal national income and other macroeconomic variables (Gebregiorgis and Handa, 2005:119). The roles of money include forecasting, information sourcing, indicating economic activity and generally facilitating monetary policy. However, some measurements of money perform these roles better than others. Therefore, an appropriate definition of money needs to be determined for each economy and re-examined periodically to keep it aligned to economic, innovative and technological changes (Gebregiorgis and Handa, 2005:120).

Monetary policy objectives and frameworks have continued to evolve over the past 20 years in both developed and developing countries. These changes have transformed the definition and function of monetary aggregates as a monetary policy tool. The major highlight that can be cited is the abandonment of the monetary targeting framework in the 1980s by the United Kingdom, New Zealand, Germany and Australia among others (Drake and Fleissig, 2006:681). In 2000 and 2007, emerging market economies such as South Africa and Ghana respectively, abandoned the monetary targeting framework and adopted inflation targeting on the basis of a seemingly insignificant relationship between money and inflation (Stals, 1997; Acquah, 2007). Even though monetary aggregates have generally failed as the intermediate target for inflation, Central Banks still use them among other variables to forecast inflation outcomes twelve to twenty-four months ahead, and also as economic indicators (Drake and Fleissig, 2006:681). In essence, monetary aggregates are still important monetary policy tool even though they are currently indirectly utilised.

Over the years a number of monetary aggregation methods have been used by researchers. The simplest and most common measure is the simple sum monetary aggregation method. This method involves the simple adding together of heterogeneous monetary assets to form aggregates such as M1 (M1A[2] plus other demand deposits), M2 (M1 plus short and medium-term deposits) and M3 (M2 plus long-term deposits). The effectiveness of such aggregate has been debated by economists over the years because it has failed to sustain a stable and predictable relationship with macroeconomic variables such as inflation and gross domestic output (Duca and VanHoose, 2004:265). The major criticism against the simple sum aggregate is that it approaches different assets such as currency, bank time deposits and long-term deposits as perfect substitutes for each other assuming an equal weighting of unit for each of these different assets. Barnett *et al.* (1992:2088) illustrate this problem by showing that the different assets in each aggregate, such as six assets in M1, eight in M2 and about two dozen in M3, have a wide spectrum that ranges from currency and travellers' cheques that are liquid to commercial paper and savings bonds which are less liquid. Barnett *et al.* (1992:2088) argue that it is difficult to justify the summation of the component assets which differ in yield and term to maturity given that simple summing is based on the view that only commodities with perfect substitutes can be summed as one commodity.

Financial innovations in the banking sector, specifically the introduction of monetary assets that are close but less than perfect substitutes for highly liquid assets, have further made the simple sum aggregate less robust (Drake and Fleissig, 2006:682). The highly innovative and technologically progressive environment made the use of equal component weights inappropriate and has affected the productivity and liquidity of these monetary assets; therefore the weights cannot be assumed to be the same (Binner *et al.*, 2004:214). This argument is based on the "moneyness" of the assets, meaning that the service that each asset provides differs, as a result their weights should also be different (Drake and Fleissig, 2006:683). These innovations elucidate the problem of simply adding up various financial assets (currency, demand deposit, NOW accounts[3]), raising more arguments on the usefulness of the simple sum rendering it less useful as an intermediate target for monetary policy (Drake and Fleissig, 2006:683).

A number of methods have been proposed to overcome these criticisms; the most advocated method is the Divisia index which was popularised by Francois Divisia in 1925. This monetary aggregation method is derived using the statistical index numbers theory (Handa, 2000:186) and

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[2] Notes and coin in circulation plus cheque and transmission deposits of the domestic private sector with monetary institutions.

[3] Negotiable Order of Withdrawal accounts.

was defined by Hulten (1973:1017) as a weighted average of the growth rates of different monetary assets of an aggregate. The assets are weighted according to their usefulness for making transactions which is proxied by their user cost. The Divisia index has been recommended as a good monetary aggregation measure (cf: Barnett, 1980; Belongia, 1996; Wesche, 1996; Gazely and Binner, 2000; Gilbert and Pichette, 2003; Dahalan *et al.*, 2005 and Drake and Fleissig, 2006). Authors have argued that the Divisia monetary aggregates have superior information content, forecasting and predictive power over the simple sum. Moreover, the Divisia aggregates allow non-perfect substitution between assets with varying weights. In essence, the Divisia index allows a more accurate measurement of money in an economy based on its moneyness (Drake and Fleissig, 2006:685).

Moreover, in relation to the simple sum the Divisia index separates the transactional function of money from its functions as a store of value (savings) and unit of account. More specifically, the Divisia index assesses the utility the consumer derives from holding a portfolio of different monetary assets instead of measuring the stock of money held in the economy (Wesche, 1996:2). Barnett *et al.* (1992:2088) taking a microeconomic view, argue that an optimal statistical summary for transaction services available shows that the Divisia index displays a closer correlation, and is a better leading indicator of nominal spending and inflation than its simple sum counterparts. On the other hand, Gazely and Binner (2000) notes that the computation of the Divisia index is far much complicated than the simple sum method, and the results are not usually clear cut. Stracca (2001:12) states that since the Divisia index focuses on the transactional function of money it should by no means be considered as an encompassing indicator of the role of money in the economy. In spite of some of the disadvantages stated above, Gilbert and Pichette (2003:3) still recommend the Divisia index over the simple sum.

Given the debate around monetary aggregates, especially between simple sum and Divisia aggregates, and the supposed advantages of the Divisia over simple sum, it is vital to construct such an index for South Africa, since it is currently not available. The construction of the Divisia index will help in evaluating the performance of the alternative monetary aggregates in terms of their relationship with macroeconomic variables, their controllability by the SARB, and information content.

1.2 OBJECTIVE OF THE STUDY

The main objective of the study is to evaluate the monetary aggregation methods in South Africa, namely the simple sum (SM) and Divisia index (DM). The ultimate goal is to recommend the most appropriate monetary aggregation method for South Africa. To achieve this objective the following goals are pursued:

- To construct a Divisia index for South Africa,
- To evaluate the DM and SM monetary aggregates in terms of their explanatory power of inflation and national income proxied by the manufacturing index,
- To determine the controllability of DM and SM monetary aggregates,
- To rank the information content of the DM and SM monetary aggregates, and
- To make recommendations on the most appropriate monetary aggregates for making policies.

1.3 DATA AND METHODOLOGY

The data to be used for the construction of the Divisia index are the monetary assets (bank notes and coins, cheques and transmission deposits, other demand deposits, short and medium term deposits and long term deposits) ranging from January 1986 to December 2006. Negotiable certificate of deposit (NCD) 3, 6, 12 and 36 months and Government 10-year yield bonds are also be employed for the Divisia index in the calculation of the user cost. The data will be collected from the South African Reserve Bank and Thomson DataStream. The derivation of the Divisia index will be done using the Tornquist-Theil discrete time method, and the econometric analysis used to evaluate the monetary aggregates is the Polynomial Distributed Lag (PDL). These methods will be explored in detail in Chapter four.

1.4 OUTLINE OF STUDY

The rest of the study is organised as follows: Chapter Two gives an overview of the evolution of monetary aggregation and monetary policy in South Africa. Chapter Three explores the theoretical evolution of monetary aggregation and empirical studies that form the basis of this study. Chapter Four explains the derivation of the Divisia index using the Tornquist-Theil discrete index, and the comparison of these monetary aggregates is done using the Polynomial Distributed Lag model. The results of the study are presented and discussed in Chapter Five. Chapter Six provides the conclusions, policy recommendations, limitations of the study and suggestions for further research.

CHAPTER TWO:
OVERVIEW OF MONETARY AGGREGATION AND MONETARY POLICY IN SOUTH AFRICA

2.1 INTRODUCTION

This chapter provides an overview of the evolution of South African monetary aggregation. The chapter also highlights the changes that have taken place in the economy and their likely consequences for the function of monetary aggregates in a range of monetary policy frameworks that have been implemented in South Africa. The chapter further shows how monetary policy frameworks have evolved, and how the function of monetary aggregates has changed over time. These changes are mainly a result of financial innovations and the explicit move from market controls towards liberalised market-oriented policies. These changes are some of the reasons why the SARB moved from monetary targeting to an inflation targeting framework which indirectly makes use of monetary aggregates as a monetary policy tool.

2.2 SOUTH AFRICAN RESERVE BANK (SARB) OBJECTIVES AND TOOLS

The primary objective of the SARB is to protect the value of the rand and guarantee sustained economic growth. Price stability is attained when changes in the general price level do not significantly affect the economic decision-making processes (Casteleijn, 2003:4). It is important for the SARB to achieve price stability and remain consistently in its policy framework so that it can gain credibility. This will encourage investment and economic growth (Smal and de Jager, 2001:16). To achieve this objective, the SARB implemented a number of frameworks such as exchange-rate targeting, monetary targeting and currently inflation targeting (Casteleijn, 2003:4). The decision of which policy to follow is the critical decision that policymakers have to make. This study analyses the use of monetary aggregates as a monetary policy tool and evaluates their performance in achieving these economic objectives.

2.3 BRIEF HISTORY OF MONETARY AGGREGATION IN SOUTH AFRICA

The monetary aggregates in South Africa were originally based on the transactions criterion. The first official money supply figures were published in 1946. This definition of money supply included the sum of gold, silver and copper coins in circulation, the net amount of banknotes held outside the banking system, demand deposits with the commercial banks and deposits with the Reserve Bank other than bank deposits (De Jongh, 1947:90). At the beginning of 1963 considerable changes were made to the analysis and the liquid criterion was adopted for the first time in defining a broad money concept. Money was therefore defined as notes and coins in circulation outside the banking sector and demand deposits with the commercial banks and the Reserve Bank, excluding the deposits of the commercial banks, the government and the International Monetary Fund with the Reserve Bank.

In 1966 more formal aggregates were announced as “money” and “near money”. The definition of money was extended to include notes and coins in circulation outside banks, demand deposits with commercial banks and the Reserve Bank, call money with the National Finance Corporation and discount houses, and demand deposits with merchant banks and certain other monetary banking institutions. Near money included money as shown above and short- and medium-term deposits with commercial banks, merchant banks, the Land Bank and other monetary banking institutions (Driscoll *et al.*, 1981:219). The new definition signified a further shift from the transactions criteria towards a liquidity approach.

Another notable change was the revision of these aggregates in 1984, which brought the inclusion of the deposits with certain deposits-receiving institutions into the definitions of monetary aggregates, specifically those with non-monetary banks, building societies and the post office savings bank and pooled funds, in addition to deposits with the monetary banking sector (Van der Merwe and Terblanche, 1984). With the continual evolution of money more monetary aggregates were announced by the SARB, and these included M10 which only included coins and bank notes in circulation, M1A, which was M10 plus cheques and transmission deposits, M1 which was M1A plus other demand deposits, M2, which was M1 plus other short- and medium-term deposits and finally M3, which is M2 plus long-term deposits (SARB, 1997). Another notable change in 2004, particularly to M2 and M3, was the inclusion of negotiable promissory notes. The monetary aggregates have always included negotiable certificates of deposit, but excluded promissory notes. In the recent past, negotiable promissory notes have gained considerable importance and have emerged as an extremely close substitute for negotiable certificates of deposit (NCDs) (SARB, 2004:82-85). This brief overview shows how monetary aggregation has evolved over time from the 1960s to the present. The following section shows the evolution of monetary policy in South Africa.

2.4 EVOLUTION OF MONETARY POLICY FRAMEWORKS (1960s to present)

This section highlights the evolution of the monetary policy frameworks since the 1960s. Special emphasis is on showing how the definition and function of money has changed over time with the monetary policy framework changes.

2.4.1 Liquid asset ratio-based system (1960-1981)

This regime employed the liquid asset ratio which was based on quantitatively controlling interest rates and credit (Aron and Muellbauer, 2006:2). In this framework interest rates had a minor corrective role, while the major monetary tool was controlling liquid asset[4] requirements. Commercial banks had to hold a certain percentage of liquid assets as a minimum proportion of deposits. The main idea behind this method was to limit the supply of and yields on these assets, and thereby reducing bank lending and consequently money supply growth rate, and curbing inflation (Aron and Muellbauer, 2006:2).

Strydom (2000:2) identifies a number of internal conflicts and instrument inadequacy that became drawbacks to this monetary policy framework. For instance, the method allowed banks to easily convert advances into liquid assets and comply with the bank regulations, and this undermined the effect of the policy instrument. According to Strydom (2000:2), policy effectiveness was also compromised by interest rate controls. Credit extension during this period was distorted because of extensive disintermediation caused by the limits on credit extension by the banking sector, and reintermediation when the credit ceiling was abandoned (Casteleijn, 2003:4). The increased dissatisfaction with this framework saw a review of the monetary policy framework in the early 1980s.

[4] The liquid assets used were SARB notes, coins, gold coins, cash balances with the SARB and large number of financial assets such as treasury bills, government stocks, banker’s acceptances and trade bills.

2.4.2 Mixed system during transition (1981-1985)

The De Kock Commission (1978) was appointed to evaluate the monetary policy framework, and this led to the removal of non-market-oriented controls such as deposit rates and bank credit ceilings, and thus to more liberalised policies (Strydom, 2000:3). This decision led to the introduction of the market related policies such as the floating exchange rate system and the fluctuation of short-term interest rates with the business cycle. The policy objectives at this time were merged: these included price stability or control of inflation, and monetary aggregate targeting was also used as an immediate target. This brought the announcement of the first money supply target in 1985 (Smal and de Jager, 2001:2). This was a transitory phase and was followed with a more formal framework which will be discussed in the following section.

2.4.3 Cost of cash reserves-based system with pre-announced monetary targets (1986-1998)

Under this framework, monetary control operations were based on the cost of the cash reserves rather than the quantity or availability of cash reserves as in the liquid asset ratio system. The SARB's discount rate influenced the cost of overnight lending, and consequently the market interest rate; hence the name "cost of cash reserves". The short-term interest rate became the main monetary policy instrument because of its influence on the cost of overnight lending and market interest rates in reducing the demand for credit (Casteleijn, 2003:4). To effectively implement this process in the late 1990s the Reserve Bank had to create a persistent "money market shortage" to induce banks to borrow from it. Thus monetary control was used indirectly to reduce the demand for money, although a 12-month lag time existed to influence inflation (Aron and Muellbauer, 2006:2).

As recommended by the De Kock Commission (1985), explicit money growth rate-targets were announced for M3 from 1986 to1998. A three-month broad money growth average was used to set the monetary targets annually. The target was aimed at projecting economic growth and controlling inflation. The major setback was the transparency of the target selection procedure. These pre-announced monetary targets were indirectly achieved by adjusting interest rates through slowing down demand for money (Aron and Muellbauer, 2006:3). Target deviations were prevalent and there was persistent overshooting from 1994 after the sharp increase in capital inflow into South Africa. In 1994 M3 increased at rates consistently higher than the set targets, but inflation nevertheless declined, contrary to expectations. This prompted the introduction of the eclectic approach to monetary policy-making in the late 1990s (Smal and de Jager, 2001).

2.4.4 Eclectic approach[5] (1998-1999)

The usefulness of monetary targeting seemed to have sharply declined in the early 1990s due to financial liberalisation and structural developments. The extensive financial changes which began as early as the 1980s was further intensified in the 1990s by large capital flows. The relationship between growth in the money supply, output and prices was significantly distorted. This reduced the usefulness of money supply targets[6]. The reduced use of monetary targeting led to the introduction of an eclectic set of indicators to supplement the guidelines[7]. Since the usefulness of supply targets was compromised because of economic changes, this lead to the use of the eclectic framework whose indicators had previously been used but to a lesser extent (Aron and Muellbauer, 2006:2). Since money appeared to have lost its usefulness as the most important indicator of possible future trends in macroeconomic variables, it was no longer an appropriate anchor for monetary policy.

Monetary accommodation was introduced in 1998 using a daily tender of liquidity through repurchase transactions. A predetermined fixed interest auction was used at the inception of the new system, and discontinued in early 2000. In March 1998, the M3 growth guidelines were published for a three-year period, and an informal inflation target of 1-5 per cent was set for the first time. The aim of this monetary policy framework was to effectively ration the amount of liquidity in the banking system. The SARB intended to signal policy intention through the amount offered at the daily auction for repurchase transactions (Casteleijn, 2003:5). Nonetheless, the disadvantage was that conflicting signals were set for money supply and for inflation. The need for policy focus, coordination, transparency and accountability contributed to the abolition of the eclectic monetary policy framework.

