MONEY SUPPLY ENDOGENEITY: AN EMPIRICAL INVESTIGATION OF SOUTH AFRICAN DATA (2000Q1-2011Q4)

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by

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DECLARATION

I, Stuart William Schady, do declare that all work herein is my own and where I have used external sources and other researchers work I have referenced them and given acknowledgement.

Date:

Signed:

ABSTRACT

This study is about whether the money supply in South Africa under a monetary policy regime of inflation-targeting is exogenously or endogenously determined. The proposition of an exogenous money supply has been offered by monetarists, where the Central Bank determines the quantity of money supplied to the economy and this has a causal influence on income and credit extension. The endogenous money theory is a post-Keynesian proposition whereby the money creation is determined by banks adjusting their responses to demands for credit-money from economic agents.

The data analysis is from 2000Q1 to 2010Q4 and entails the use of the variables monetary base (MB), domestic credit extension (DCE), M3, and gross national product (GDP). All variables are logged. The empirical tests conducted start with the Augmented Dickey-Fuller unit root test to determine the variables order of integration. Johansen cointegration tests are done followed by Vector Error-Correction Models (VECMs) and Granger causality tests to determine whether there is unidirectional or bidirectional causality between variables over the long and short-run.

Based on the results of the testing it was discovered that over the inflation-targeting regime money supply in South Africa was endogenously determined. Furthermore, the data best supports the Accommodationist analysis of endogenous money as opposed to that of Structuralism and Liquidity Preference.

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INTRODUCTION

1.1 CONTEXT OF STUDY

Friedman (1956) presents a re-statement of the Quantity Theory of Money and shows that the velocity of money is a stable function in the short-run, turning this theory into a theory of nominal income. In his analysis the direction of causality is from money stock to nominal income. The Central Bank institutionally initiates changes in the money stock, increasing or decreasing the quantity of money. Interest rates then adjust to equate the level of money demanded to money supplied.

This process occurs through the money multiplier whereby controlling the level of reserves in the banking system, by either injecting or retracting high-powered money, the level of deposits in commercial banks can be controlled (Lavoie 1984:773). It is believed that this will incite changes in portfolio decisions of banks causing them to extend the amount of loans created, and thereby increasing the quantity of money. Interest rates will be decreased in order to encourage economic agents to take out new loans. This extra money is then used to fuel consumption and production leading to changes in income and inflation. This is what Davidson (2006:147) terms the "portfolio change process of money supply".

The causal linkages and mechanism explained above describe the exogenous money supply process which is pre-dominantly a monetarist view point. However, the post-Keynesians refute the notion of the money supply as being exogenous. Post-Keynesians challenge the notion of the money stock being institutionally determined and argue for an analysis of a "monetized production economy in Keynes's sense" (Moore 1989:65).

Moore (1989:68) argues that there is a credit driven money supply, and because of this the direction of causation between the money stock and nominal income is the exact opposite of that proposed by monetarists. Moore believes that the Central Bank should endeavour at all costs to ensure the stability of the financial system and because of this should supply all reserves requested by banks at the key (or "policy") short-term interest rate (KIR) at all times.

According to the endogenous money position, the level of money stock within the economy is fully determined at all times by the demand for credit money, i.e. it is endogenously determined. Money appears as the result of production processes and the need to finance them (Lavoie 1984:779). Every loan creates a deposit in an accounting sense. In the endogenous money view it is only *ex post* that banks apply for reserves from the Central Bank and are then accommodated. This can be seen to be in direct contrast with the exogenous money position whereby a change in the reserves of the banking system triggers a change in the money stock.

Within the endogenous money position there are numerous view points as to just how endogenous the money supply is. The Accommodationist position is described by Moore (1989:66) whereby he says that the KIR is set exogenously by the Central Bank and all demands for credit money are then accommodated by the banking system. This implies a horizontal money supply curve that is completely interest elastic with the quantity of money in the economy being demand determined. Here there is full money endogeneity, i.e. money stock is completely determined by demand for credit at an exogenously determined short-term interest rate.

Palley (1996) furnishes the "Structuralist" position on endogenous money theory. Although accepting the broad money endogeneity hypothesis, Palley argues that the money supply process is not as simple as Moore would have us believe. Structuralists suggest that there is still an upward sloping money supply curve because the Central Bank does not fully accommodate the demand for credit money at all times. Palley (1996:585) asserts that the Central Bank has other policy tools than just exogenously setting the interest rate and that through open market operations the Central Bank does exercise some form of control over the stock on money in the economy. In essence, there is some control exercised by the

Central Bank and the demand for credit money is not fully accommodated, leading to an increase in interest rates.

The Liquidity Preference Theory of endogenous money emerges from Howell's (1995) attack on the Accommodationist position. Howell (1995: 90) believes that the money supply curve is independent of the money demand curve and that the Accommodationist position is only correct if there is some kind of mechanism that can equate money demand with money supply. Kaldor and Trevithick (1981) argue that people with excess money balances above that which is demanded use that extra money to pay back existing debt which then destroys this money, equating demand with supply. Howell (1995:92) believes this is incorrect because those economic agents who end up with additional money balances are not necessarily those same agents who have debt to repay, making the Kaldor and Trevithick argument redundant.

If there is an independent money demand function, different from that of supply, then the liquidity preference of the economic agent could cause constraints on the ability of loans to create deposits. In the banking sector if there is high liquidity preference because economic sentiment is poor, then banks may increase short-term lending rates, regardless of what the Central Bank's key interest rate is. Furthermore, the Central Bank may not wish to fulfil its role as lender of last resort to a potentially insolvent bank (Fontana 2003:299). This limits the amount of credit money creation as it is not always fully accommodated by the banking system.

1.2 GOALS OF RESEARCH

The goal of this research is to

(i) Empirically determine whether the money supply in South Africa is exogenously or endogenously determined.

(ii) If it is endogenously determined, investigate whether the Accommodationist, Structuralist or Liquidity Preference Theory of money endogeneity is prevalent.

1.3 METHODS, PROCEDURES, TECHNIQUES

In order to test whether the money supply in South Africa is endogenous or exogenous the concept of causality and the various tests associated with it will be employed. A series of bi-directional causality tests will be used to determine which variables cause or influence one another over the long and short-run. Based on these results it will be possible to determine whether the money supply in South Africa is exogenous or endogenous.