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[5] This method included, daily tenders of liquidity through repurchase transactions (repo system), plus pre-announced M3 targets and informal targets on core inflation.

[6] Researchers such as Belongia (1996) state that the breakdown was due to erroneous measurement of money.

[7] The exchange rates, asset prices, gross domestic output, balance of payments, wage settlements, extension of credit and the fiscal policy.

2.4.5 *Formal inflation targeting (2000 to present)*

Informal inflation targeting came with some success, which prompted the authorities to formalise the framework in 2000. The major reasons for this move were the uncertainty to the public which the informal inflation targeting brought, better coordination of monetary and other policies, and the need for clear targets and increased independence in policymaking (Van der Merwe, 2004:2). Although monetary targeting was abandoned, the inflation targeting framework uses money as an indirect indicator, and more importantly in its repo rate[8] system. These monetary policy frameworks are summarised in Table 2.2 below:

Table 2.1: Evolution of South Africa's Monetary Policy Frameworks

YEARS	**MONETARY POLICY**
1960-1981	Liquid asset ratio-based system with quantitative controls over interest rates and credit
1981-1985	Mixed system during transition
1986-1998	Cost of cash reserves-based system with pre-announced monetary targets (M3)
1998-1999	Daily tenders of liquidity through repurchase transactions (repo system), plus pre-announced M3 targets and informal targets for core inflation
2000-present	Formal inflation targeting

Source: compiled by author from Aron and Muellbauer (2006).

Table 2.1 above shows the changes in monetary policy frameworks from 1960 to the present, and that in all the frameworks money played an integral part. The central focus in the liquid asset ratio based system was to limit and lower yields of liquid assets, which consequently forced banks to reduce lending and money-supply growth. The cost of cash which explicitly had pre-announced monetary targeting used the money-market shortage to affect its discount rates, which would influence the supply of credit. From 1999 to the present, the repo rate system has been used and it depends on money-market shortages to be effective. This suggests that money is central in monetary policymaking in South Africa.

[8] The Reserve Bank creates a money market shortage so as to make its repo rate effective and influence the market.

2.5 CONCLUSION

The changes that South Africa has undergone as an economy have brought changes to the function and significance of monetary aggregates as a monetary policy tool. These changes have also led to the evolution of monetary policy frameworks in an effort to adapt to economic changes and still accomplish the macroeconomic objectives such as price stability. The definition of money has evolved with time due to the continual global changes. There is need to constantly revisit the measurement of money to allow its direct or indirect use to capture these changes and allow effective monetary policy formulation. From the overview it is evident monetary aggregation has been fundamental in the monetary policy frameworks that South Africa has adopted because of its impact on economic activity. The next chapter discusses the theoretical and empirical background of monetary aggregation, measures of money and their advantages and disadvantages. Finally, the chapter will explore the methods of evaluating the monetary aggregates in order to select the most appropriate monetary aggregation method.

CHAPTER THREE:
MONETARY AGGREGATION: REVIEW OF THEORETICAL AND EMPIRICAL ISSUES

3.1 INTRODUCTION

The success of any economy is based on its ability to achieve the four main macroeconomic objectives, which are economic growth, full employment, price stability and balance of payment stability (Gazely and Binner, 2000). The achievement of these objectives depends to a large extent on the monetary policy frameworks and tools that the monetary authorities choose to implement. A number of these frameworks and tools have been used and have also evolved with changes in economic environments. Targeting monetary aggregation is one of the tools that have been employed successfully, but has recently been criticised on its relevance in monetary policy formulation and questioned on its direct use as a monetary policy tool.

Contradictory views on the importance and function of money as a monetary policy tool have been brought forward by many economic theorists. The debate started with the early Keynesians, who attached very little importance to money and consequently its function as a monetary policy tool. On the other hand, the monetarists brought forward a theory that emphasised the importance of money in an economy and its vital role in monetary policy formulation (Froyen, 2005). According to Belongia (1996:1065), the inferences about the effects and importance of money depend on the choice of monetary aggregation methods used to calculate money, thereby determining its effectiveness. The objective of this study is to determine the most appropriate aggregation method. To accomplish this objective the current chapter will review both the theoretical literature and the large pool of empirical studies regarding the importance of money measurement, and compare the different methods empirically.

The chapter is organised in the following manner: the first section defines money and its functions, and explains how these have evolved over time. The second section explores the theoretical background of monetary aggregation methods, their weaknesses, and how these affect money measurement. The final section outlines empirical evaluation techniques of monetary aggregation methods. These empirical studies are organised chronologically to show how the studies have developed. The review starts with developed countries and follows with empirical studies of developing countries. In conclusion, this chapter summarises the general findings from emerging and industrialised countries confirming which aggregation method is effective.

3.2 THE DEFINITION AND IMPORTANCE OF MONEY

The definition of money has been a topic of debate for centuries; there are several possible variants of its form and several possible ways of selecting a preferred definition among them. One way of defining money is according to its function. The functions of money are broadly categorised as: unit of account, store of value, medium of exchange and standard deferred payment function. According to Van der Merwe and Terblanche (1984:36), theoretical definitions of money abound with the problem of statistical demarcation and measurement. They also differ from country to country and these differences are largely dependent on the emphasis that is placed on the various functions of money.

According to Yue and Fluri (1991:21), Handa (2000:178) and Hancock (2005:39) the medium of exchange is the most important characteristic of money, such that any asset that does not perform this function could not be regarded as money. This narrow definition of money was limited to only include currency and demand deposits, and excluded financial assets such as saving deposits, cheques and treasury bills (Gazely and Binner, 2000:1608). Critics of this criteria believed that this approach did not always apply in practice, and also argued that no asset is in all circumstances acceptable as a means of payment (Gowland, 1982:3).

Furthermore, regulatory changes and financial innovations cast doubt on the usefulness of the medium of exchange as a definition of money. Due to these changes this narrow definition of money had to change to include financial assets such as currency demand deposits and NOW accounts which were previously not included. Therefore, the spectrum of monetary assets became broad ranging from currency and travellers' cheques that are liquid to repurchase agreements and Eurodollars, to the far extreme of commercial paper and savings bonds, which are less liquid (Drake and Fleissig, 2006:682).

The financial and regulatory changes, particularly interest rate payments led to the consideration of balances held for other purposes. In practice, even if there is no interest rate paid on transactional balances, balances are usually held for other reasons, like precautionary and speculative ones. These changes and problems lead to the Keynes theory of liquidity preference. The underlying idea of this theory is that the demand for money is dependent on the desire for liquidity as well as the need to finance current purchases (Keynes, 1957:170). This means that the transactions approach has to be supplemented with the speculative and precautionary demand for money to get total demand. The liquidity approach emphasises the store of value function unlike the medium of exchange, which stressed the transactional approach. The means of payment represents generalised purchasing power, so that it may be held and act as a store of value or wealth until a point in time at which the holder wishes to exercise the purchasing power. The main advantage of the store of value is that it represents immediately realisable purchasing power, so that wealth held in this form can be spent or converted into other assets with a minimum of inconvenience or delay.

The store of value function was further emphasised by Friedman (1964) ,suggesting that money is a temporary abode of purchasing power because it enables people to separate the act of purchase from that of sale. Proponents of the liquidity approach point out that virtually all financial assets can be converted into a means of final settlement, and also believe that control of the more narrowly defined monetary aggregates may lead to the substitution of narrowly defined money for money-related financial assets. Empirically this approach has been proven to be more ambiguous than the transactions approach, since there is no clear definition of liquidity to guide the selection of financial assets to be considered as money (Hicks, 1962:787).

The definitions explained above show that monetary theory does not provide a unique practical definition of money; therefore various empirical criteria have evolved to establish this definition. One of the empirical approaches brought forward is that the definition of money is mainly concerned with the policy questions of which monetary aggregate can best explain and predict relevant macroeconomic variables such as nominal economic growth (Handa, 2000:178). This definition performed better in its predictions than the other aggregates, which were based on the medium of exchange and the liquidity criteria (Gebregiorgis and Handa, 2005:121). Even though nominal income is one of the macroeconomic variables to be explained, it still needs to be used with caution since financial deregulation and innovations since the 1960s have changed monetary aggregates (Handa, 2000:179). Another important criterion in defining money is the monetary authority's ability to control the level and growth of money. The degree of control depends on the operational variable and the sensitivity of the demand of money to these variables.

Money is significantly different from and more important than other assets because it plays a direct role in transactions, and facilitates trading activities in any economy, among many other functions (Chrystal and MacDonald, 1994). The Quantity Theory of money states that the money stock plays a significant role in determining the long-term price level. In contrast, the monetarists state that in the short-run money influences real activity (Froyen, 2005). In other words, there is a relationship between money (monetary aggregates), inflation and other macroeconomic variables. These relationships are an important part of monetary policy activities, which are aimed at maintaining a stable macroeconomic environment, thereby making money an integral part of monetary policy (Gazely and Binner, 2000:2).

In more recent approaches to monetary policy analysis, there is often no explicit role for the monetary aggregates due to the empirical evidence showing a breakdown in the relationship between money and macroeconomic variables (Binner *et al.*, 2004:214). This breakdown caused changes in monetary policy frameworks with most Central Banks moving towards the use of short-term interest rates. Monetary policy was assumed to influence macroeconomic variables such as inflation and gross domestic product more directly without the use of money stock. Even though money is no longer directly used, Central Banks have to create a money market shortage[9] to enforce the short-term interest rate; therefore money is still an essential tool to any macroeconomic model which subsequently influence growth of real output through factors like investment (Soderstrom, 2001:1).

There are several other reasons why the Central Bank monitors the developments of monetary aggregates. Firstly, money is used as an indicator of future inflation allowing the Central Bank time to implement appropriate policy to reduce the expected inflationary pressure. Secondly, money can be used as a source of information which helps policy authorities to predict present and future movements in macroeconomic variables. Finally, the close relationship between

[9] It is the extent of accommodation or assistance granted by the Reserve Bank to the banking system. Money market shortage is a vital ingredient in the implementation of monetary policy in South Africa. Its significance is that it enables the Reserve Bank to make the repo rate effective (Faure, 2006).

money and credit makes money a very crucial part of the credit channel in the monetary transmission mechanism, and plays an important role in making the process effective (Soderstrom, 2001:1).

Monetary aggregation concepts may be theoretically sound and important but they will not be very useful for analytical and policy purposes if they cannot be appropriately measured. The important functions of money can only be effectively carried out if money is measured accurately. The accurate measurement of money is not an easy task mainly because of two reasons. Firstly, the range of component assets is wide-ranging, from narrow money, which includes coins and bank notes, to broader money, which includes long-term deposits. This complicates the measurement of money because of the varying liquidity levels. Secondly, different monetary assets have different liquidity[10] levels, and therefore they need to be weighted differently and not assumed to be perfect substitutes (Gazely and Binner, 2000). The problem of measuring money has been compounded by financial innovations,[11] making the definition and consequently the measure of money more complicated. According to Handa (2000:177), these financial innovations led to a reduced ability of monetary aggregates in explaining macroeconomic variables; consequently the definition and measure of money became doubtful. These changes emphasise the need for an accurate re-measurement of money which takes into account the new financial assets, producing a more meaningful measure of money and restoring its explanatory power.

The above discussion reveals that the definition of money is not static: it evolves with economic, structural, financial and technological changes (Gazely and Binner, 2000:1608). This makes the definition of money and the subsequent measurement of the latter more difficult, but also important. Given the importance of the measure of money, monetary aggregation theory was postulated and has evolved with time, producing a number of aggregation methods that will be explored in the next section.

[10] They provide different levels of monetary services for transactions (liquidity) and different yields (interest).

[11] Financial innovation such as the liberalisation of markets and competition in the banking sector have led to changes in demand between the components of money which have undermined earlier empirical findings and made it more difficult to distinguish money which is held for transaction purposes from money which is held for savings purposes (Mullineux, 1996).

3.3 THE THEORETICAL BACKGROUND OF MONETARY AGGREGATION

The importance of money and its use in monetary aggregation is based on an accurate measure of money. Thus, the quest for an appropriate definition and measure of money led to the study of the theory of monetary aggregation, and later the statistical index theory, which will be explored in this subsection. The theory of monetary aggregation can be defined as the adding together of monetary components or assets that are considered to be likely sources of monetary service. This procedure is used since any measure of money is an aggregate or composition of its component assets. The economic aggregation theory further shows the methods of selecting assets for the monetary aggregate, and the construction of aggregator functions[12] (Binner *et al.*, 2004:214).

The theory of monetary aggregation requires weak separability among the assets to be included where the test for weak separability provides a mechanism for judging the validity of the asset to be included in the monetary aggregate (Handa, 2000:177). Weak separability, according to Elger *et al.* (2008:117), implies that the marginal rate of substitution between pairs of assets in the aggregate is independent of the quantities of all variables that are not in the aggregate. This implies that monetary aggregation is unaffected by pure shifts in the composition of spending on non-monetary goods. This characteristic ensures that a quantity index of the composite assets can be constructed from the quantity of the assets only in the group, and that changes in the quantities or the prices of the assets not in the group do not directly change the index for the composite assets (Handa, 2000:179). Monetary aggregation can be done, among many other methods, by the simple sum aggregation (Anderson *et al.,* 1997:31). The most appropriate method of monetary aggregation is the crucial question that this study attempts to answer. Another theoretical basis of monetary aggregation is reviewed in the next section.

The statistical index number theory can also be used in monetary aggregation. This theory came into existence because of two developments: firstly, Diewert's (1976:115) introduction of superlative index numbers[13]helped in closing the gap between index number theory and monetary aggregation theory. Secondly, Barnett's (1990:209) derivation of the user cost of monetary assets services assisted in closing the gap between monetary theory and economic

[12] Mathematical operations to allow the summary of the value of given monetary components.

[13] An index number functional form is said to be 'superlative' if it is exact for (i.e., consistent with) a 'flexible' aggregator functional form (Diewert, 1976:115).

aggregation theory. This theory also significantly overcomes the aggregation flaws of the simple sum methods, as will be explored in later sections of this chapter.

More formally, statistical index numbers provide parameter-free and specification-free approximations to economic aggregation. Statistical index numbers are also characterised by their statistical properties and by their economic properties that make them more comprehensive (Fisher, 1922 and Theil, 1967). The economic properties of statistical index numbers are defined in terms of the indices ability to approximate economic aggregates.

The statistical index[14] provides a variety of quantity and price indices that treats prices and quantities as jointly independent variables. Indeed, whether they are price or quantity indices, they are widely used since they can be computed from price and quantity data alone, thus eliminating the need to estimate an underlying structure as in the theory of aggregation (Barnett *et al.,* 1992:2092). Index numbers are widely used to provide a single broad measure for a disparate collection of assets. Well-known examples of index numbers are the industrial index, the consumer price index and the producer price index. These index numbers depend on the prices and quantities of items included in the index because the values of commodities involved are determined by their physical quantities and corresponding prices (Yue and Fluri, 1991:21). The following subsections look at some of the aggregation methods that are based on the theoretical background discussed above.

3.3.1 Simple sum

In the definition of money the most common functional form for monetary aggregation is the simple sum. This aggregation method is defined as a method of adding together heterogeneous financial assets formulating aggregates such as M1 and M3. This is done by defining the specific aggregates through determining which financial components to include, and then simply adding

[14] The main advantages of this index theory is the statistical property that any changes in the prices of the components of the index only change the price index, and any changes in the quantities of the components only change the quantity index, while the multiple of the price and the quantity indices thus computed equals the index of the expenditure on the service of the assets (Handa, 2000:186). Further statistical index numbers are specification- and estimation-free functions of the price and optimal quantities observed in two time periods. Unlike aggregator functions, statistical index numbers contain no unknown parameters. A statistical index number is said to be exact for aggregator function if the index number tracks the aggregator function, evaluated at the optimum, without error (Anderson *et al*., 1997:40).

these selected components together; hence the name "simple sum" (Yue and Fluri, 1991:21; Barnett *et al.*, 1992:2092). Barnett (1980:44) further defined the simple sum as a stock of monetary assets required in national accounting, or bank liability as required in bank accounting, but not an appropriate measure of structural economic variables.

The underlying assumptions of the simple sum aggregation method come directly from the classical economists, who stated that the essential function of money is to serve as a medium of exchange (Thornton and Yue, 1992:35). Secondly, the simple sum assumes all monetary assets as perfect substitutes, ignoring their different levels of moneyness (Yue and Fluri, 1991:21). The simple sum monetary aggregation can be expressed symbolically as follows:

$$M = \sum_{i=1}^{n} X_i \qquad [3.1]$$

where:
X_i is the i*th* monetary component of any sub-aggregate of M monetary aggregate.

However, the perfect substitution assumption is the major weakness of the simple sum. It implies that assets holders face a linear indifference curve, meaning utility maximisation requires consumers to hold either one monetary asset with the lowest opportunity cost, or an indeterminate mix of assets, each sharing the same lowest opportunity cost. Evidently, these asset behaviours are simply not observed in the real world, where consumers hold mixed portfolios of monetary assets with different opportunity costs (Schunk, 2001:274). This assumption becomes clearly unrealistic at some point unless further broadening of the monetary aggregate is limited (Gebregiorgis and Handa, 2005:122). Furthermore, the simple sum index cannot untangle income from substitution effects if its components are not perfect substitutes (Barnett *et al.*, 1992:2092).

As an attempt to overcome the disadvantages of the simple sum, the formula above is generalised to give a weighted sum aggregate allowing the coefficients to take on positive weights between zero and one. This weighting aggregation, according to Friedman and Schwartz (1970:152), assumes each asset as a component of the total aggregate with different degrees of moneyness, and defines the quantity of money as the weighted sum of the total of all assets, the weights for individual assets varying from zero to unity, with a weight of unity attached to that asset or assets regarded as having the largest quantity of moneyness per dollar of aggregate value. This approach, according to Barnett *et al.* (1992:2092), is deficient only in failing to point out that even weighted aggregation implies perfect, but not dollar-for-dollar substitutability unless the aggregation procedure is non-linear.

In conclusion, the simple sum is commended by very few authors because of its simplistic approach. In general the major disadvantage of the simple sum is the assumption of perfect substitution. Therefore, there is a need for an aggregation procedure that is able to estimate different degrees of substitution between monetary assets. The two convenient procedures that permit this are the Divisia index and the variable elasticity of substitution procedures (Gebregiorgis and Handa, 2005:122). The next section explores the variable elasticity of substitution

3.3.2 The variable elasticity of substitution

The variable elasticity of substitution (VES) method was proposed by Chetty in 1969 who defined it as a function that estimates the elasticities of substitution which directly reflect the degree of substitution between monetary assets. The major advantage of this method is its ability to directly estimate the degree of substitution between money and near money, which the simple sum aggregation could not do. Chetty (1969) confirmed that there is a close substitution effect between money and other financial assets, and their degree of substitution could be determined.

The two major problems that are encountered when using the VES estimates are that some variables seem to be simultaneously related since their amounts are determined simultaneously in the optimisation process[15]. The second major problem arises from the non-stationarity of the values of the assets considered for the monetary aggregates (Gebregiorgis and Handa, 2005:124). The estimations of the elasticity of substitution are said to be limited in their usefulness because of the form of their aggregation function specification, and by the use of cost rather than the user cost of assets, which is used directly in estimating the degree of substitution between money and near money (Handa, 2000:184).

[15] This is the discipline of adjusting a process so as to optimize some specified set of parameters without violating some constraint.

In the money-demand literature there has been interest in the subject of imputing a price to monetary assets. This price has been viewed to be some unknown function of the price level, the own-interest rate, the rate of change of the price level, and a discount rate. All conventional demand system approaches require the imputation of a price to each good or asset (Barnett, 1978:145). As shown, the VES does not price its aggregates appropriately using the user cost. Therefore there is need to explore a more appropriate method such as the Divisia index, whose effectiveness revolves around an accurate measure of the user cost (weighting) as discussed in section 3.3.3.

3.3.3 The Divisia index

The Divisia index was postulated by Francois Divisia in 1925, and was defined as a function in which the growth rate of the monetary aggregate is the weighted average of the growth rate of the component quantities. Theoretically, it is derived from the economic aggregation theory and first-order conditions of utility optimisation. Thus the Divisia index attempts to separate the transactional function of money from the other functions that money performs. It further assesses the utility that consumers derive from holding a portfolio of different monetary assets instead of measuring the stock of money held in an economy. Advocates of the weighted monetary aggregates typically have a transactions model of money in mind by arguing that money is held largely to facilitate transactions (Barnett *et al.*, 1992:2092).

Consequently, money holdings are related to the level of real activity and are likely to have good indicator properties. The transactions services offered by money holdings are the object of interest, not the stock of money holdings measured by the simple sum. Monetary assets vary widely in their ability to facilitate transactions; clearly not all monetary assets are perfect substitutes for transactions purposes as assumed by the simple sum. Given that notes and coins provide quite different transactions services from interest-bearing bank accounts these monetary assets should have different weights using the Divisia index (Pill and Pradhan, 1994:2).

The advantages of the Divisia index are: firstly, the weighting used in terms of each asset is its share of the total expenditure on the flow of liquidity services provided by it, and the impact of any change is incorporated in these shares (Dahalan *et al.*, 2005:1140). Secondly, the major property is that the growth rate of the aggregate is the sum of the similar weighted growth rates of the individual assets. Thirdly, the Divisia quantity aggregate is a quantity index. Therefore it changes only if quantities of the component assets change, but its correspondence price index would similarly show a price change only if the prices of the component assets change, while the multiple of the quantity and price indices provide the index of the nominal value, meaning total expenditure (Handa, 2000:188). These are the major statistical properties that make the Divisia index more appealing to the monetary policy makers.

The calculation of the Divisia index entails two important assumptions. Firstly, non-liquid deposits such as long-term deposits are not used for transaction purposes, unlike more liquid assets like notes and coins. The second assumption is that higher interest rates are paid on less liquid assets. The next step of the calculation is to aggregate the rate of growth of various components of money using weights which are based on their relative return, thus deriving the index that is a proxy for the balance held for use in transactions. According to Hancock (2005:40), to construct the weights or the user cost[16] (which the VES could not construct) there is a need for information on interest rate paid on the monetary aggregates components and a benchmark rate.[17] Then subtract interest rates paid on each component from the benchmark to derive the components weights. The weights of each component are then used to calculate the Divisia money rate of growth. Therefore, this growth rate shows the rate of growth of balances used for transaction purposes. In the case that notes and coins grow faster than illiquid deposits, they will have a higher weighting, thereby giving a more accurate measure of the assets economic participation (moneyness) (Hancock, 2005:40). The details of the derivation of the Divisia index will be fully explained in the methodological section in the Chapter 4. According to Rotemberg *et al.*, (1991:12) the Divisia index also has its own disadvantages. It can be measured in discrete time but it tends to drift away from this normal trend. Furthermore, it is not easy to determine the liquidity of an asset to be included in the monetary aggregates. This is easily resolved by the currency equivalent method which is explored in section 3.3.4.

[16] The user cost is measured as the opportunity costs of foregone interest associated with holding funds in different types of monetary assets (Yue and Fluri, 1991:22).

[17] A benchmark asset, which is defined as a risk-free asset that can be used only for intertemporal transfer of wealth and provides no monetary service, under the consumer theory assumes no liquidity or other monetary service. It is mainly held only for accumulating and transferring wealth across time; its interest rate is the highest in the economy (Hancock, 2005).

3.3.4 *The currency equivalent*

According to Serletis and Molik (1999:106) currency equivalent (CE) is the same as the simple sum index, but it has a simple weighting mechanism added. The currency equivalent is time-varying weighted averages of the stocks of different monetary assets with weightings which depend on each asset's yield relative to that of a benchmark zero liquidity. Simply put, it is defined as a utility-based monetary aggregate (Rotemberg *et al.*, 1991:1). The CE can be expressed mathematically as:

$$CE_t = \sum_I \frac{r_{b,t} - r_{I,t}}{r_{b,t}} m_{I,t} \qquad [3.2]$$

where:

$r_{b,t}$ = the rate of return on zero liquidity

$r_{I,t}$ and $m_{I,t}$ = represents the yield and stock of monetary assets *i* and *t*

The main advantages of this aggregation method are that it has a straightforward interpretation unlike the other methods. The other attractive property of the CE is that assets which do not pay interest, such as currency and travellers' cheques, are added together with weights of unity. These assets are simply added with weights of between zero and one and assets with higher yield receiving lower weights. This makes intuitive sense given that high return assets provide lower liquidity services. The benchmark asset in particular provides no liquidity services. By the same intuition assets which return equal or exceed those of the benchmark asset do not contribute to the currency equivalent aggregate (Serletis and Molik, 1999:106).

Unlike the simple sum aggregation which fails to adjust to the introduction of new financial assets due to advancement in financial innovation, the CE adapts easily to changes in the financial environment. When there is the introduction of new assets such as interest-bearing accounts, these can easily be added to the aggregate without complication. The problem of determining whether an asset is liquid enough to be included in the monetary aggregate as encountered by the Divisia is resolved by the reference to their interest yields (Rotemberg *et al.*, 1991:11). In terms of the Divisia index, the CE has some advantages, such as the Divisia index's tendency to drift away from the discrete time level while the CE aggregate usually maintains its trend. Furthermore, the CE aggregate has a definite meaning, while the Divisia index seeks to measure changes in the sub-utility from assets. These functions cannot be used for international comparisons of liquidity or to evaluate the different levels of liquidity held by different individuals (Rotemberg *et al.,* 1991:12). The CE can easily handle situations where the function changes over time. These changes are a major characteristic of monetary aggregation since the set of available monetary assets changes constantly (Rotemberg *et al.*, 1991:12).

The CE and the Divisia index have almost similar differences with those of simple sum and the Divisia index. The CE index is a stock measure, although it is a different stock measure from that of the simple sum, while flow measures are estimated by the Divisia index. More specifically, the CE measures the stock of monetary wealth, whereas the Divisia index measures the flow of monetary services. However, the CE and the simple sum can measure the flow of monetary services given a specific set of assumptions. The major difference between the CE and the simple sum is that the CE measures the flow of monetary services under a less restricted set of assumptions than the perfect note-for-note substitution assumption of the simple sum (Serletis and Molik, 1999:106). Since this research is focused on the simple sum and the Divisia index the following section will directly compare the two aggregation methods.

The analysis of monetary aggregation methods explored above shows in general how the monetary aggregation theory has evolved over time from the simple sum to the currency equivalent method. Of all the methods the simple sum is the most popular, with most banks still using it despite the flaws as discussed above (Handa, 2000). The main reason banks make use of the simple sum is its simplicity and straightforwardness. However, in recent years more and more banks have tried to combine the simple sum with the Divisia index, especially in the developed countries. Some of these banks are the European Reserve Bank, the Bank of England, and the Federal Reserve System, to mention just a few. Despite its mathematical complication, the Divisia index has gained popularity because of its statistical properties that make the measurement of money more accurate. Therefore this study concentrates on empirically comparing these two aggregation methods. The evaluation of these methods has remained a topical issue up to this day. A number of evaluation techniques have been formulated to assist in the selection of an aggregation method that will be appropriate for any particular country. The following section explores the evaluation techniques and substantiates them with empirical evidence from other studies.

3.4 EMPIRICAL EVALUATION OF MONETARY AGGREGATES

Given the importance of money in an economy and the vast number of methods used to measure it, it is important to review empirical monetary aggregation methods. The two methods that have gained the most popularity over the years are the simple sum and the Divisia index, and numerous studies have sought to empirically compare them. According to Schunk (2001:272) the monetary aggregates can be compared in terms of their ability to estimate an accurate money demand function or the efficiency in the roles of money as an indicator and/or forecaster of broader economic activity. Finally, the information content and controllability of these aggregates is also a tool used to evaluate their performance, as discussed in the following sections.

3.4.1 Money demand function

The money demand function can be used to predict economic variables only if it is stable. If it is not stable its predictive value for policy purposes will be limited (Handa, 2000:188). Therefore the methods of aggregating money in an economy can be evaluated in terms of its ability to determine a stable demand function. Empirical evidence from Cockerline and Murray (1981) advocated the use of the Divisia index instead of the simple sum because it follows a more consistent time path and displays greater parameter stability, which would reflect greater theoretical consistency. In support of these findings, Barnett *et al.* (1984) argued that the Divisia index estimates the money demand function far better than the simple sum, also in terms of the plausibility and stability of parameter estimates and forecasting accuracy. Belongia and Chrystal (1991:497) concluded for the UK that Divisia monetary aggregates are more closely related to the growth of nominal GDP and have stable money demand functions, and Spencer (1994:125) confirmed these results. Furthermore, Fase and Winder (1994:1) reached a conclusion that the European money demand function is fairly stable when the Divisia index is used instead of the simple sum aggregate index. Ishida and Nakamura (2000) confirmed better stability of money demand function when the Divisia M2 is used than when the simple sum M2 is used.

Recently Dahalan *et al.* (2004:1134) compared the money demand function of the simple sum and Divisia index using the error correction models for Malaysia. The study examined short-run dynamics between these monetary aggregates and money demand determinants such as inflation, domestic and foreign interest rates, financial wealth and income. The conclusion reached was that the Divisia index was the most appropriate monetary aggregate to track money demand in Malaysia, and should be used when conducting monetary policy.

3.4.2 Forecasting

Given the widely held belief that inflation is a monetary phenomenon, useful information on the future price and inflation developments can be revealed by the amount of money in the public's hands. For the monetary authorities to tackle appropriately any inflationary pressure that may arise in the future there is need to produce accurate and reliable forecasts of inflation with low forecasting errors. Therefore a monetary aggregate that performs this function accurately is the most appropriate for that economy. Barnett *et al.* (1984:1057) reported that Divisia monetary aggregates give greater stability for parameter estimates and greater forecasting accuracy in the U.S. Swofford and Whitney (1991) provided further evidence by comparing these monetary aggregates methods by using a vector error correction model of inflation and money growth. It was concluded that the Divisia index has a smaller absolute average forecasting error in all but one case. In support of these findings, Chou (1991:1700) also finds that Divisia index aggregates produce lower forecast errors for the U.S.

Similar to the forecasting ability of monetary aggregates, it is also important that they can be indicative of future economic situations. The predictive power of the aggregate could be evaluated in its ability to predict short-run or long-run price movements more accurately. According to Anderson and Kavajecz (1994:2), monetary aggregates exist largely as indicators and/or targets of monetary policy, and therefore an important empirical criterion in judging them is the relative ability of the alternatives to predict economic activity. To characterise the performance of monetary aggregates as a predictor of economic activity Serletis and King (1993:91) used Granger causality tests to compare the significance of the alternative aggregates. In general the results were in favour of the Divisia index as a better predictor of economic activity. Fluri and Spoerndli (2000) produce mixed results using vector autoregressive models for Switzerland. The findings show that the Divisia M1 predicts short-run price movements better than simple sum M1, but does not predict long-run price movements more accurately. Janssen and Kool (2000) concluded that Divisia aggregates are better indicators of real growth and inflation in the Netherlands than their simple-sum equivalents, with Divisia M3 providing the best out-of-sample forecast of inflation.

3.4.3 Causality from money to income

Monetary aggregation is useful in controlling nominal national income if changes in the monetary aggregates cause changes in income (Handa, 2000:190). This relationship is important to monetary authorities because they try to influence the economy through the money supply and interest rates when implementing the monetary policy. Therefore if there is a causal relationship between income and money, this makes their policies more effective. Consequently, a monetary aggregate with a stronger causal relationship will determine the monetary aggregation that is suitable for that particular economy. Ishida (1984:80) shows that for Japan the downward trend in the velocity of Divisia M2 was much weaker than its simple sum version, and implies that the relationship between Divisia M2 and GNP is more stable than that between simple sum M2 and GNP. Therefore a combination of the Divisia M2 should be considered along with the simple sum aggregates in conducting monetary policy. Serletis and King (1993:100) used the cointegration method to analyse long-run relationship between money, prices and income in Canada, and concluded that the Divisia index was more useful in determining the long-run relationship with nominal income.

The findings on the money inflation relationship have led to money becoming less important as a monetary policy tool, and consequently the abandonment of monetary targeting in most countries. Belongia (1996:1065) argued that the breakdown in the relationship between money and the macroeconomic variables can be attributed to the erroneous use of the simple sum monetary aggregation. Belongia (1996) replicated the models from five[18] other studies on the subject whose results contradicted the common view about the link between money and macroeconomic activity. The conclusion was that in at least four of five cases the substitution of the Divisia index measure for the simple sum aggregate reversed the conclusions drawn in the studies. Belongia (1996:1083) concluded that the measurement issue of money lies at the heart of the alleged breakdown in the relationship between money and the macroeconomy. Schunk (2001:282) supported these findings and concluded that the Divisia index is more useful for tracking the behaviour of key macroeconomic variables such as output and prices.