This entails a three step process, the time series are analysed to determine their level of stationarity and their order of integration. Secondly, the long-run relationship between variables is tested using cointegration technique. Finally, the short and long-run relationship between variables is tested using the Vector Error Correction Model (VECM) and Granger causality tests

The variables tested will be M3 money supply, monetary base (MB), domestic credit extension (DCE) and gross domestic product (GDP). Table 1 gives a summary of the different theoretical direction of causality between these variables for the different theories of money supply.

Table 1: Summary of causality implications of different theories

Exogenous position	**Endogenous positions**		
Monetarist	**Accommodationist**	**Structuralist**	**Liquidity Preference**
M3⇐MB M3⇒DCE M3⇒GDP	M3⇒MB M3⇐DCE LM3⇐GDP	M3⇔MB M3⇔GDP	M3⇔DCE

The time series will be logged and then evaluated and tested for a unit root using the Augmented Dickey-Fuller (1969) unit root test. A unit root test is necessary in order to determine the level of stationarity and order of integration. The order of integration is necessary to validate the cointegration procedure.

To test for long-run directional causality between variables the econometric method will follow the Johansen (1988) Maximum Likelihood procedure which will test for the number of cointegrating vectors. This is preferred to the Engle-Granger (1987) methodology as it is more robust (Dickey et al, 1991). The trace and maximum eigenvalue tests suggested by Johansen and Juselius (1990) will be used to indicate the number of cointegrating vectors. An unrestricted Vector Autoregressive (VAR) model is estimated and the Schwarz information criterion (SIC) can be used to determine the appropriate lag length as the Johansen and Juselius test statistics are very sensitive to the amount of lags used (Enders 2010:401).

If the variables in the VAR system are cointegrated, then following Johansen and Juselius (1991), a VECM can be used to assess the direction of causality. An estimate of the error-correction coefficient is given. This gives the speed at which adjustment back to long-run equilibrium occurs for one variable, given a deviation from equilibrium, as the result of current changes in the other variable. If a variable does not respond to the discrepancy from long-run equilibrium as a result in changes in the other variable then it is weakly exogenous (Enders 2010:407). Tests for weak exogeneity will be done on the error-correction terms to determine the direction of causality between cointegrated variables.

Finally, the standard Granger causality tests (Granger 1969) are used when the variables have been differenced to determine whether past values of one variable affect current realisations of another.

The sample time period under consideration is from 2000Q1 to 2011Q4. All data is obtained from the SARB website, and where it is monthly data it is converted into quarterly data. The repurchase (repo) rate system was introduced in South Africa in 1998 and was considered a more transparent method of accommodation in that it continually signals the South African Reserve Bank's (SARBs) intention toward monetary policy. In early 2000 inflation targeting was formally adopted as South Africa's monetary policy framework whereby the SARB sets a target level of inflation and uses its policy tools to ensure that inflation does not deviate from this level (Smal and de Jager 2001:4). This study aims to further the work of Nell (1999) who does a similar study on money endogeneity in South Africa from 1964 to 1997 under the direct and indirect control procedures of the SARB in that period. He found that money was endogenously determined at all times, however, no work exists that deals with money supply since the new monetary policy framework was introduced.

Chapter 2

REVIEW OF THEORY

2.1 INTRODUCTION

The aim of this literature review is to present an alternative model to that assumed by the monetarist school, which seems to have become convention, and then show the distinctions and developments within this new approach. The part money has to play in an economy has been re-evaluated in recent years, mainly by a body of scholars called post-Keynesians. Post-Keynesians also present an alternative money creation process and different causal linkages. Davidson (2006:141) sums up the debate:

"*A recurring theme in the long evolution of monetary theory is the dispute whether exogenous changes in bank money supplies play a causal part in influencing the price level and/or economic activity, or whether variations in the observed money supply are an endogenous effect of changes in economic activity*"

There has been extensive debate between the monetarists and post-Keynesians as to whether the central monetary authorities control the level of the money stock in the economy and in doing so affect output, or whether output, specifically the transactions motive for entrepreneurial activity, determines the stock of money in the economy at any time. Part 1 of the literature review will deal with all debates in this regard.

Within the post-Keynesian position there is disagreement as to the exact level of money endogeneity, or phrased differently, the exact level of control the central monetary authorities exercise over the quantity of the money stock. The Accommodationists position, of which Moore is the primary advocate, holds that the authorities completely accommodate all requests for reserves (resulting from credit money creation) at their specific key interest rate. While the Structuralists, of whom there are many, accept the core of endogenous money theory but argue that the Accommodationist approach is too simplistic and excludes preferences and multi-time period analysis. Part 2 of this literature review will deal exclusively with these two positions and the significance of their differences.

Finally, Part 3 of this review will deal with empirical studies on endognenous/exogenous money supply and Accommodationist/Stucturalist findings from various countries and economic blocks around the world.

2.5 MONETRISM VS. POST-KEYNESIANISM: THE ENDOGENITY OF THE MONEY SUPPLY

2.2.1 MONETARISM AND EXOGENOUS MONEY

In the standard economic paradigm it is typical to consider the money supply as being exogenously determined by some central monetary authority. What this means is that the direction of causation is typically thought to be from the money supply to output and inflation. Friedman (1956: 11) gives a restatement of the Quantity Theory of Money that can be written in the form:

$$M.V = P.Q \qquad .....[1]$$

where M is the money stock, V is the velocity of money, P the price level, and Q the level of nominal income.

Friedman (1972:16-17) shows that the velocity of circulation of money is relatively stable over time and, therefore, V can be treated as stable over the short-run. The significance of this is that the Quantity Theory then becomes a theory of nominal income. Monetarists, in general, read equation [1] from left to right with MV being treated as exogenous and PQ as endogenous, i.e. exogenous changes in M by the monetary authorities lead to changes in income and inflation (Lavoie 1984:781). It is because of this that Friedman (1972:28) famously states that one of the principal tenants of monetarism is:

"inflation is always and everywhere a monetary phenomenon"

This process operates according to a credit money multiplier (Lovie 1984: 778) which is given by:

$$M = mB \qquad .....[2]$$

where m is the money multiplier, M the money stock, and B the monetary base.