[18] Rotemberg (1993), Cover (1992), Kydland and Prescott (1990), Friedman and Kuttner (1992) and Stock and Watson (1989).

Darrat *et al.* (2005:100) also re-examined the relationship between money and the macroeconomy using the cointegration method to compare the simple sum index and the Divisia index. The results reveal that the cointegration is overwhelming when the Divisia index is used unlike in the simple sum, where cointegration was weak. In the Divisia index case, even when there were policy shifts and dramatic financial innovation in the post-1980 period, there was still cointegration. Based on these results, the Divisia index can be regarded as superior to the simple sum in monetary policy implementation.

3.4.4 Information content

The information content of monetary aggregates is a very important determinant of an effective aggregate, and it is used mainly because of its collective ability to predict both present and future movement in macroeconomic variables such as nominal income and inflation (Mills 1982:305). This assists policymakers to make well-informed decisions which will positively impact the economy. Information that can be derived from monetary aggregates can also be useful for forecasting inflation (Mete and Adebayo, 2006:55). The essence of information content is that the more information the aggregates can bring forward, the more it will assist policy makers to make more informed decisions on economic issues. The study concludes that simple sum aggregation destroys much of the information available, implying that the monitoring of the currently defined simple sum aggregation is a suboptimal means of ascertaining future movements of nominal income changes in the UK (Mills, 1982:310).

3.4.5 Controllability of the monetary aggregates, policy instruments and targets

The Central Bank should be able to control the monetary aggregates that can be used by applying policy instruments at its disposal. Thus the practical use of a monetary aggregate as an intermediate target depends on its controllability (Yue and Fluri, 1991:30). Even if some of the monetary aggregates share a close relationship with inflation or nominal GDP, they will be of little use as monetary targets if their growth cannot be controlled by monetary authorities. Yue and Fluri (1991:30) examined the usefulness of the Divisia index in monetary targeting and concluded that all aggregates of the Divisia index were directly related to the monetary base and were more controllable and therefore more effective as a monetary policy tool.

However, it is important to note that the empirical studies reviewed above are limited to developed countries. There is need to review empirical literature focusing on developing countries which might have economic circumstances similar to South Africa as a developing country. For instance, Tariq and Matthews (1997) used a cointegration approach to compare the simple sum and the Divisia level estimates of the demand for money for Pakistan from 1974 to 1992. It was observed that there is minute evidence of superiority of the Divisia monetary aggregate. Both the methods produce stable demand for money function and perform satisfactorily in post sample stability tests (Tariq and Matthews, 1997:1).

Dahalan *et al.* (2005:1137) compared the Divisia measures with simple sum M1 and M2 in a money demand function for Malaysia. Using error correction models, the short-run dynamics were examined between these monetary aggregates and money demand determinants such as inflation, domestic and foreign interest rates, financial wealth, and income. It was concluded that Divisia M2 is the most appropriate monetary aggregate of the four candidates to track money demand in Malaysia and should be used when conducting monetary policy. A more relevant study in Africa was done by Gebregiorgis and Handa (2005:119) who computed the Divisia index for Nigeria in 2005. This study obtains unexpected results contrary to those discussed above, that the monetary policy in Nigeria should focus on the supply of currency and or of narrow money rather than broad money or the Divisia index (Gebregiorgis and Handa, 2005:119). It can be observed that there are clear differences on the empirical results from developed and developing countries. Furthermore, the empirical evidence is not clear on which method is the most appropriate for aggregation because of the mixed results on the effectiveness of these aggregation methods given the evidence from developed and developing countries. Therefore this study focuses mainly on evaluating the performance of money when measured using two different methods. The goal of this study is to make a significant contribution to the measurement and importance of monetary aggregation in the conduct of monetary policy in South Africa.

3.5 CONCLUSION

This chapter has provided a theoretical and empirical review on monetary aggregation. Section 3.2 explored the definition of money and its importance. This section also showed how money has evolved over time. Section 3.3 gave a brief background on the theory of monetary aggregation. The section went further to explore the different aggregation methods and their advantages and disadvantages. Finally, Section 3.4 compared the monetary aggregates evaluation techniques and gave empirical evidence for each. Together with Chapter two, this chapter laid the foundation for the empirical analysis to ascertain if the role of monetary aggregates in monetary policy is still relevant given different measure of money and changes in the economic and financial environment in Africa. The next chapter will explore the methodology used to construct the Divisia index and compare its performance against the simple sum.

CHAPTER FOUR:
METHODOLOGY AND ANALYTICAL FRAMEWORK

4.1 INTRODUCTION

This chapter explores the statistical and econometric methods that will be used to achieve the objectives outlined in this study. Firstly, to construct a Divisia index for South Africa using the Tornquist-Theil discrete time statistical index adapted from Dahalan *et al.* (2005). Secondly, to empirically evaluate the performance of monetary aggregate measures, namely, the simple sum and the Divisia index using their predictive power of present and future movement of macroeconomic variables such as inflation and national income. Further evaluation of these aggregates is done using their controllability by the Central Bank and their information content. Following Trivedi and Pagan (1979), Batten and Thornton (1983), Thornton and Batten (1985), Yue and Flurie (1991) and Acharya and Kamaiah (2001), this study uses the Polynomial Distributed Lag model to evaluate the performance of the monetary aggregates. This chapter is organised as follows: Section 4.2 explains the statistical index theoretical derivation that is used to derive the Divisia index for South Africa; Section 4.3 derivation of the Divisia index, Section 4.4 discusses the econometric techniques and outlines the procedures and steps followed in this study. Finally, Section 4.5 explains the data and variables used, and provide justification for their inclusion in the study.

4.2 CONSTRUCTION OF STATISTICAL INDEX NUMBERS

Theoretically, index numbers are defined as a ratio of a variable's current value to its base value expressed as a percentage (Enns, 1985:667). These index numbers can be categorised as price, quantity and value indices[19]. Furthermore, index numbers can be single item indices or composite indices. The latter can further be categorised as unweighted and weighted indices. Since this study is using the Divisia index, which assigns weights on the different monetary assets, the weighted indices will be explored in more detail. The weights are used so that individual elements in the basket of items have a different influence on the overall price index [20] (Hoel and Jessen, 1982:467). The weighting can be done using a number of techniques these include fixed quantity weights, and the base weighted method (Laspeyres), the current weight

[19] Value indices are a combination of price and quantity indices.
[20] In terms of this research the groups of assets are monetary aggregate components.

method (Paasche)[21], Fisher-Ideal index method and the Divisia index method (Enns, 1985:667). The latter two methods will be explained in more detail below:

4.2.1 Fisher - Ideal Index

The Fisher-Ideal index is one of the statistical index methods that are used to aggregate monetary components. Proposed by Fisher (1922) and Bowley (1928), this index takes the form of a geometric mean of the Laspeyres and Paasche indices[22]. It attempts to overcome the disadvantages of these two indices by finding their geometric mean. Furthermore, Frisch (1936) and Wald (1939) showed that given the optimising behaviour of economic agents, the Fisher-Ideal index is an exact aggregator function and is defined as superlative because it can provide a second-order approximation[23] to an arbitrary, linear, homogenous aggregator function (Ishida, 1984:73).

4.2.2 Divisia Index - Tornquist and Theil

The second statistical index method is the Tornquist-Theil Divisia index which was proposed by Tornquist (1936), Theil (1967) and Kloek (1967). The Tornquist-Theil takes the form of a weighted average of the rate of increase in each component, using the corresponding expenditure share as weights. Diewert (1976) reviewed the Divisia index, concluded that it is exact for the translog aggregator function, and termed it the "Diewert superlative". As a translog aggregator function it also provides a second-order approximation to an arbitrary linear homogenous aggregator.

The advantage of the Fisher-Ideal index over the Divisia index is that, as an index measured in levels, the Fisher-Ideal index can handle the introduction of new assets and changes to the characteristics of the financial assets in the indices (Longworth and Atta-Mensah, 1995:13). Changes in the Divisia index are based on the changes in the logarithms of its components, and because the logarithm of zero is minus infinity, the formula for computing the Divisia index

[21] The fixed weight aggregate uses actual price of the variable. The advantages of the Laspeyres method are that it is easy and cheaper to construct mainly because only base quantities need to be determined, and meaningful comparisons can be made because of the base year. However, it does not account for change in quantity as price or other variables change and therefore may cause an overstatement. Unlike the Laspeyres method, the Paasche method takes into account changes in quantity. Nonetheless, the quantities need to be determined for each time period, which can be extremely costly, and it tends to underestimate inflation as it uses the latest quantities.

[22] For a discussion on the Laspeyre and Paasche indices see Enns (1985).

[23] This is a mathematical procedure that provides an exact fit for a data set making it more accurate.

implies that the growth rate of the Divisia aggregate equals infinity when a new asset is introduced. Thus, in a period when a new monetary asset is introduced, one can use the Fisher-Ideal index by setting the growth rate of the new asset to zero (Longworth and Atta-Mensah, 1995:13). On the other hand the Tornquist-Theil Divisia index uses expenditure shares or the moneyness of the assets as weights, thereby making its economic meaning more intuitive and relevant for monetary policy making. Dahalan *et al.* (2005) point out that although there are many superlative index numbers, the Tornquist-Theil index number is the only one known to retain its second-order tracking properties more accurately when some common aggregation theoretical assumptions are violated. In addition, it has the advantage of furnishing a discrete approximation of the Divisia index in the continuous case over the Fisher-Ideal (Ishida, 1984:73).

According to Yue and Fluri (1991:32) the Divisia index is estimated in the continuous or discrete time version where the continuous time Divisia index numbers are derived from microeconomic theory and the discrete time version is an approximation of the continuous time version. Furthermore, according to Yue and Fluri (1991:32) the continuous time always has to be changed to discrete to make the data more useful. A number of empirical studies have used the discrete version of the Tornquist-Theil Divisia index (cf: Jorgenson and Griliches, 1967; Christensen and Jorgenson, 1970; Star and Hall, 1976; Anderson *et al.*, 1997 and Dahalan *et al.*, 2005). Statistical derivation of the Divisia index in this study follows the Tornquist-Theil discrete method which was used by Barnett (1980:38), Barnett *et al.* (1984:1052), Anderson *et al.* (1997:41) and Dahalan *et al.* (2005:1140).

4.3 DERIVATION OF THE DIVISIA INDEX

To derive the Divisia index for South Africa, this study employs the Tornquist-Theil discrete time approximation as in Dahalan *et al.* (2005:1040) following Barnett (1980), Barnett *et al.* (1984) and Anderson *et al.* (1997:55). The Tornquist-Theil discrete time approximation is specified as follows:

$$DM_t = DM_{t-1} \prod_{i-1}^{N} \left(\frac{M_{it}}{M_{it-1}}\right) s_{it}^{*} \qquad [4.1]$$

where:

DM_t = Divisia index

DM_{t-1} = lagged Divisia index

S_{it} = expenditure share of the monetary assets i at time t

S_{it}* = the average of S_{it} and S_{it-1}

M_{it} = the balance of asset i at time t

N= monetary component

Π= product sign

The outstanding and unique feature of the Divisia index is its ability to put weights on the monetary assets. The weights for the different monetary assets are represented by the expenditure share that shows the moneyness of each monetary asset in the total aggregate. This is calculated using the expenditure share (S_{it}) of monetary assets i at time t as shown in the formula below. The first step in constructing the Divisia index as in Equation 4.1 is determining the expenditure share. To determine the expenditure share of the monetary components the following formula adopted from Dahalan *et al.* (2005) is applied as below:

$$S_{it} = \frac{\pi_{it} M_{it}}{\sum_{j=1}^{N} \pi_{jt} M_{jt}} \qquad [4.2]$$

where:

π_{it} = is the user cost of each asset at time t

M_{it} = monetary assets i at time t

The key component of Equation 4.2 is the user cost (π_{it}) of each monetary asset. The user cost of money is the opportunity cost of holding money and is calculated by obtaining the difference between a monetary component's own interest rate and a benchmark rate (Ishida, 1984:79). Symbolically the formula for the user cost is represented as:

$$\pi_{it} = \frac{P_t (R_t - r_{it})}{1 + R_t} \qquad [4.3]$$

where:

π_{it} = is the user cost of each asset at time t

R_t = is the benchmark rate at time t

r_{it} = is asset i's rate of return at time t

P_t = is the consumer price index

Following Ishida (1984:77), Equation 4.3 can be simplified as:

$$\pi_{it} = \mathrm{R_t} - \mathrm{r_{it}} \qquad [4.4]$$

The formula for the user cost above shows that it relies on the benchmark rate and the rate of return on the individual asset; these will be discussed in turn. For each monetary asset there must be a measure of the interest rate paid (r_{it}) on the marginal unit held, so that the rate is just sufficient to induce the depositor to continue to hold the existing balances in that form. Usually quoted interest rates are used to measure the average interest rate offered on the deposit. According to Hancock (2005:40) this may be problematic given the different rates that are charged per customer and bank. Thus a range of interest rates will be available and the selection process may become difficult.

The first monetary component is coins and bank notes, and it is seen as pure money with a zero rate of return. The same is done for cheques and transmission deposits. There has been a lot of debate on the rate of return on other demand deposits, because they do not bear any explicit interest rates (Anderson *et al.*, 1997). However, there are a number of incentives that banks provide to their clients that can be considered as implicit interest rates. This can take the form of service charges below the cost of operating an account, making loans to depositors at preferential interest rates, providing free consultations, and offering free gifts in promotional schemes (Dahalan *et al.*, 2005:1141).

Klein (1974) argues that banks indirectly pay a competitive rate of return on demand deposits and advocates a formula to calculate this implicit return. In analogy, Laidler (1993) argues that it is erroneous to assume that no compensation is paid on demand deposits, and so variations in such compensation would lead to variations in the quantity of money demand. This study follows Klein (1974) and Dahalan *et al.* (2005) to compute a rate of return on demand deposits as:

$$r_D = r_1(1 - \left[\frac{R}{D}\right]) \qquad [4.5]$$

where:

r_D = the implicit interest rate on demand deposits

r_1 = the bank's base lending rate

R/D = the ratio of reserve to deposits

where:

R= reserves of banking institutions

D = other demand deposits

This study employs the Klein (1974) method following Anderson *et al.* (1997) and Dahalan *et al*. (2005). The weighting of the other demand deposits by the inclusion of implicit interest rates makes the derivation of the Divisia index more accurate and effective. Starz (1979) suggests that the fully competitive rate derived from the Klein method is rather high. He suggests that the implicit rate of return for demand deposits is between 0.34 and 0.58 times the fully competitive Klein's method rate to make the rates more realistic and accurate. Hence, following Dahalan *et al*. (2005), this study multiplies the rate of return on demand deposits by the upper limit, which is 0.58.

The fourth monetary asset is split into short-term deposits and medium-term deposits since the Divisia index, as explained above, uses weights when aggregating its monetary assets. The rates of return on 6 and 12 months NCD instruments are used to calculate the user cost of the short- and medium-term deposits respectively. The last monetary asset is the long-term deposits and the rate of return is measured using the 36-month NCD. The NCD was chosen as the interest rate to calculate the user cost because it is a more representative interest rate that captures directly the activities of the economy more than other interest rates[24].

The benchmark rate (R_t) is the second most important information needed to calculate the user cost. It is defined as the maximum expected yield of a pure store of value asset. The benchmark asset is a theoretical construction which, according to Dahalan *et al.* (2005:1140), provides no liquidity or monetary service, with no default risk, and is used by economic agents only for wealth transfer between periods. The benchmark asset's rate of return must exceed the own rates on all assets that provide monetary service (Anderson *et al.,* 1997:72). Therefore, an optimal benchmark asset should at least be a good store of value as components of money supply but have no transactional value (Hancock, 2005:40). According to Hancock (2005:41), this may not be the case if some of the benefits of holding the asset are fully captured by the interest rate. An

[24] This contribution by Professor Faure is highly appreciated.

example is free financial advice that may be available for holding balances in some accounts. However, good examples of the benchmark assets are hardly available in practice. For simplicity most studies use the long-term government bond yield as a benchmark proxy. This method has been criticised by Stracca (2001:16). For instance, the 10-year maturity is too long and not representative of agents' investment horizon, and shorter horizons bond yields are not risk free (Stracca, 2001:16).