Monetarists read equation [2] from right to left: by controlling the monetary base B, through a multiplier, m, the authorities can control the ultimate money stock. By doing so, in conjunction with equation [1], it is believed that they are able to influence the income and inflation levels in an economy. The causative process behind this is neatly explained by Nell (1999:3):

"*Reserves therefore make deposits and the deposits that result from an increase in the monetary base are exogenously determined by the monetary authorities, explicit in this approach is that the money multiplier is stable and predictable, so restrictive monetary policy will not be offset by an increase in the money multiplier*"

It is because of this that monetarists are focused on the liabilities side of the Central Bank's balance sheet. It is the liabilities of the Central Bank that makes up the monetary base, which through the multiplier influences the money supply, which then in turn affects nominal income.

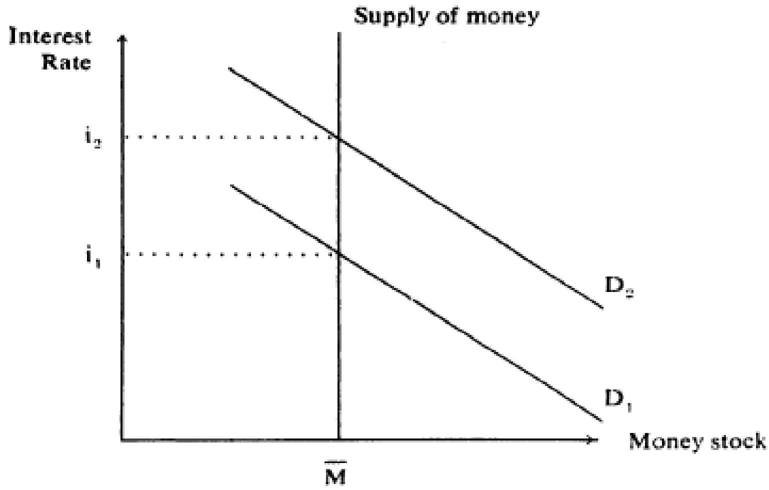

Figure 1.

Figure 1 (Lavoie 1984:783): Exogenous Money Supply Curve

This position can be illustrated in Figure 1 whereby the money supply curve is represented as a vertical line. Within this framework, Lavoie (1984:782) points out that:

"The central bank must aim at controlling the stock of money rather than the cost of credit (that is, interest rates)…. if the publics' demand for money increases, interest rates go up."

From this statement it now becomes clear at just what cost the Central Bank is able to control the quantity of money. Clearly, interest rates must change in order to equate the supply of money with the demand for money. Thus, at the cost of freely floating interest rates the monetary authorities are able to control the quantity of the money stock. In the case of an increase in the demand for money which is not met and accommodated by the banking system, after there has been a sale of other liquid assets (such as bonds) in order to obtain more money, portfolio adjustments occur to create equilibrium which changes prices (interest rates in this case).

Davidson (2006:147) describes what happens when the Central Bank practices a 'monetarist' policy and aims at implementing a portfolio change process and increasing the money supply exogenously. The Central Bank enters the open market and purchases liquid assets, most likely from banking institutions (but it can also purchase these liquid assets from the general public). If the assets are bought from the banking sector then their accounts and the Central Bank will be credited with extra reserves (i.e. there is an increase in the monetary base). With reference to equation [2], this leads to an increase in the variable B. It is the hoped that this will induce banks to make more loans and extend credit, through the credit multiplier, which will increase the money stock and lower interest rates. As stated by Davidson (2006:147):

"In the portfolio money supply, the initial cause of change in the money supply is an explicit ceteris paribus policy decision on the part of the Monetary Authority to shift the supply function of money at any given rate of interest. Accordingly, the portfolio change money process always involves an exogenous change in the money supply function".

2.2.2 ENDOGENOUS MONEY

It is now appropriate to turn the attention to the post-Keynesian view of money supply and how and endogenous money supply differs from an exogenous one as described by monetarists. Lavoie (1984:774) sums up the post-Keynesian position succinctly by stating simply that:

"*There can be no money without production".*

This cues our attention to the production processes in the economy. It is very apparent from this review so far that the monetarist position considers money to be the causal, exogenous, variable. What this means is that an increase in the money supply can cause an increase in the production process in an economy. Thus, monetarists divorce the quantity of money in the economy from the level of economic activity, and see the level of money as fixed regardless of current production processes.

Post-Keynesians consider the exact opposite to be true. Moore (1989: 66) describes the alternative when he says:

"The alternative paradigm implies that in all modern capitalist economies the total volume of bank deposits is effectively determined by the demand for bank credit. The credit money stock is credit-driven and demand-determined. Both the base and the money stock are endogenous."

In direct contrast with exogenous money supply theory, the entrepreneurial spirit in the economy determines the demand for bank credit, and this demand for credit money is what creates deposits. It is only *ex post* that banks then apply for reserves from the Central Bank at the going rate of interest. As Nell (1999: 3) says:

"the monetarist view is in direct contrast with the real world where commercial banks are price setters and quantity takers."

Davidson (2006: 146) describes what he calls the income finance motive and money supply process. In every economy, depending on the "Keynesian animal spirits" (i.e. sentiment in the economy), entrepreneurs will have the desire to increase or decrease production and consumers to increase or decrease consumption. If there is a desire to increase production and consumption people enter into debt contracts with the banking system. If these debt contracts are then accepted, because the banks' lending requirements are met, then loans are made. This is done without any active intervention from the Central Bank as the monetarist position implies. The additional credit money granted through loans is then used to finance expenditure.

"In this process, a change in the production flow process induces a change in quantity of money supplied. In the income-generating finance process, the quantity of money supplied is always endogenous." (Davidson 2006: 146)

When additional loans are granted via the income generating finance process, banks are only able to grant all the loans required of them to keep up the means of production if the Central Bank is willing to accommodate them via supplying them with reserves. Moore (1989:68) believes that the Central Banks most essential responsibility is to ensure financial stability. To ensure the integrity of financial assets, and the stability of the financial system, the Central Bank must stand ready to perform their role as the lender of last resort. The only way that this can happen is if the Central Bank stands ready to supply reserve money to banks through the discount window at all times, i.e. to accommodate all bank demands for reserves. In essence: it is the granting of bank loans that creates new bank deposits, which *ex post* create reserves through Central Bank accommodation.