This study follows Dahalan *et al*. (2005) who set the benchmark rate equal to the maximum rate of return over a large class of assets: both financial and non-financial are included. This allows the benchmark to be more representative of the economic agents, and it is above the rate of return of assets at all times with the inclusion of the constant. The formula is given as:

$$R_t^* = \max\{RODD_t, RSTD_t, RMTD_t, RLTD_t, GB_{it}\} + c \qquad [4.6]$$

where:

R^*_t = benchmark asset

RODD= rate of return on other demand deposits

RSTD= rate of return on short term deposits

RMTD= rate of return on medium term deposits

RLTD = rate of return on long term deposits

GB = government 10 year bond

c = constant

The value of the constant is 100 basis points and its inclusion guarantees that the benchmark rate is strictly greater than the rate of return on any monetary asset (Anderson *et al.*, 1997:75).

The result for the benchmark rate and the rate of return for monetary assets are substituted into Equation 4.4 to obtain the user cost of the monetary assets. As explained above, the user cost is a key component of the expenditure share, and is substituted into Equation 4.2. To derive the Divisia index, the values of the average of the expenditure share (S_{it}*) are substituted into Equation 4.1. Finally, following Dahalan *et al.* (2005) the Divisia index and simple sum are normalised to equal 100 in the first month of 1986 to calculate the lagged Divisia index since the starting point of the Divisia index is unknown. Similarly, the simple sum is normalised to 100 in the first month to facilitate an accurate comparison of these monetary aggregates. The next section of this chapter explores the econometric method used to compare the Divisia index and the simple sum.

4.4 ECONOMETRIC ANALYSIS

This section seeks to determine and evaluate the performance of the Divisia index and its simple sum counterpart using the Polynomial Distributed Lag model. The evaluation criteria have been discussed in detail in Chapter 3; they include information content, controllability and predictive power of macroeconomic variables. The macroeconomic variables to be used for the evaluation are discussed in the following section.

4.4.1 Polynomial Distributed Lag (PDL) Model

The PDL framework was first introduced by Shirley Almon (1965). This study adapts this framework following Batten and Thornton (1983), Thornton and Batten (1985), Yue and Fluri (1991) and Acharya and Kamaiah (2001) to evaluate the performance of the two monetary aggregates. The PDL model uses a large number of lagged variables while reducing the number of coefficients which have to be estimated by requiring the coefficients to lie on a smooth polynomial in the lag (Hall, 1967). Unlike the OLS estimators, the PDL reduces multicollinearity[25] which is common in economic data, thereby increasing precision of the estimation. Thus the rationale for the use of the PDL technique is that it increases the precision of the estimates. However, estimates of the individual lag weights will be generally biased, unless the correct lag length and degree of polynomial are specified (Batten and Thornton, 1983:15).

Following Gujarati (1995:612) and Maddala (2001:412), the PDL is derived from the finite distributed lag model as shown below:

$$y_t = \beta_0 x_t + \beta_1 x_{t-1} + \cdots + \beta_k x_{t-k} + \mu_t \qquad [4.7]$$

[25] It occurs when variables are so highly correlated with each other that it is difficult to come up with reliable estimates of their individual regression coefficient (Gujarati, 1995:319)

The βcoefficient describes the lag of the effect of x on y assuming y (inflation or manufacturing index) denotes the dependent variable and x (monetary aggregates) the explanatory variables. In many cases, the coefficient can be estimated directly using this specification. The problem with this estimation is the high correlations between x_t and its lagged values. Therefore, this estimation cannot produce reliable estimates of the parameters β_i. Almon (1965:180) generalised this to the case where the β_i follow a polynomial of degree r in i. This is known as the Almon lag or the polynomial distributed lag. This is denoted as PDL (k, r), where k is the lag length, and r the degree of polynomial. To illustrate the concept, assume that $r = 2$ and β_i is represented as follows (Maddala, 2001:412):

$$\beta_i = \alpha_0 + \alpha_{1i} + \alpha_{2i}^2 \qquad [4.8]$$

Equation 4.8 uses the PDL to impose a smoothness condition on the lag coefficients. Smoothness is expressed as requiring that the coefficient lie on a polynomial of relatively low degree. Substituting Equation 4.8 into Equation 4.7 results in the following:

$$y_t = \sum_{i=0}^{k}(\alpha_0 + \alpha_{1i} + \alpha_{2i^2})x_{t-i} + \mu_t \qquad [4.9]$$

$$= \propto_0 \boldsymbol{z_{0t}} + \propto_1 \boldsymbol{z_{1t}} + \propto_2 \boldsymbol{z_{2t}} + \boldsymbol{\mu_t}$$

where:

$$z_{0t} = \sum_{i=0}^{k} x_{t-i} \qquad [4.10]$$

and the same for z_{1t} and z_{2t}.

Thus y_t is regressed on the constructed variables of z_{0t}. After obtaining the estimates of $\propto$, Equation 4.8 is used to obtain estimates of β_i (Maddala, 2001:413). As explained in the method above there are two pieces of information that are vital, the lag length and the degree of polynomial. Ideally, it is desirable to use one of the commonly used lag length selection methods for choosing both the lag length and the degree of polynomial. The following section looks at the selection of the lag length and the degree of polynomial.

i. Lag Length Selection

This study selects the lag length of the PDL on the basis of maximum adjusted R-squared and information criteria following Thomas (1977), Gujarati (1995:614) and Maddala (2001:414). According to Davison and MacKinnon (1993:676), the top-down approach can be used starting with a very large value of the lag length and then seeing whether the fit of the model (adjusted R-squared and information content) deteriorates significantly when it is reduced without imposing any restrictions on the shape of the distributed lag. A more formal test, according to Gujarati (1995:615), is to look at the values of the information criteria such as the Schwarz criterion where the values are minimised. This procedure is very important because choosing the wrong lag length will lead to the inclusion or omission of relevant variable, causing a bias, thereby compromising the accuracy of the results. According to Yue and Fluri (1991:29), specifications with relatively long lag lengths and relatively low polynomial degree produce the highest adjusted R-squared.

ii. Polynomial Degree Selection

The lag length discussed above is used in the selection of the appropriate polynomial degree. According to Gujarati (1998:615), the degree of the polynomial should be at least one more than the number of turning points in the curve relating to β_i for all i. *A priori*, however, one may not know the number of turning points, and therefore, the choice of polynomial degree is largely subjective. According to Maddala (2001:415), the top-down approach can also be used for more accurate polynomial degree selection. Maddala suggests that a significantly high degree be chosen, as in Equation 4.9, and start dropping the higher terms sequentially until the best fit model is achieved.

Once the lag selection and the degree of polynomial have been specified Equation 4.11 can easily be constructed as shown below. In the case that the lag length is 5 and the degree of polynomial is 2, the PDL equation can be specified as (Gujarati, 1995:616):

$$z_{ot} = \sum_{i=0}^{5} x_{t-i} = (x_t + x_{t-1} + x_{t-2} + x_{t-3} + x_{t-4} + x_{t-5}) \qquad [4.11]$$

This is the same for z_{1t} and z_{2t}.

This method provides a flexible way of incorporating a variety of lag structures. It also does not have the problem of the presence of lagged dependent variables as an explanatory variable in the model, and the problems it creates are also eliminated. However, the major drawback of this method is related to the determination of both the lag length and the degree of polynomial.

The PDL model, as explained above, is used to evaluate the performance of the simple sum and the Divisia index to determine its predictive power of inflation and aggregate national income which is proxied by manufacturing index in this study. The PDL model is also employed to evaluate the monetary aggregates' controllability levels and information content. Applying the PDL model to determine the relationship between macroeconomic variables and monetary aggregates begins by determining the appropriate lag length and the degree of polynomial which produces the best model. The top-down approach is used to determine the lag length, and this starts at a high value of 24 lags. This value was chosen since the data used in this study is monthly and the lag for most monetary policy implementation is 18 to 24; therefore the upper limit of 24 was chosen. To determine the appropriate lag length, the fitness of the model was constantly monitored as the lag length was changed to notice if there was any significant deterioration of the model fitness. To determine the fitness of the model the adjusted R-squared was preferred at more significant levels, and information criteria were preferred at the lowest levels possible.

After determining the lag length, this value is used to determine the most appropriate polynomial degree. One of the methods used, as explained above, is adding 1 to the number of turning points in the estimation curves until the best fit model is achieved as shown in the appendix A-Figure 1, this is done following Gujarati (1995:612). The top-down approach is used, and the process of dropping the higher terms sequentially until the best fit model is achieved is followed. The top-down method was started at a high degree of 10 and reduced until the best model was achieved using the adjusted R-squared and information criteria. The model will be specified as follows:

$$MEV\ c\ ar\ (1)\ pdl\ (MA, k, r) \tag{4.12}$$

where:

MEV = dependent variable

c = constant

ar = autoregressor of order 1

MA = monetary aggregates

k = lag length

r = degree of polynomial

The model specified is used to estimate the relationship between the macroeconomic variables and the different monetary aggregates. The autoregressor of order one is incorporated in this model because it describes a stochastic process that can be described by a weighted sum of its previous values and a white noise error. An AR (1) process is a first-order one process, meaning that only the immediately previous value has a direct effect on the current value. After the estimation is done, to compare the strength of the relationship between the macroeconomic variables and the monetary aggregates the study will analyse the sum of the lag coefficients, t-statistics of the sum of the lag coefficients, standard error, and the adjusted R-squared.

The sum of the lag coefficients shows the summation of the estimated coefficients of β_i which are the original coefficients of the distributed lag model as in Equation 4.8. The sum of the lag coefficients tests whether the sum of the lagged money growth coefficient is significantly different from zero. The greater the value of the sum of the lag coefficients the stronger the relationship between the variables in the model (Yue and Fluri, 1991:29). The t-statistic is also used to determine the significance of the value of sum of the lag coefficient. The more significant the t-statistic is the stronger the relationship between the variables in the model (Yue and Fluri, 1991:29). The standard error (SE), on the other hand, is the estimated standard error of the regression which is used as a measure of goodness of fit of the model (Gujarati, 1995). The smaller the value of the standard error, the better the goodness of fit of the estimated model. Finally, the adjusted R-squared increases only if the new term improves the model more than would be expected by chance; therefore the higher the adjusted R-squared the better the relationship between the regressed variables. This also shows the explanatory power of the variables (Gujarati, 1995).

The monetary aggregates will also be evaluated using their controllability levels. The concept of controllability is only feasible when the Central Bank has a particular variable that it can control which is closely related to the monetary aggregates. Given that the SARB is able to control the monetary base, this study uses the extent to which it explains the monetary aggregates to gauge their controllability. The regression to determine this relationship is expressed as follows:

$$MA\ c\ ar\ (1)\ pdl\ (gmb, k, r) \qquad [4.13]$$

where:

MA = monetary aggregates

gmb = growth rate of monetary base

c = constant

ar = autoregressor of order 1

k = lag length

r = degree of polynomial

To determine the monetary aggregate which is more controllable the values of the sum lags, standard error, t-statistic, and the adjusted R-squared are analysed using the criteria as explained above.

Finally, the information content of a monetary aggregate can be determined in terms of a particular goal variable such as inflation and aggregate national income (manufacturing index). Following Acharya and Kamaiah (2001:317) the information content formula is shown as follows:

$$I = -0.5\log\left[\frac{1-R^{*2}}{1-R^2}\right] \qquad [4.14]$$

where:

I = Information content

R^{*2} and R^2 are respectively the coefficients of determination of the following regression equations:

$$G = A_p(L)G + B_q(L)M + u \qquad [4.15]$$

$$G = A_q(L)G + v \qquad [4.16]$$

where:

A_p and B_q[26] are polynomials in L associated with G and M respectively, L is lag operator and u and v are error terms. All the variables used are in growth rates. Equations 4.13 and 4.14 are estimated and the values of their adjusted R-squared are obtained and substituted into the main Equation 4.12. The monetary aggregate that has the largest value after the calculation is said to have the highest information content in terms of the particular macroeconomic variable

4.5 DATA AND SOURCES

The study makes use of monetary aggregates data, namely M0, M1A, M1, M2 and M3. The monetary components of these aggregates include coins and bank notes, cheques and transmission deposits, other demand deposits, short- and medium-term deposits,[27] and finally long-term deposits, which are central in this study. This data was obtained from the SARB. Since the Divisia index measure uses interest rates to calculate the user costs, it is necessary to obtain interest rate data. Therefore, data on the 3, 6, 12 and 36 months NCD were obtained from Thomson DataStream to calculate this opportunity cost. Since the study seeks to evaluate the performance of the monetary aggregates in terms of macroeconomic variables, inflation and manufacturing index data were also obtained from the SARB website. All the data used in this study runs from 1986:01 to 2006:12 and the growth rates[28] of these variables were used. A summary of the data is shown in Table 4.1 below.

4.5.1 Inflation and manufacturing index

Several studies have used inflation as a macroeconomic variable to evaluate the performance of monetary aggregates (cf: Yue and Fluri, 1991; Thornton and Yue, 1992; Dahalan *et al.*, 2005). Following the previous studies, this research empirically tests the relationship between monetary aggregates (Divisia index and simple sum) and inflation in South Africa. Inflation is calculated as the annualised growth rate of CPI. To further evaluate the performance of the monetary aggregates this study further uses the manufacturing index. Ideally, a measure of aggregate national output, such as GDP, is preferred, but due to the absence of high frequency data on this series, it could not be used.

[26] p and q are the optimal lag lengths chosen.

[27] To acquire more accurate results data on short-and medium-term deposits was split into short-term deposits and medium-term deposits to maximize on the weight effect.

[28] Growth rate = (y_t-y_{t-1}/y_{t-1})*100

Table 4.1: Data used in computing Divisia monetary aggregate

MONETARY AGGREGATES	DEFINITION	COMPOSITION	RATES	ASSUMPTIONS
Coins and banking notes in circulation	Currency in circulation	Notes and coins	zero	No interest rates
Cheque and transmission deposits	Non-cash currency	Cheques	zero	No interest rate
Other demand deposits	Other demand deposits with banking institutions	Deposits	Calculated	Implicit interest rates
Other short- and medium-term deposits	All savings deposits of the domestic private sector with monetary institutions including savings deposits with and savings bank certificates issued by the postbank	Short-term deposits Medium-term deposits	NCD 6 Month NCD 12 Month	The NCD rates are representative of the short- and medium-term deposits
Long-term deposits	Long-term deposits of the domestic private sector with monetary institutions, including national saving certificates issued by the postbank	Long-term deposits	NCD 36 Month	The NCD rate is a good representative of the long-term deposits

Notes: NCD Negotiable certificate of deposit, Benchmark asset option: Envelope method (maximum of selected financial and non-financial asset returns) plus a constant.
Source: Compiled by Author

4.6 CONCLUSION

This chapter examines the analytical framework for this study. Specifically, it explores how the Tornquist-Theil discrete time approximation and its components, which include the rates of return and benchmark assets (to derive the user cost) and benchmark rate, are used to construct the Divisia index. The PDL used for the comparative analysis between these monetary aggregates was also explored in detail. The chapter further explains how the PDL will be used to determine monetary aggregates controllability and information content. The following chapter applies the methods presented in this chapter and presents the empirical results and their interpretation.

CHAPTER FIVE:
EMPIRICAL RESULTS

5.1 INTRODUCTION

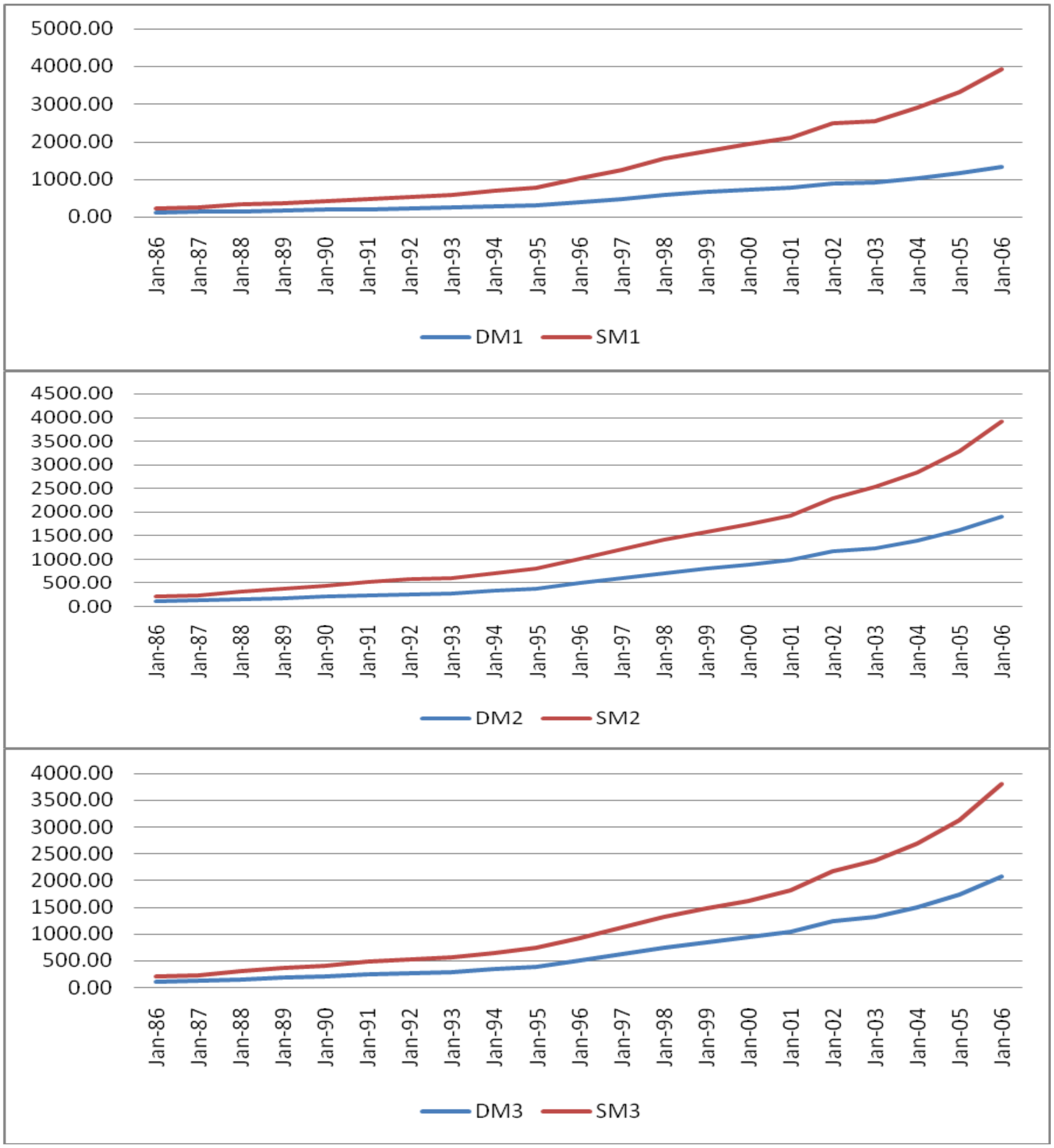
This chapter presents the results on the evaluation of the simple sum and the Divisia index in South Africa. The evaluation criterion is in terms of their ability to predict movements of inflation and aggregate national income proxied by the manufacturing index. The evaluation results also include controllability of monetary aggregates and their information content. The literature review on the performance of different measures of monetary aggregates produces mixed results. For instance, authors such as Gebregiorgis and Handa (2005) concluded that monetary policy in Nigeria should focus on the simple and narrow money rather than the broad Divisia index money, while Dahalan *et al*. (2005) empirically proved that the Divisia index is the most appropriate measure of money for Malaysia. On the other hand developed countries have advocated the use of the Divisia index (cf: Gazely and Binner, 2000; Drake and Fleissig, 2006; Barnett *et al.*, 1992; Binner *et al.*, 2004; Handa, 2000; Gilbert and Pichette, 2003; Stracca, 2001). Thus the different, and sometimes inconsistent, results obtained by the different authors and the different economic performance of these variables highlight the importance of a comparative study for South Africa to determine an appropriate aggregation method. The aim of this chapter is to present results that will determine an appropriate monetary aggregation method for South Africa. The specific tasks that are addressed are:

- To estimate the Divisia monetary aggregate,
- To report and interpret empirical evidence on the relationship between the different monetary aggregates on one hand, and inflation and manufacturing index on the other,
- To examine the controllability of different monetary aggregates so as to determine which one is more controllable,
- To determine and report on the information content of the monetary aggregates.

5.2 PRELIMINARY ANALYSIS

A preliminary analysis of the monetary aggregates is done using graphs to provide pictoriall illustrations of the relationship between these monetary aggregates. Figure 5.1 shows the graphical analysis of the annual average Divisia index and simple sum M1, M2 and M3 from 1986 to 2006 as below.

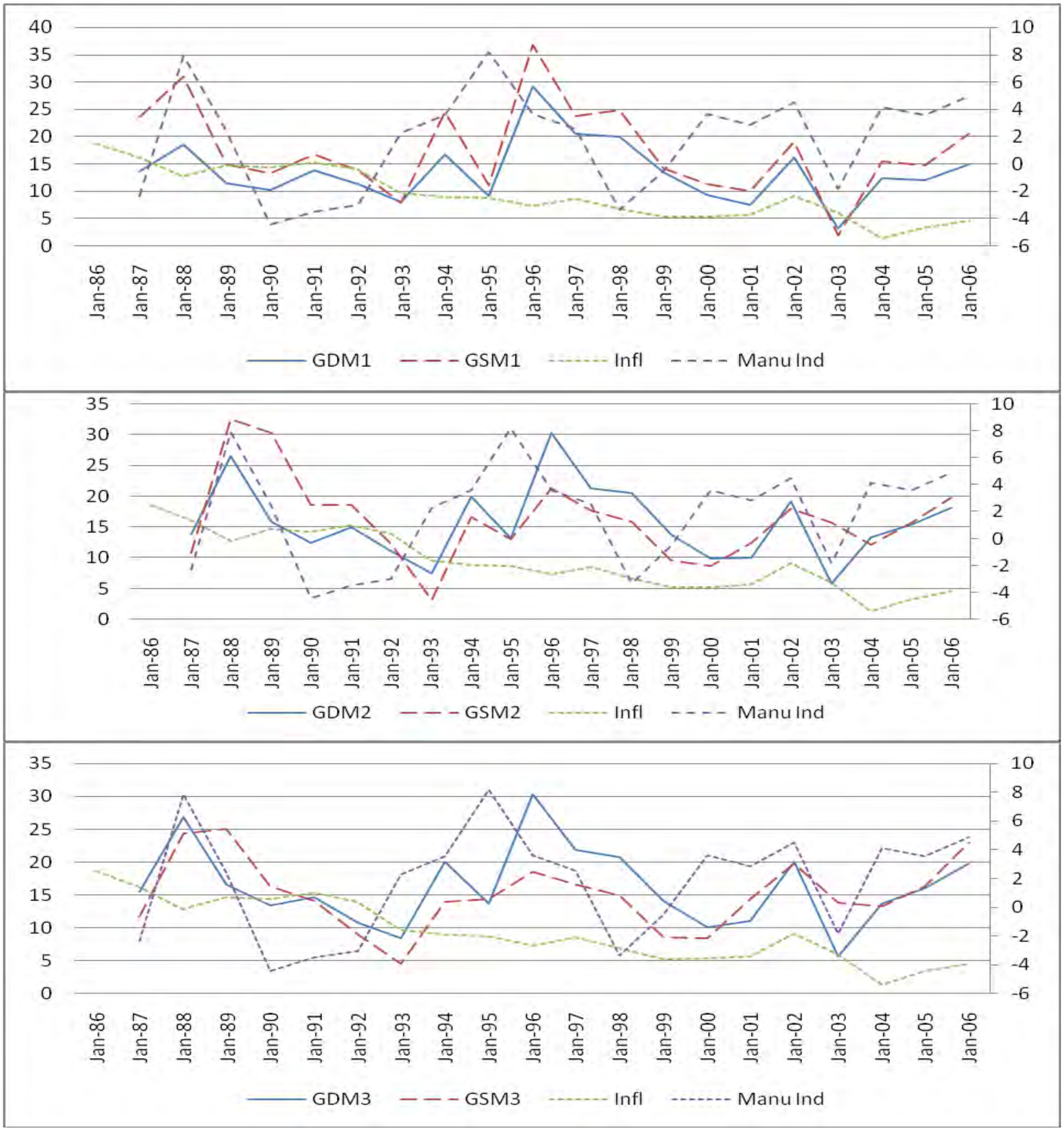
Figure 5.1: Annual average Divisia index and simple sum (1986:01-2006:12)



Note: SM1, SM2 and SM are the level of simple sum indices and DM1, DM2 and DM3 are Divisia monetary aggregates indices.
Source : computed by author based on data from the South African Reserve Bank.

As shown in Figure 5.1 all the monetary aggregates show a considerable steady upward trend. In the three monetary aggregates, as expected because of the variable weighting in the Divisia, the computed Divisia indices are lower than the simple sum aggregates. The observed higher values of the SM compared to the DM are consistent with Dahalan *et al.* (2005:1142) for Malaysia and Ishida, (1984:56) for Japan.

Figure 5.2: Annual average Growth rate of SM, DM and Macroeconomic variables (1986:01-2006:12)



Note: Growth rate of simple sum (GSM1, GSM2, GSM3) and Growth rate of Divisia Index (GDM1, GDM2,GDM3) while Inflation (Infl) and GMIND (Growth rate of manufacturing index).

Source : computed by author based on data from the South African Reserve Bank..

Figure 5.2 above shows a basic comparison of the trends of the growth rate of these two monetary measures and the trend of the macroeconomic variables. Figure 5.2 shows that the two measures of money move in the same direction and are closely related. The graphs also show that all the monetary aggregates are volatile, implying that the rate of growth flactuates at a very high level. From the first graph it is evident that M1 is highly volatile, and more specifically GSM1 is more volatile than GDM1. This observation suggests that narrow money, that is coins and banking notes in circulation, cheque and transmission deposits and other demand deposits are very volatile in terms of their growth rates, and more so in the SM1. An almost similar trend is seen in GSM2 and GDM2. Similar trends are also noted for DM3 and SM3 which show slight increase in DM3 volatility levels.

Since this research is not an analysis of these monetary aggregates in isolation, the study investigates the relationship that exists between the monetary aggregates and other macroeconomic variables in the economy, specifically, inflation and manufacturing index. Figure 5.2 illustrates the relationship between macroeconomic variables and monetary aggregates. The general analysis from all the graphs is that generally monetary aggregate growth rates are related or follow almost a similar trend with the macroeconomic variables. The extent of these relationships varies with the level of volatility that each variable presents. Thus the strength of this relationship is the most important factor to consider to determine which monetary aggregate is more appropriate for monetary policy use. The strength of these relationships will be statistically proven at a later stage of this study.

Table 5.1 below provides the summary statistics of the variables of this study, namely, sample means, maximums, minimums, medians and standard deviation for monetary aggregate growth rates. The average behaviour of the monetary aggregates over the 20 years of the sample suggests broad and general similarities which will be explained and put into context in this section. The descriptive statistics which this study focuses on and discusses are the median which reveals clear variations among the growth rates of the alternative aggregates. These range from 13.01 for GDM1 to 15.87 for GDM3. This is further supported by other measures of dispersion which are the maximum and minimum values and standard deviation. The standard deviation shows the volatility of the different monetary aggregates. The standard deviation ranges from 5.34 for GSM3 to 8.19 for GSM1. This generally shows that there are significant differences among the monetary aggregates, which necessitate a choice to be made among them on the basis of some economic criteria or evaluation techniques which are discussed in section 5.4.

Table 5.1: Descriptive Statistics - Monetary Aggregates Growth Rate

	GDM1	GDM2	GDM3	GSM1	GSM2	GSM3
Mean	13.603	15.685	16.145	17.501	16.173	15.124
Median	13.006	14.429	15.046	15.18	15.868	14.48
Maximum	29.11	30.339	30.31	36.76	32.535	25.118
Minimum	3.253	5.834	5.603	1.951	3.183	4.629
Std. Dev.	5.658	6.084	6.092	8.187	6.782	5.336

Source: Estimated by author.

5.3 POLYNOMIAL DISTRIBUTED LAG MODEL RESULTS

This section presents results on the evaluation of the Divisia index and simple sum in terms of their relationship with the specified macroeconomic variables. The performance of these aggregates will be determined by the strength of the relationship between the monetary aggregate and inflation and the manufacturing index as a proxy of aggregate income. Furthermore, these monetary aggregates will be evaluated in terms of their controllability by the monetary authorities and their information content.

5.3.1 Macroeconomic variable: inflation

The PDL model specified to determine the relationship between the monetary aggregates and inflation is as below:

$$Infl\ c\ ar\ (1)\ pdl\ (MA, 21, 3) \qquad [5.1]$$

where:

lnfl = inflation

c = constant

ar = autoregressor of order 1

MA= monetary aggregate

Using the selection techniques discussed in Chapter 4, the lag length and degree of polynomial were set at 21 and 3[29] respectively because these produced the best model without compromising the fitness of the model. To keep the model comparable with other monetary aggregates the lag length and degree of polynomial are maintained at 21 and 3 respectively. To compare the

[29] The polynomial curve is shown in Appendix A-Figure 1.

relationship between monetary aggregates and inflation, the significance of the sum of the lag coefficients[30], t-statistic, adjusted R-squared and standard error of each of these regressions is reported and analysed.

The results in Table 5.2 show that the values of the sum of the lag coefficients shows that all the coefficients of the Divisia aggregates are higher than their simple sum counterparts. Furthermore, the results show that the relationship between all monetary aggregates and inflation are statistically significant as seen from the t-statistic of the sum of the lag coefficients which ranges from 1.67 to 4.68. This is evidenced by the strong level of significance with 5 out of 6 of the coefficients of the monetary aggregates being statistically significant at 1% level of significance. More specifically, in comparison with the other monetary aggregates, the GSM1 is the most significant at 1%. In contrast GSM2 is the least significant at 10% of all the variables. Similarly, based on their adjusted R-squared, the models with the Divisia aggregates consistently have higher explanatory power than their simple sum counterparts. Lastly, consistent with the high adjusted R-squares, the standard errors of the regressions are generally low for all the models, which suggest a good fit for the models. Again, looking at the values of their standard errors, it is evident that with the exception of the M1, the standard errors of the Divisia models were lower than their simple sum counterparts. Thus, overall, the results suggest that the Divisia aggregates are stronger predictors of inflation than the simple sum aggregates.

The stronger predictive power of the Divisia aggregates of inflation, as opposed to their simple sum aggregates, is consistent with Yue and Fluri (1991) who produced superior results in terms of inflation when GDM2 was compared with the simple sum for Switzerland, and Gazely and Binner (2000:1607) for the U.S., the U.K. and Italy. Janssen and Kool (2000) also find that the broader Divisia index M3 has a stronger relationship with inflation than the equivalent simple sum in the Netherlands. The strength of simple sum in narrow money is consistent with Gebregiorgis and Handa (2005:119), who established that SM1 and SM2 outperform the Divisia index for Nigeria.

[30] The hypothesis that the sum of the lag coefficient is zero was rejected in all cases; therefore a significant relationship exists.