Lavoie (1984:778) recommends a revised credit multiplier that represents the post-Keynesian viewpoint, which is a manipulation of equation [2]. He calls it the credit divisor and presents it as:

$$B = (1/m).\ M \qquad \text{....[3]}$$

In the post-Keynesian paradigm M is seen to be independent and B is the dependent variable. Equation [3] is read from right to left. In this case the money supply is determined by credit accommodation, and then afterwards the money base is created by the Central Bank as a passive response.

With regard to Equation [1] above, post-Keynesians read the direction of causation in the equation from right to left (opposite to monetarists). What this means then is that PQ is the independent exogenous variable, and M is the endogenous variable which responds to changes in the price level and income. If there is an increase in PQ, then, assuming that the velocity of money V is stable as postulated by Friedman, there will be an increase in M the money supply. According to equation [3] the increase in M will be accommodated by the Central Bank in supplying the banking system with additional base money B.

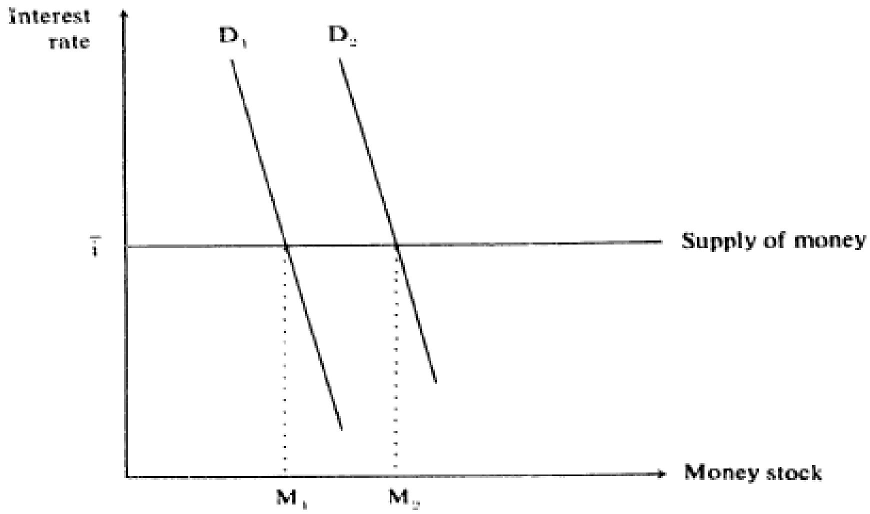

Figure 2.

Figure 2 (Lavoie 1984:784): Endogenous Money Supply Cuve

It is now appropriate to show this graphically. Figure 2 displays a horizontal money supply curve as postulated by post-Keynesians. What can be seen is that at the set interest rate, the quantity of credit money demanded in the economy is supplied by the banking system. The causal linkages have been shown above by coupling equation [1] and [3].

For an economy to grow to a higher level of production and income firms require planning long in advance in order to ensure that payment to the factors of production, such as capital and labour, are upheld. Banks must stand ready to supply them with credit money so that they may finance this production. According to Davidson (2006:148) it should be fairly obvious that the banking system must provide:

"'elastic currency' so that the expanding needs of trade can be readily financed."

According to Moore (1989: 67) the underlying cause of inflation is the continual increase in the money wages per unit of labour, over and above the increase in the growth of labour productivity. An endogenous money supply provides credit finance to meet the needs of real trade but is unable to distinguish between increased employment to finance greater production, on the one hand, and increased money wages per unit of labour, on the other. When the credit money is used to increase production by investment in capital or more labour then income will grow. If it is used to finance greater labour costs then inflation will occur. Essentially, if the increase in endogenous money outstrips the supply elasticity of the economy inflation is the result.

2.2.3 CRITICISMS OF ENDOGENOUS MONEY

The basic positions of the conventional exogenous and post-Keynesian endogenous money supply have been described. However, there is still a point of contention that has not been dealt with so far that concerns empirical findings of Friedman. Friedman (1972: 27) says that:

"There is a consistent though not precise relationship between the rate of growth of the quantity of money and the rate of growth of nominal income. If the quantity of money grows rapidly so will nominal income and conversely."

This by itself is not particularly threatening to the post-Keynesian position as they assume much the same relationship, just in the opposite direction. The key aspect of Friedman's work that needs to be addressed is that which puts the post-Keynesian causal relationship in dispute, namely:

"On average, a change in the rate of monetary growth produces a change in the rate of growth of nominal income about six to nine months later."

This seems to confirm the monetarist position of exogenous money supply whereby money supply changes, as determined institutionally by the Central Banks, later cause changes in nominal income.

Lavoie (1984:786-787) addresses this in saying:

"*Some monetarists (starting with Friedman) claim to have discovered a temporal relationship between the stock of money and the value of national income, the former always preceding the later in empirical time.*"

However, Lavoie believes that this does not prove causation and there are many reasons why not. If, as post-Keynesians do, there is a belief in a finance motive for demand for credit money, the demand for money and loan accommodation occurs, sometimes, before income is received and often before pay out for goods and services. Moore (1989: 72) holds that because production takes time, production costs then become the firms' demand for working capital which must be borrowed before production can start. The credit money stock then increases initially as a consequence of the expenditures that firms expect to realise. This would then explain the increase in the money supply occurring temporally before that of nominal income, even though causation is from nominal income to money supply. It can be though that expected or desired nominal income is what causes an increase in the money supply.

In summary, the core difference between conventional, exogenous-vertical, money supply, and post-Keynesian endogenous-horizontal money supply is the direction of the relationship between money stock changes and nominal income changes. The root cause of change for monetarists is institutionally determined adjustments by the Central Bank to the stock of money. Post-Keynesians, on the other hand, believe the root cause of change is the requirement to finance real trade or expansion. This then is passively accommodated by the banking system in the form of increases in credit money.

2. 6 ACCOMMODATIONISTS VS. STRUCTURALISTS: THE ENDONGOUS MONEY DEBATE

Once the core theory of an endogenous money supply is accepted, the debate does not end. In fact, there is a large amount of contention as to the exact level of money endogeneity with regard to demand for credit money being supplied. Fontana (2003:291) reiterates what has been said in the previous section, namely that:

"The essence of endogenous money theory is that the stock of money in a country is determined by the demand for bank credit, and the latter is causally dependent upon the economic variables that affect the level of output."

What this means is that it is the need of entrepreneurs to increase production by increasing employment and working capital that leads to bank credit demand which results in determining the money stock within an economy. Moore (1989: 68) argues that it is the responsibility of any Central Banking institution to ensure the stability of the financial system above all else. In order to do this the Central Bank must stand ready to supply money to banks in the form of reserves and continually act as a lender of last resort. Firms demand credit money in order to finance working capital so that production levels may be increased if there is a positive turn in business sentiment.

The extent to which this process occurs is the difference between Accommodationists and Structuralists. According to Fontana (2003:294):

"The accommodationist approach assumes an infinite elasticity of the supply of credit-money: in a Cartesian diagram, a horizontal line at the going rate of interest represents the credit-money supply function."

In the spirit of the Accommodationist approach it is clear that the banking system is willing to accommodate all demands for credit money at the going rate of interest. Therefore, it is the demand for credit money that determines the supply of credit money, and the money stock in general. Advocates of this believe that the Central Bank continually inserts or removes reserves from the banking system in order to keep the interest rates at the exogenously determined level (Shanmugam *et al. 2003: 599).* Therefore, the Central Bank controls the level of the interest rates and not the supply of reserves, and in general an increase in the demand for credit money to finance trade is not met with an increase in the interest rates, but rather a change in banking reserves (accommodated by the Central Bank).

Palley (1996) specifies a model that demonstrates an appropriate graphical representation of the Accommodationist position. This is shown in figure 3.

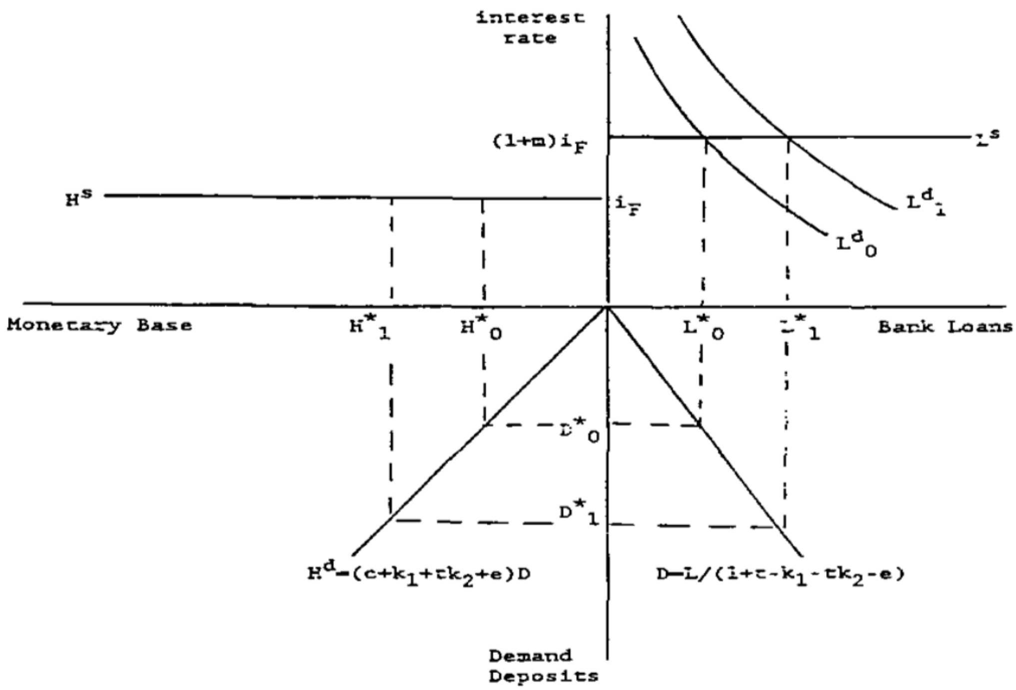

Figure 3 (Palley 1996:588): Accommodationist Money Supply Curve

Within Figure 3, the upper left panel shows the discount window in which the reserves are supplied at a fixed interest rate exogenously determined by the Central Bank. The upper right panel shows the market for bank loans or credit money, note that the supply curve is perfectly elastic as shown horizontally and money is supplied at an interest rate above that of the key interest rate determined by the Central Bank. The lower right panel shows the banking sector balance constraint and the post-Keynesian position in that there must be a specific level of deposits associated with a given level of bank lending, i.e. loans create deposits. The lower left panel demonstrates the level of reserves required for any given level of deposits.

As demonstrated, when there is an increase in the demand for bank loans the banking system fully accommodates this demand and there is an increase in deposits and reserves, while the interest rate remains the same. Palley (1996: 589) states that the causal sequence is from:

"Central Bank policy → loan market outcome. The central bank sets the interest rate and the loan market outcomes are contingent on this setting."

The Structuralist approach differs in that, although it does accept the endogenous nature of the money supply, it is thought that full accommodation in a real world environment is unrealistic, and, at least to a certain extent, the demand for credit is constrained by the central monetary authority (Nell 1999:4).