Table: 5.2 PDL Regression of Inflation on Money Growth Rates

	DM1		SM1		DM2		SM2		DM3		SM3	
	COEFF	T-STAT	COEFF	T-STAT	COEFF	T-STAT	COEFF	T-STAT	COEFF	T-STAT	COEFF	T-STAT
LAG												
0	0.005	0.296	0.005	0.419	-0.001	-0.037	-0.016	-0.604	-0.00	-0.029	-0.023	-0.69
1	0.009	0.432	0.018	1.085	-0.005	-0.249	-0.042	-1.373	-0.005	-0.215	-0.059	-1.444
2	0.021	0.712	0.032	1.5	-0.002	-0.056	-0.056	-1.488	0	0.001	-0.077	-1.443
3	0.038	1.057	0.049	1.855	0.009	0.262	-0.06	-1.36	0.013	0.34	-0.078	-1.221
4	0.06	1.45	0.067	2.209	0.026	0.646	-0.056	-1.134	0.032	0.746	-0.064	-0.903
5	0.085	1.884	0.086	2.576	0.048	1.081	-0.045	-0.843	0.056	1.205	-0.039	-0.508
6	0.112	2.352	0.105	2.958	0.074	1.561	-0.027	-0.495	0.084	1.711	-0.003	-0.038
7	0.141	2.845	0.123	3.348	0.102	2.078	-0.005	-0.092	0.114	2.255	0.04	0.506
8	0.171	3.352	0.141	3.738	0.131	2.619	0.02	0.36	0.145	2.824	0.088	1.119
9	0.199	3.856	0.158	4.117	0.159	3.167	0.048	0.848	0.177	3.401	0.139	1.779
10	0.225	4.339	0.172	4.47	0.187	3.702	0.076	1.353	0.207	3.963	0.19	2.45
11	0.248	4.783	0.184	4.786	0.212	4.202	0.103	1.848	0.234	4.488	0.239	3.087
12	0.267	5.175	0.193	5.058	0.234	4.649	0.129	2.306	0.257	4.955	0.283	3.649
13	0.28	5.506	0.199	5.281	0.25	5.033	0.151	2.709	0.274	5.355	0.321	4.112
14	0.287	5.776	0.2	5.458	0.26	5.35	0.168	3.048	0.285	5.683	0.35	4.472
15	0.286	5.989	0.197	5.596	0.263	5.604	0.18	3.324	0.288	5.944	0.367	4.742
16	0.277	6.154	0.189	5.704	0.257	5.803	0.184	3.545	0.281	6.148	0.371	4.942
17	0.258	6.281	0.174	5.794	0.242	5.957	0.18	3.717	0.264	6.305	0.358	5.09
18	0.228	6.375	0.154	5.874	0.215	6.067	0.166	3.835	0.235	6.421	0.327	5.196
19	0.185	6.406	0.127	5.925	0.176	6.098	0.141	3.847	0.192	6.463	0.275	5.229
20	0.13	6.13	0.092	5.732	0.123	5.786	0.103	3.497	0.135	6.177	0.2	4.941
21	0.061	3.915	0.049	3.965	0.056	3.531	0.051	1.966	0.062	3.862	0.099	3.061
SUM LAGS	3.571		2.716		3.017		1.394		3.329		3.304	
T-STAT	4.592*		4.678*		3.985*		1.667***		4.267*		2.886*	
SE	0.778		0.58		0.757		0.836		0.78		1.145	
AR(1)	0.984		0.984		0.981		0.978		0.982		0.98	
AdjR^2	0.978		0.977		0.978		0.976		0.978		0.977	
D-W	1.836		1.763		1.824		1.814		1.744		1.958	

*Note: *, **,*** denotes significance at the 1%, 5%,10% level, respectively, SE (standard error) D-W (Durban Watson).*
Source: estimates by author.

5.3.2 Macroeconomic variable: manufacturing index

Next, the study considers the relationship between monetary aggregates and the manufacturing index which is a proxy for aggregate national income. Since the manufacturing sector[31] is one of

[31] Manufacturing sector provides a locus for stimulating the growth of other activities such as services and achieving specific outcomes, such as employment creation and economic empowerment. Manufacturing presents an opportunity to significantly accelerate the country's growth and development.

the most significant contributors to South African's economic growth rate it could be a good proxy for economic activity. The PDL model specified for this regression is shown below:

$$gmind\ c\ ar\ (1)\ pdl\ (MA, 14, 3) \qquad [5.2]$$

where:

gmind = growth rate of the manufacturing index

c = constant

ar = autoregressor of order 1

MA = monetary aggregates

Using the lag selection and degree of polynomial selection techniques discussed in Chapter 4 this model used 14 and 3[32] as the lag length and degree of polynomial respectively. The results reported in Table 5.2 shows that the values of the sum of the lag coefficients are generally very low, suggesting a very weak relationship between the monetary aggregates and manufacturing index. Besides the very low sum of the lag coefficients the t-statistic of the sum of the lag coefficients ranges from 0.07 to 1, further suggesting that there is an insignificant relationship between all monetary aggregate growth rates and growth rates of manufacturing index. Moreover, the models have weak explanatory power as shown by their very low adjusted R-squares. However, the low adjusted R-squares are not due to estimation errors since the standard errors of estimates are generally very low. Therefore the weak explanatory power of the models could be due to a weak relationship between the monetary aggregates and the manufacturing index. This is an indication that the manufacturing index may not be adequately capturing aggregate economic activities. Unfortunately, because of data limitations, due to lack of high frequency data, the current study could not explore other measures of aggregate economic activities such as GDP.

The weak relationship between the monetary aggregate and manufacturing index is contrary to the significant relationship found by Gebregiorgis and Handa (2005:133) for Nigeria, where the index of industrial production was used instead of a manufacturing index. Similarly, Serletis and King (1993:100) found a significant relationship between monetary aggregates (Divisia index) and nominal income (GDP) for Canada. Darrat *et al.* (2005:95) also confirms an overwhelmingly

[32] See appendix for graphical extract to prove that the degree of polynomial is 3.

strong relationship between Divisia index and real GDP. Thus it appears that studies using broader macroeconomic aggregates like GDP and industrial production obtained stronger evidence on their relationships with monetary aggregates. As noted earlier, this study could not use such variables because of a lack of high frequency data on them in South Africa.

Table 5.3 PDL Regression of Manufacturing Index on Money Growth Rates

	DM1		**SM1**		**DM2**		**SM2**		**DM3**		**SM3**	
	COEFF	**T-STAT**	**COEFF**	**T-STAT**	**COEFF**	**T-STAT**	**COEFF**	**T-STAT**	**COEFF**	**T-STAT**	**COEFF**	**T-STAT**
LAG												
0	-0.02	-0.437	-0.002	-0.047	-0.01	-0.222	0	-0.004	-0.004	-0.09	0.088	1.105
1	0.005	0.162	0.01	0.477	0.013	0.452	0.013	0.379	0.016	0.531	0.055	1.158
2	0.022	0.871	0.019	1.049	0.029	1.176	0.019	0.736	0.03	1.168	0.029	0.755
3	0.032	1.249	0.024	1.336	0.038	1.5	0.02	0.741	0.038	1.434	0.008	0.211
4	0.036	1.403	0.027	1.476	0.041	1.608	0.017	0.604	0.041	1.524	-0.007	-0.173
5	0.035	1.449	0.027	1.572	0.039	1.628	0.011	0.405	0.039	1.554	-0.018	-0.465
6	0.031	1.37	0.026	1.6	0.034	1.532	0.003	0.115	0.035	1.49	-0.024	-0.7
7	0.024	1.102	0.023	1.471	0.027	1.241	-0.006	-0.253	0.028	1.241	-0.027	-0.816
8	0.015	0.677	0.019	1.168	0.018	0.788	-0.014	-0.565	0.019	0.826	-0.026	-0.751
9	0.006	0.24	0.014	0.806	0.008	0.335	-0.02	-0.732	0.01	0.398	-0.022	-0.583
10	-0.003	-0.135	0.009	0.472	-0.001	-0.033	-0.022	-0.788	0.001	0.04	-0.016	-0.397
11	-0.011	-0.454	0.003	0.168	-0.008	-0.324	-0.02	-0.75	-0.007	-0.26	-0.008	-0.198
12	-0.017	-0.699	-0.002	-0.131	-0.013	-0.52	-0.013	-0.499	-0.013	-0.5	0.002	0.05
13	-0.02	-0.679	-0.007	-0.334	-0.013	-0.462	0.001	0.044	-0.016	-0.524	0.013	0.264
14	-0.018	-0.4	-0.011	-0.332	-0.009	-0.205	0.024	0.412	-0.015	-0.321	0.025	0.304
SUM LAGS	0.116		0.178		0.192		0.014		0.201		0.071	
T-STAT	0.491		1.032		0.848		0.07		0.88		0.275	
SE	0.237		0.173		0.227		0.207		0.228		0.259	
AR(1)	-0.43		-0.429		-0.431		-0.425		-0.43		-0.426	
AdjR^2	0.171		0.172		0.172		0.165		0.171		0.167	
D-W	2.052		2.053		2.054		2.039		2.054		2.048	

Note: See note on Table 5.2 above for a description of the terms used in the table above.
Source: estimates by author.

5.3.3 Controllability of monetary aggregates

As stated earlier the use of a monetary aggregate as an intermediate target depends on its controllability. In some cases monetary aggregates share a close relationship with inflation or other macroeconomic variables, but this would be of less significant use for monetary policy purposes and more specifically monetary targeting if its growth rates cannot be controlled by the

Central Bank. The monetary base variable will be used since the SARB has the ability to control it. The PDL regression used to estimate the strength of this relationship is shown as below:

$$MA\ c\ ar\ (1)\ pdl\ (gmb, 13, 3) \qquad [5.3]$$

where:

gmb = growth rate of monetary base

c = constant

ar = autoregressor of order 1

MA = monetary aggregate.

The lag length of 13 and degree of polynomial of 3[33] was selected for this model using the method as explained above.

Table 5.4 reports the results on the relationship between growth rate of monetary aggregates and growth rates of monetary base to determine their controllability. The results presented in Table 5.4 show that in terms of the sum of lag coefficients, though their values were generally very low, the SM in all cases was higher than the DM. Also the SM was statistically significant in two instances (M2 and M3), while none of the Divisia aggregates was significant. However, the overall explanatory powers of the models, though generally low, were higher for the Divisia models than the simple sum. By and large, all the models used to test the controllability have very low explanatory power, even though the standard errors of the regressions were low. Thus the low explanatory power of the models was not due to estimation errors, but likely due to a weak relationship between the monetary aggregates and the monetary base. The results suggest that the monetary aggregates are hardly controllable using the monetary base, irrespective of the kinds of monetary aggregates used.   This evidence for South Africa is in contrast with Yue and Fluri (1991:30), who conducted a similar study for Switzerland and found that SM1, DM1 and DM2 were highly controllable, but there was no evidence of significant controllability in SM2.

[33] See appendix for graphical presentation.

Table 5.4: PDL Regressions of growth rates of monetary aggregates on monetary base

	DM1		SM1		DM2		SM2		DM3		SM3	
LAG	**COEFF**	**T-STAT**	**COEFF**	**T-STAT**	**COEFF**	**T-STAT**	**COEFF**	**T-STAT**	**COEFF**	**T-STAT**	**COEFF**	**T-STAT**
0	0.181	4.590	0.211	4.071	0.198	5.177	0.138	5.031	0.191	5.104	0.100	4.558
1	0.081	3.172	0.100	2.916	0.097	3.885	0.085	4.515	0.095	3.904	0.065	4.385
2	0.015	0.666	0.024	0.804	0.028	1.296	0.048	2.749	0.030	1.415	0.041	3.021
3	-0.024	-1.045	-0.021	-0.669	-0.013	-0.589	0.023	1.305	-0.009	-0.419	0.025	1.800
4	-0.041	-1.791	-0.042	-1.342	-0.033	-1.472	0.010	0.550	-0.028	-1.277	0.016	1.175
5	-0.042	-1.906	-0.044	-1.491	-0.036	-1.697	0.005	0.270	-0.031	-1.490	0.013	0.963
6	-0.031	-1.488	-0.034	-1.205	-0.028	-1.380	0.005	0.325	-0.023	-1.184	0.012	0.999
7	-0.014	-0.679	-0.017	-0.596	-0.013	-0.665	0.009	0.581	-0.010	-0.509	0.014	1.114
8	0.003	0.146	0.001	0.040	0.002	0.091	0.015	0.857	0.004	0.187	0.015	1.156
9	0.016	0.678	0.014	0.451	0.013	0.579	0.018	1.026	0.013	0.611	0.014	1.053
10	0.018	0.772	0.016	0.511	0.014	0.643	0.018	1.017	0.013	0.613	0.010	0.735
11	0.004	0.195	0.001	0.033	0.001	0.052	0.012	0.685	-0.001	-0.045	0.000	0.026
12	-0.030	-1.164	-0.037	-1.068	-0.032	-1.284	-0.003	-0.168	-0.035	-1.421	-0.017	-1.129
13	-0.091	-2.291	-0.103	-1.974	-0.091	-2.359	-0.029	-1.068	-0.093	-2.473	-0.043	-1.951
SUM LAG	0.046		0.072		0.107		0.354		0.117		0.266	
T-STAT	0.240		0.278		0.581		2.380**		0.649		2.319**	
SE	0.190		0.257		0.185		0.149		0.181		0.115	
AR(1)	-0.369		-0.296		-0.363		-0.110		-0.376		-0.169	
AdjR^2	0.199		0.135		0.205		0.095		0.212		0.094	
D-W	2.174		2.109		2.158		2.002		2.180		2.030	

Note: See note on Table 5.2 above for a description of the terms used in the table above.
Source: estimates by author.

5.3.4 Information content of monetary aggregates

Finally, the monetary aggregates can be used as a source of information for monetary policy decision-making. The higher the information content of a monetary aggregate the more useful that aggregate is to decision-makers and allows them to make more informed decisions regarding the economy. The PDL model used is specified as follows:

$$MEV\ c\ ar\ (1)\ pdl\ (MEV, k, r) \quad [5.4]$$

$$MEV\ c\ ar\ (1)\ pdl\ (MEV, k, r)\ pdl\ (MA, k, r) \quad [5.5]$$

where:

MEV = macroeconomic variables

c = constant

ar = autoregressor of order 1

MA = monetary aggregates

k = lag length

r = degree of polynomial

The values of adjusted R-square obtained from equation 5.4 and 5.5 are substituted into equation 4.14 to determine the information content[34] of the macroeconomic variables as explained in Chapter 4. Table 5.5 reports the results of information content of growth rates of monetary aggregates in terms of inflation, manufacturing index and monetary base. The first part of the table reports the value of the information content computed based on Equation 4.12 above, while the second part of the table provides a ranking of these aggregates based on the computed values of their information content. Overall, the monetary aggregates provide the highest information about inflation behaviour, followed by manufacturing index, while the monetary based is the least. In terms of inflation all the monetary aggregates have quite high information content, with the DM2 leading, followed by DM1, SM3, DM3, SM1 and SM2 in that order. But while DM2 have significantly higher information content, the other aggregates have fairly closed values for their information content. Overall, on average, the Divisia aggregates, compared to their simple sum counterpart, tend to perform better in providing information about inflation.

In the case of the manufacturing index the DM1 ranked highest followed by SM1 and SM3, and the DM2 and DM3, while SM2 comes last. In the case of the monetary base, the three Divisia aggregates ranked highest in the order of DM1, DM3 and DM2, while the simple sum followed with the same order.

Put together, the information content results suggest that Divisia aggregates possess higher information content in terms of the variables examined – inflation, manufacturing index and monetary base. This is consistent with Acharya and Kamaiah (2001:318), who also found evidence that the Divisia index generally had greater information content than its simple sum counterpart for India. Similar findings on the higher information content in the Divisia index are also suggested by Mills (1982:305) for the UK and Mete and Adebayo (2006:55) for Nigeria.

[34] The values the lag length and the degree of polynomial of all the variables used in this estimation are maintained from equations 5.1, 5.2 and 5.3.

Table 5.5: Information Content

	Inflation	M. Index	M.Base
SM1	2.070	1.238	0.313
SM2	2.061	1.010	0.311
SM3	2.192	1.204	0.311
DM1	2.203	1.395	0.321
DM2	2.649	1.106	0.319
DM3	2.158	1.074	0.320
	RANKING		
1	DM2	DM1	DM1
2	DM1	SM1	DM3
3	SM3	SM3	DM2
4	DM3	DM2	SM1
5	SM1	DM3	SM3
6	SM2	SM2	SM2

Note: m.index (manufacturing index), m.base(monetary base). Appendix A-Table 1 shows the estimation of information content of gsm1.
Source: estimated by author

5.4 CONCLUSION

This chapter presents and discusses the results with regard to various monetary aggregates evaluation techniques. The first part of the chapter presents a preliminary analysis of the relationship between the different monetary aggregates using descriptive statistics and graphical presentations. The descriptive statistics show that the monetary aggregates are volatile, and the differences between them warrant an extensive analysis on the most appropriate aggregate. The graphs show the trends of the simple sum vs. the Divisia index with the Divisia index being lower than their simple sum counterpart. The long-run relationship between the monetary aggregates and macroeconomic variables were then investigated using the Polynomial Distributed Lag model. Further evaluation of these aggregates was done using their controllability by the Central Bank and the information content provided by each of these monetary aggregates.

Overall, of all the variables used to evaluate the performance of the monetary aggregates, the relationship between inflation and the monetary aggregates was the strongest. All the monetary aggregates show a highly statistical relationship with inflation, with models having very high explanatory power. However, the results suggested that the Divisia indices are superior to the simple sum in terms of predicting inflation. The evidence further suggests that the Divisia aggregates provide higher information about inflation than the simple sum aggregates. Regarding the controllability of the monetary aggregates, the evidence presented in this chapter suggests that they can hardly be controlled using the monetary based. Finally, the manufacturing index shows weak relationship with monetary aggregates.