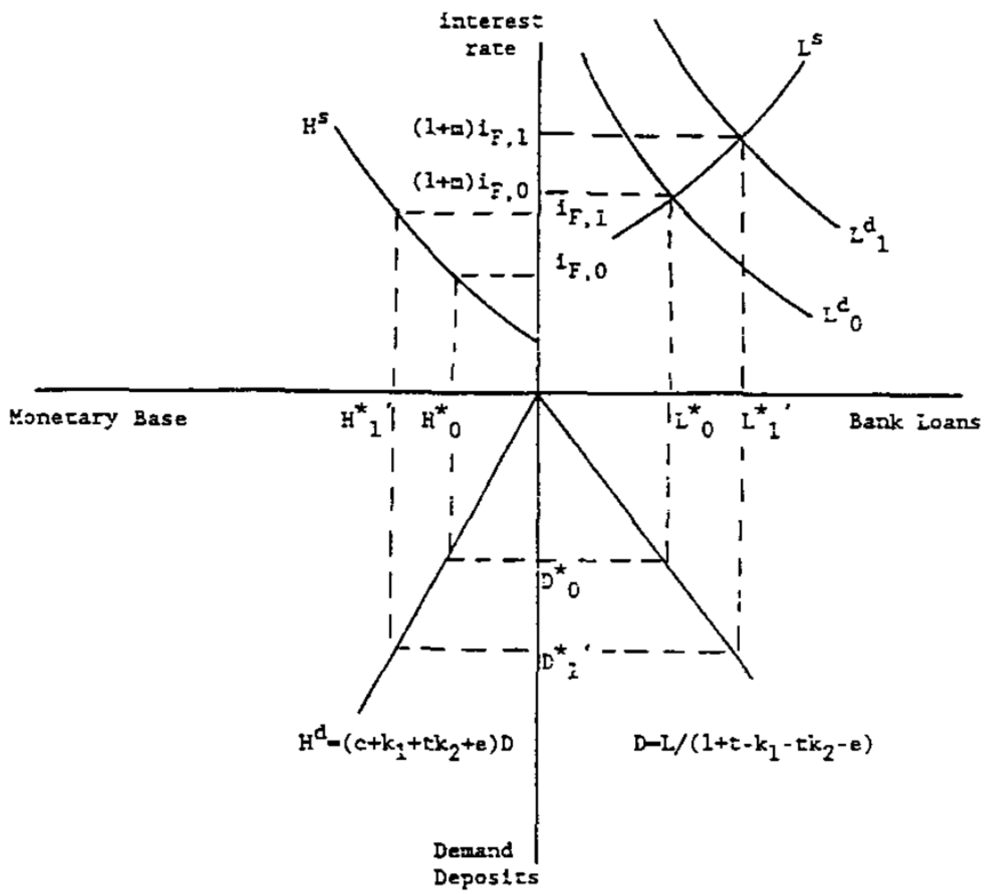

Figure 4 (Palley 1996:592): Structuralist Money Supply Curve

This new, Structuralist position is demonstrated in Figure 4 with the quadrants of the Cartesian plane representing the same variables as in Figure 3. In the top left quadrant, the supply of reserves can be seen to increase in price (interest rate) as the quantity demanded by banks increases and, therefore, in the top right quadrant, there is an upward sloping money supply curve. Palleys' (1996) Structuralist attack on Accommodationism (i.e. why interest rates increase as the demand for credit increases) is in terms of (i) the Accommodationist tendency to ignore banks' ability to engage in liability management and (ii) the Accommodationist claim that the only policy instrument that the Central Bank is able to control is the interest rate.

According to Palley (1996:589) the Central Bank can target the money supply or the interest rates, or even some other variable. The Central Bank is able to affect the level of bank lending by:

"*raising the discount rate, restricting discount window borrowing, or draining non-borrowed reserves from the federal funds market to offset any increase in borrowed reserves."*

This is in contrast to the Accommodationist approach whereby the Central Bank only determines the exogenously set interest rate, thereby affecting the cost of credit, and the banks then accommodate all demands for credit at the interest rate. Structuralists believe that open market operations affect the reserves market, and through it the level of money supplied. This is seen as a viable Central Banking policy operation.

This then leads onto (i) Palley's other contention that a change in interest rates, because of targeting the money supply, causes banks to change their portfolio decisions. It is this feature of adjustment which is the key to the Structuralist position. According to Palley (1996:590-591):

"Once the central bank has engineered an increase in the federal funds rate and loans rate, banks will have an incentive to engage in asset and liability management as a means of obtaining the cheapest source of funds."

This then allows banks to find cheaper sources of funding rather than relying solely on reserves, especially in a situation where the Central Bank has allowed short-term interest rates to rise. Liability management such as this allows banks to partly overcome the reserve constraints imposed on them by the Central Bank (Shanmugam *et. al.* 2003:602).

Moore (1998) responds to these two critiques. Firstly, with regard to (i), by saying that Accommodationism does not disregard feedback effects, such as possible portfolio change, but only that the Accommodationist position is taken to refer to the immediate market period, not multiple periods in the future. According to Moore (1998: 175):

"It is appropriate over such a short time horizon to regard the interest rate as set exogenously by the monetary authority, and the money supply function as horizontal."

and

"as evidenced by the historical behaviour of short-term rates, there is no general necessity for interest rates to rise …with the level of bank lending."

Therefore, Moore believes that Palley misunderstands the time frame of analysis in which he was dealing in his Accommodationist approach. With regard to (ii) Moore (1998: 176) states that:

"*There is no disagreement that by open market sales or purchases, the central bank at its discretion reduces or increases the quantity of bank non borrowed reserves. But since banks' required reserves in any period are predetermined by past bank lending and deposit creation, changes in non–borrowed reserves … cause changes in the short-term interest rates."*

However, under a money endogeneity hypothesis, the Central Bank practices short-term interest rate targeting and attempts to keep rates within its target band. Therefore, according to Moore (1998:176):

"*the central bank continually injects or withdraws reserves in the process of keeping the short-term interest rate within its target band."*

Thus, the Central Bank may use open market operations in order to affect the quantity of reserves within the system, but it does so only insofar as it can influence the level of the short-term interest rates and ensure that it remains within the required band. Therefore, the Accommodationist position does not deny that open market operations targeting the money stock happen, but it is felt that the only reason the Central Bank does this is to keep short-term interest rates at their target levels, rather than doing them in order to change or affect short-term interest rates.

Palley (1998: 2) responds to Moore by saying that:

"Moore misrepresents me by claiming that I say structuralists maintain that monetary policy is based on targeted adjustments on the quantity of reserves. For structuralists, the monetary authority may choose to target interest rates, or it may choose to target the monetary base, or it may choose either as an instrument on reaching some other target. If it targets interest rates, open market operations involving swaps are still required."

It is because of this that Palley (1998:2) comes to regard Accommodationism as a specific case of Structuralism and that it can be seen as 'nested' within the Structuralist model corresponding to a particular stance of monetary policy.

Another line of criticism of the Accommodationist approach comes from Howell (1995:90-91) where the viewpoint that money can never be in excess supply because there is no money supply function independent of money demand. The money supply is demand-determined because it is credit money that is being talked about. Credit money is only supplied when it is demanded for trade.

Moore (1991:125-126) draws an analogy between goods produced “to contract” and goods produced “to market”. For goods produced to market the supply function exists independently of the demand function and depending on the price of the good, inventories change in order to equate the two. In this situation is it possible to envisage an excess supply. Goods produced to contract, such as bank loans, cannot exist without the contract beforehand so these types of goods are necessarily and always demand-determined (it is also here that Moore famously makes his comparison of bank loans to haircuts!).

Howell (1995:91-92) believes that this analogy is unhelpful because even though the quantity of a good produced to contract is determined where the supply schedule intersects the demand curve, it does not mean that there is no independent demand curve. The question then, according to Howell (1995:91), is that in order to make the Accommodationist view valid:

“what reconciles the deposits resulting from this lending with people’s willingness to hold money?”

Kaldor and Trevithick (1981) argue that those with excess money balances automatically repay their loans. This they believe is an appropriate mechanism for reconciling the money supply with the demand for money. If economic agents automatically repay their debts then there is no problem as the question of excess (or shortage) of deposits becomes redundant. Howell (1995:93-94) refutes this by reminding us that there are various economic agents, and it is not always the agents who hold money who have a debt or overdraft facility:

“*It is not sufficient to argue that so long as someone somewhere has an overdraft, ‘excess’ money balances will eventually be destroyed by loan repayment. Unless everyone has an overdraft, unwanted deposits may continue to circulate. It is precisely this that gives rise to those repercussions on prices, quantities, of goods, assets or whatever.”* (Howell 1995:94).

Moore (1989:67) also reiterates the Kaldor and Trevithick (1981) automatic repayment mechanism, although not explicitly. Moore (1991:129) says that people will always hold money since it is generally accepted as a mean of payment and that money is always and everywhere accepted in exchange for goods and services. As a result of this there should be no adjustment or change in prices as money accepted is always money demanded. Howells's (1995:105) suggestion is that it is a change in relative interest rates of various liquid assets that equate the supply of newly created deposits with the newly created loans. This is known as the liquidity preference viewpoint.

Fontana (2003: 298) sums up the liquidity preference viewpoint by saying that:

"liquidity preference is considered to be a short-hand way of referring to the complex behavioural functions of households, firms, banks, and the central bank."

The important institutions to consider in this regard are the banks and the Central Bank. This theory operates with particular reference to "Keynesian animal spirits". The economy is always moving between periods of positive sentiment and periods of negative sentiment. If there is negative sentiment in the economy and liquidity preference is high then banks are less willing to meet credit demands of households and may automatically raise their premium over the short-term interest rate as set by the Central Bank. In periods of positive sentiment the Central Bank may do the opposite (Fontana 2003:299). The Central Bank is also burdened with the responsibility of liquidity preference because this affects the amount of funds (reserves) the Central Bank makes available to the banking system. If there is a high liquidity preference because of poor economic sentiment then the Central Bank faces the risk of placing funds with a potentially insolvent bank. Therefore, the Central Bank may adjust short term interest rates rather than merely accommodating all demands for credit in the ailing economy (Fontana 2003: 300). The message of the liquidity preference view is that the analysis may not me so simple as the Accommodationist viewpoint initially made it seem, and the banks and Central Bank may have plausible reasons for not fully accommodating the demand for credit at all times, leading to an increase in interest rates.

On a final note, both the Accommodationist and Structuralist viewpoint start with the idea of an endogenous money supply whereby loans create deposits. As was mentioned earlier, many feel that the two positions are reconcilable, with the Accommodationist model merely being a special case of the Structuralist position. Fontana (2000: 379) in this regard says that:

"*Thus, the single period analysis proposed by the horizontalists is an important contribution to the generalised theory of endogenous money.*"

Palley (1991, 1996) and Fontana (2000, 2003) are of the opinion that the Structuralist position merely seeks to expand and improve on the single period analysis and that over multiple periods the feedback effects of monetary policy, such as portfolio changes and liquidity preference, should logically be included within any model that seeks to describe this process. In this regard Fontana (2003:380-381) states:

" the formal features of a single period imply that disappointment or new opportunities would not have an effect on the state of current expectations. It is only in the next period that the reserve market and the credit market would record new demand and supply conditions."

Simply phrased, a generalised theory of endogenous money is possible if it is accepted that the Accommodationist approach adopts a single period analysis whereas the Structuralist approach adopts a continuous, multiple-period, analysis. All of the problems with the Accommodationist viewpoint only posit themselves over a longer period of analysis than a single period, generally once change has occurred, and as such I find this to be a plausible viewpoint. Perhaps the contention then is not how endogenous money supply is, but rather how does the endogeneity of the money supply change as time progresses?

2.4 THEORETICAL FINDINGS ON ENDOGENOUS MONEY HYPOTHESIS

Although it is undeniable in an accounting sense that loans create deposits there is still very little empirical work for the endogenous money hypothesis. This section aims to detail the statistical and empirical results on whether money is exogenous or endogenous, and if it is endogenous, exactly what version of endogeneity is supported by the evidence.

Shanmugam *et al.* (2003) uses a series of causality tests and error-correction models in order to determine whether the money supply in Malaysia is endogenous, and if so whether the Accommodationist, Structuralist or liquidity preference view is correct. It is found that there is cointegration and stable long-run relationship between gross national product (money income) and M3 money supply. An error-correction model is run on these two variables and it is found that both error-correction terms are significant. This supports the liquidity preference view that money income causes money supply, through the loans create deposits scenario, but also that there is an independent money demand function, or liquidity preference, which limits money supply. However, it is noted that there is no evidence to disprove the Accommodationist or Structuralist approach.