CHAPTER SIX:
SUMMARY OF FINDINGS AND POLICY RECOMMENDATIONS

6.1 INTRODUCTION

The importance of money and its subsequent aggregation methods has been a topical issue and a major area of extensive research. This study explores the different measures of money and seeks to ascertain the appropriate measure of money for South Africa by evaluating the performance of different monetary aggregates to predict the movement of selected macroeconomic variables, controllability and information content of these variables. The first step was to derive the Divisia index for South Africa using the Tornquist-Theil method. The empirical analysis of this study used descriptive statistics such as mean, median and standard deviation. Graphical presentations are also used to compare the simple sum and the Divisia index with the macroeconomic variables. The econometric analysis employs the PDL model to explore the relationship between monetary aggregates and inflation. It was further used to determine monetary aggregates' controllability and information content in terms of inflation, manufacturing index and monetary base.

The objectives of this chapter are: firstly to provide a general summary of the key findings of this study, focusing on the results and empirical evidence presented in Chapter 5. Secondly, to highlight the policy implications of the findings and policy recommendations based on the findings. Lastly, the chapter will conclude by highlighting limitations of the study and give areas for further research.

6.2 SUMMARY OF KEY FINDINGS AND POLICY IMPLICATIONS

Overall, the result of the PDL regression of inflation on monetary aggregates shows a significant relationship between inflation and all the monetary aggregates. Thus, any of the monetary aggregates can be used to predict inflation. However, the evidence strongly suggests that the Divisia aggregates have stronger predictive power than their simple sum counterparts. The predictive power of the Divisia was strongest for the M1 followed by the M3.

The second step of this study was to regress the manufacturing index on monetary aggregates using the PDL. The results generally show an insignificant relationship between monetary aggregates and manufacturing index. The weak relationship between manufacturing index and the monetary aggregates may be due to the inadequacy of the manufacturing index in capturing aggregate economic activities. Thus, the use of other variables would be recommended, and this could be a topic for further research.

Further regressions were estimated to determine the controllability of monetary aggregates by the Central Bank. Overall, the evidence suggests a weak link between the monetary aggregates and monetary base, which shows a limited ability of the SARB to control the monetary aggregates through the use of monetary base, irrespective of whether the Divisia or the simple sum aggregates are used. This suggests that the move away from monetary targeting by the SARB is a move in the right direction.

Lastly, the analysis of information content of the monetary aggregates in terms of inflation, output and monetary base is very robust in suggesting high information content for inflation but not for the other variables used. Thus again the evidence suggests that monetary aggregates could be very useful tools for predicting inflation in South Africa. More specifically, the analysis further confirms the superiority of the Divisia aggregates over the simple sum in providing information about inflation behaviour in South Africa.

6.3 CONCLUDING REMARKS

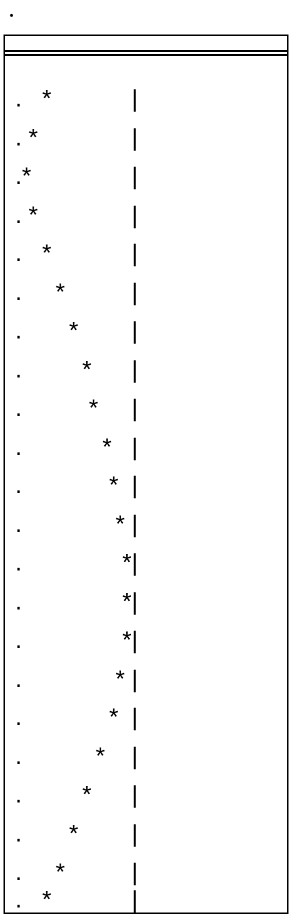
Given the importance of the measurement of money, the primary objective of this study was to construct the Divisia index and compare it with its simple sum counterpart in terms of its performance as an indicator of macroeconomic variables. The evaluation of these aggregates was further done considering their controllability and information content. By and large, the study concludes that the Divisia indices are superior to the simple sum counterparts, particularly in terms of predicting inflation. The findings of the study further show that the Divisia aggregates have higher information content on inflation compared to the simple sum aggregates. Evidence on the controllability of all the monetary aggregates suggest that the monetary authorities can hardly control any of the monetary aggregates using the monetary based. Finally, the manufacturing index showed a weak relationship with all the monetary aggregates. Drawing from the theoretical review and empirical finding from this study, it is recommended that the SARB should construct a Divisia index and use it in its current inflation targeting framework as an indicator and source of inflation trends. Based on the results of this study, Divisia aggregate could lead to better inflation forecasting and therefore contribute to a more effective monetary policy and consequently better economic performance.

APPENDIX

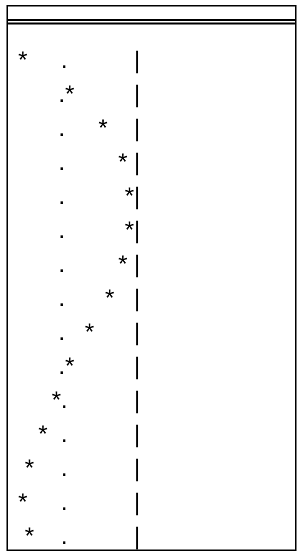
A-FIGURE 1

SELECTION OF DEGREE OF POLYNOMIAL

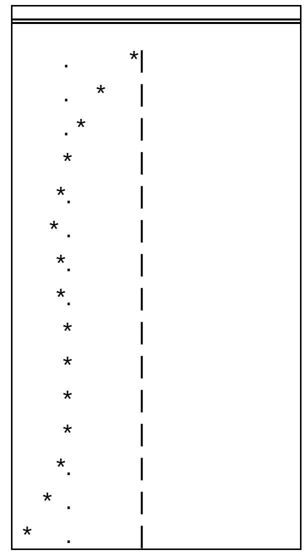
Inflation degree selection (3)



Monetary base growth(3)



Manufacturing index (3)



Note: The curves shown above were also used to determine the degree of polynomial as discussed above. The idea states that the degree of polynomial is 1 plus the number of turning points of the curve Gujarati (1995:612).

A-TABLE 1: INFORMATION CONTENT OF SM1 ON MANUFACTURING INDEX

Dependent Variable: GMIND
Method: Least Squares
Date: 12/08/08 Time: 15:49
Sample (adjusted): 1987M12 2006M12
Included observations: 229 after adjustments
Convergence achieved after 34 iterations

	Coefficient	Std. Error	t-Statistic	Prob.
C	-0.055	0.091	-0.603	0.547
PDL01	-0.109	0.020	-5.466	0.000
PDL02	0.026	0.006	4.668	0.000
PDL03	0.005	0.000	12.304	0.000
PDL04	-0.001	0.000	-9.124	0.000
AR(1)	-0.268	0.064	-4.154	0.000

R-squared	0.624	Mean dependent var	0.203
Adjusted R-squared	0.616	S.D. dependent var	2.363
S.E. of regression	1.465	Akaike info criterion	3.628
Sum squared resid	478.691	Schwarz criterion	3.718
Log likelihood	-409.362	Hannan-Quinn criter.	3.664
F-statistic	74.044	Durbin-Watson stat	2.069
Prob(F-statistic)	0.000		

Inverted AR Roots -.27

<table>
<tr><th>Lag Distribution of GMIND</th><th>i</th><th>Coefficient</th><th>Std. Error</th><th>t-Statistic</th></tr>
<tr><td>.   *|</td><td>0</td><td>0.708</td><td>0.042</td><td>16.718</td></tr>
<tr><td>.   * |</td><td>1</td><td>0.481</td><td>0.031</td><td>15.725</td></tr>
<tr><td>. * |</td><td>2</td><td>0.296</td><td>0.025</td><td>11.961</td></tr>
<tr><td>. * |</td><td>3</td><td>0.149</td><td>0.024</td><td>6.348</td></tr>
<tr><td>* |</td><td>4</td><td>0.037</td><td>0.024</td><td>1.53</td></tr>
<tr><td>*. |</td><td>5</td><td>-0.044</td><td>0.025</td><td>-1.767</td></tr>
<tr><td>* . |</td><td>6</td><td>-0.098</td><td>0.025</td><td>-3.927</td></tr>
<tr><td>* . |</td><td>7</td><td>-0.127</td><td>0.024</td><td>-5.312</td></tr>
<tr><td>* . |</td><td>8</td><td>-0.137</td><td>0.023</td><td>-6.068</td></tr>
<tr><td>* . |</td><td>9</td><td>-0.130</td><td>0.021</td><td>-6.160</td></tr>
<tr><td>* . |</td><td>10</td><td>-0.109</td><td>0.02</td><td>-5.466</td></tr>
<tr><td>* . |</td><td>11</td><td>-0.079</td><td>0.02</td><td>-4.006</td></tr>
<tr><td>*. |</td><td>12</td><td>-0.043</td><td>0.021</td><td>-2.114</td></tr>
<tr><td>* |</td><td>13</td><td>-0.005</td><td>0.021</td><td>-0.237</td></tr>
<tr><td>* |</td><td>14</td><td>0.032</td><td>0.023</td><td>1.368</td></tr>
<tr><td>.* |</td><td>15</td><td>0.064</td><td>0.024</td><td>2.644</td></tr>
<tr><td>.* |</td><td>16</td><td>0.088</td><td>0.024</td><td>3.601</td></tr>
<tr><td>. * |</td><td>17</td><td>0.099</td><td>0.023</td><td>4.187</td></tr>
<tr><td>. * |</td><td>18</td><td>0.096</td><td>0.023</td><td>4.154</td></tr>
<tr><td>.* |</td><td>19</td><td>0.073</td><td>0.024</td><td>3.041</td></tr>
<tr><td>* |</td><td>20</td><td>0.028</td><td>0.029</td><td>0.944</td></tr>
<tr><td>*. |</td><td>21</td><td>-0.044</td><td>0.040</td><td>-1.099</td></tr>
<tr><td>Sum of Lags</td><td></td><td>1.334</td><td>0.280</td><td>4.760</td></tr>
</table>

Dependent Variable: GMIND
Method: Least Squares
Date: 12/08/08 Time: 16:02
Sample (adjusted): 1987M12 2006M12
Included observations: 229 after adjustments
Convergence achieved after 39 iterations

	Coefficient	Std. Error	t-Statistic	Prob.
C	-0.063842	0.215	-0.297	0.766
PDL01	-0.11585	0.021	-5.601	0.000
PDL02	0.02587	0.006	4.484	0.000
PDL03	0.004947	0.000	12.246	0.000
PDL04	-0.000607	0.000	-8.976	0.000
PDL05	-0.011407	0.012	-0.950	0.343
PDL06	0.002646	0.004	0.731	0.466
PDL07	0.00049	0.000	1.490	0.138
PDL08	-4.42E-05	0.000	-0.565	0.573
AR(1)	-0.255558	0.066	-3.890	0.000

R-squared	0.629	Mean dependent var	0.203
Adjusted R-squared	0.614	S.D. dependent var	2.363
S.E. of regression	1.469	Akaike info criterion	3.650
Sum squared resid	472.627	Schwarz criterion	3.800
Log likelihood	-407.902	Hannan-Quinn criter.	3.710
F-statistic	41.228	Durbin-Watson stat	2.062
Prob (F-statistic)	0		

Inverted AR Roots -.26

<table>
<tr><th>Lag Distribution of GMIND</th><th>i</th><th>Coefficient</th><th>Std. Error</th><th>t-Statistic</th></tr>
<tr><td>. *|</td><td>0</td><td>0.72745</td><td>0.04364</td><td>16.6707</td></tr>
<tr><td>. * |</td><td>1</td><td>0.49475</td><td>0.03182</td><td>15.5488</td></tr>
<tr><td>. * |</td><td>2</td><td>0.30474</td><td>0.02611</td><td>11.6693</td></tr>
<tr><td>. * |</td><td>3</td><td>0.15377</td><td>0.02501</td><td>6.14850</td></tr>
<tr><td>* |</td><td>4</td><td>0.03820</td><td>0.02576</td><td>1.48281</td></tr>
<tr><td>*. |</td><td>5</td><td>-0.04561</td><td>0.02644</td><td>-1.72528</td></tr>
<tr><td>* . |</td><td>6</td><td>-0.10131</td><td>0.02629</td><td>-3.85402</td></tr>
<tr><td>* . |</td><td>7</td><td>-0.13254</td><td>0.02526</td><td>-5.24721</td></tr>
<tr><td>* . |</td><td>8</td><td>-0.14294</td><td>0.02364</td><td>-6.04549</td></tr>
<tr><td>* . |</td><td>9</td><td>-0.13617</td><td>0.02193</td><td>-6.20922</td></tr>
<tr><td>* . |</td><td>10</td><td>-0.11585</td><td>0.02068</td><td>-5.60127</td></tr>
<tr><td>* . |</td><td>11</td><td>-0.08564</td><td>0.02036</td><td>-4.20631</td></tr>
<tr><td>*. |</td><td>12</td><td>-0.04918</td><td>0.02105</td><td>-2.33659</td></tr>
<tr><td>* |</td><td>13</td><td>-0.01011</td><td>0.02240</td><td>-0.45151</td></tr>
<tr><td>* |</td><td>14</td><td>0.02791</td><td>0.02386</td><td>1.16987</td></tr>
<tr><td>.* |</td><td>15</td><td>0.06126</td><td>0.02490</td><td>2.46067</td></tr>
<tr><td>.* |</td><td>16</td><td>0.08629</td><td>0.02517</td><td>3.42864</td></tr>
<tr><td>. * |</td><td>17</td><td>0.09934</td><td>0.02467</td><td>4.02767</td></tr>
<tr><td>. * |</td><td>18</td><td>0.09679</td><td>0.02404</td><td>4.02540</td></tr>
<tr><td>.* |</td><td>19</td><td>0.07497</td><td>0.02510</td><td>2.98705</td></tr>
<tr><td>* |</td><td>20</td><td>0.03026</td><td>0.03047</td><td>0.99319</td></tr>
<tr><td>*. |</td><td>21</td><td>-0.04099</td><td>0.04172</td><td>-0.98249</td></tr>
<tr><td>Sum of Lags</td><td></td><td>1.33539</td><td>0.29151</td><td>4.58091</td></tr>
</table>

<table>
<tr><th>Lag Distribution of GSM1</th><th>i</th><th>Coefficient</th><th>Std. Error</th><th>t-Statistic</th></tr>
<tr><td>.   *|</td><td>0</td><td>0.02139</td><td>0.02406</td><td>0.88889</td></tr>
<tr><td>.   * |</td><td>1</td><td>0.00922</td><td>0.01632</td><td>0.56520</td></tr>
<tr><td>*. |</td><td>2</td><td>-0.00011</td><td>0.01345</td><td>-0.00811</td></tr>
<tr><td>* . |</td><td>3</td><td>-0.00687</td><td>0.01342</td><td>-0.51188</td></tr>
<tr><td>*   . |</td><td>4</td><td>-0.01133</td><td>0.01382</td><td>-0.81934</td></tr>
<tr><td>*   . |</td><td>5</td><td>-0.01374</td><td>0.01371</td><td>-1.00244</td></tr>
<tr><td>*   . |</td><td>6</td><td>-0.01439</td><td>0.01309</td><td>-1.09908</td></tr>
<tr><td>*   . |</td><td>7</td><td>-0.01352</td><td>0.01236</td><td>-1.09352</td></tr>
<tr><td>*   . |</td><td>8</td><td>-0.01141</td><td>0.01200</td><td>-0.95022</td></tr>
<tr><td>* . |</td><td>9</td><td>-0.00832</td><td>0.01225</td><td>-0.6789</td></tr>
<tr><td>* . |</td><td>10</td><td>-0.00451</td><td>0.01290</td><td>-0.34956</td></tr>
<tr><td>*. |</td><td>11</td><td>-0.00025</td><td>0.01350</td><td>-0.0188</td></tr>
<tr><td>.* |</td><td>12</td><td>0.00419</td><td>0.01364</td><td>0.30698</td></tr>
<tr><td>. * |</td><td>13</td><td>0.00855</td><td>0.01330</td><td>0.64272</td></tr>
<tr><td>.   * |</td><td>14</td><td>0.01256</td><td>0.01340</td><td>0.93707</td></tr>
<tr><td>.   * |</td><td>15</td><td>0.01596</td><td>0.01628</td><td>0.98035</td></tr>
<tr><td>.   * |</td><td>16</td><td>0.01849</td><td>0.02395</td><td>0.77205</td></tr>
<tr><td>Sum of Lags</td><td></td><td>0.00592</td><td>0.14928</td><td>0.03965</td></tr>
</table>

Note: The tables illustrated above are an example of the estimations run to determine information content of the monetary aggregates on manufacturing index in this case.

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