Howells and Hussein (1998) investigate the evidence for the money endogeneity hypothesis in the G7 countries. Cointegration analysis and Granger causality tests are used to determine whether causation runs from banks loans to M3 or from M3 to bank loans. It is founds that money is broadly endogenous across the G7 economic block. However, the ability for the demand for loans to cause deposits seems to be constrained by the demand for deposits. Although not said explicitly, this is an implicitly endorsement of the liquidity preference view given by Howell (1995).

Vera (2001) reviews the evidence of money endogeneity in Spain from 1987 to 1998 using a series of Granger causality tests between various money aggregates, the monetary base and net loans. The findings imply that over the period of analysis the money supply was strongly credit-driven and demand-determined, with the direction of causation being predominantly from net loans to the monetary base and various monetary aggregates.

Nell (1999) looks at the exogenous/endogenous nature of money in South Africa. He uses a series of Granger causality type tests to ascertain whether the money supply is endogenous and whether the Structuralist or liquidity preference view is correct. Nell finds in favour of money endogeneity from 1966 to1997 but is unsure if it is caused by Structuralism or liquidity preference.

Pollin (1991) tests to see whether Accommodationism or Structuralism prevailed in the US economy between 1953 and 1988. He finds that the overall results are supportive of endogenous money but that loans have not grown proportionally to reserves, as Accommodationism would predict, but rather that banks have practised liability management in line with the Structuralist approach. Pollin also finds that interest rates are not strictly determined by the Central Bank, but by a complex set of interactions between the Central Bank and financial markets. Therefore, Pollins' findings agree with the Structuralist interpretation of endogenous money hypothesis.

Chapter 3

METHODOLOGY AND PROCEDURE

3.1 EMPIRICAL HYPOTHESES

The monetarist position arises from Friedman's (1956) restatement of the Quantity Theory of Money. Friedman shows that if the velocity of money is stable in the short-run then over time the Quantity Theory of Money becomes a theory of nominal income. By controlling the quantity of money within the economy the Central Bank is able to have direct control over the level of nominal income. Therefore, there will be unidirectional causality from M3 to gross domestic product (GDP).

The mechanism through which the Central Bank controls the quantity of money in the economy is the money multiplier (Lavoie 1984). By controlling the monetary base the Central Bank is able to control the level of money within the economy which then influences nominal income. This means that there should be unidirectional causality from the monetary base (MB) to M3

Finally, the way that an increase in the quantity of money stimulates nominal income is through lowering the cost of credit. When banks have more money, through an increase in the MB that has been institutionally determined by the Central Bank, more loans are made resulting in a rise in domestic credit extension (DCE). This means that there is unidirectional causality from M3 to DCE.

Accommodationism is on the opposite side of the spectrum from Monetarism. Accommodationists believe that the Central Bank supplies all reserves to the banking system on demand and that the total volume of bank credit (and money in the economy) is demand determined (Moore 1989:66). What this means is that changes in nominal income due to changes in economic sentiment causes changes in the demand for money. So according to Accommodationism there is causality running from GDP to M3.

The mechanism through which the amount of money demanded is accommodated is the credit divisor (Lavoie 1984). When economic agents apply for credit, and if that credit is granted by the banking system, the Central Bank supplies all reserves required by the commercial banks at the administratively determined short-term interest rate at all times. This implies unidirectional causality from M3 to MB.

Also, as is quite apparent from the above description, it is a change in demand for credit money that initiates a change in money stock. In an accounting sense, this is the idea that loans create deposits, and therefore, there should be unidirectional causality from DCE to M3.

Structuralism can be seen as a combination of the orthodox monetarist approach and Accommodationism. Although Structuralists do accept the core of the endogenous money hypothesis, Structuralists believe that Accommodationism is too simple to describe the complex inter-relations of a complex real world system. Structuralists believe banking system is not accommodated at all times by the Central Bank. Rather, the Central Bank can target the quantity of money, the short-term interest rate, or even some other third variable (Palley 1996:589). This implies that if the banking system continually applies for reserves, the Central Bank is likely to raise its rates on accommodation in an attempt to reduce money creation. Whereas monetarists believe in unidirectional causality from M3 to GDP and Accommodationists from GDP to M3, the Structuralist position holds that there is bidirectional causality running from M3 and GDP.

This (the Structuralists' model) means that the Central Bank follows a partly Monetarist and partly Accommodationist policy. In terms of the mechanism through which this operates it is a mixture of the money multiplier and credit divisor. Therefore there is also bidirectional causality between the MB and M3.

A demand-determined credit money supply, as advocated by Accommodationists, implies that the quantity of money demanded is always equal to that supplied. The Liquidity Preference theory, while also falling under the endogenous money position, holds that money demand is not always necessarily equal to money supplied (Howell 1995). If this is the case then changing liquidity preferences in the economy, due to differences in economic sentiment, mean that the quantity of credit demanded can be affected by the changing liquidity preference. Likewise, the amount of money demanded and supplied can have a direct effect on economic sentiment and through that the liquidity preference of economic agents. This means there is bidirectional causality between M3 and DCE.

The direction of causality between the variables for the different positions is summed up in Table 1.

Table 1: Summary of causality implications of different theories

Exogenous position	**Endogenous positions**		
Monetarist	**Accommodationist**	**Structuralist**	**Liquidity Preference**
M3⇐MB	M3⇒MB	M3⇔MB	M3⇔DCE
M3⇒DCE	M3⇐DCE	M3⇔GDP	
M3⇒GDP	M3⇐GDP		

3.2 METHODOLOGY AND MODEL

In order to test whether the money supply is endogenous in South Africa the concept of Granger causality is employed between variables as specified in Table 1. This study aims to build on Nell's (1999) findings of money endogeneity in South Africa from 1966 to 1997. The sample period of this study is from 1998Q1 to 2011Q4 and all variables are logged.

The causality relationship will be tested in a three step procedure based on that of cointegration analysis and a Vector Error-Correction Model (VECM). The first step in this procedure will be testing the stationarity properties of the different time series using the Augmented Dickey-Fuller unit root test. It is a requirement of cointegration analysis that the variables be of the same order of integration for the results to be valid. The second step is to test for cointegration using the Johansen (1988) Maximum Likelihood procedure between different variables and seeing if they are cointegrated and have a stable long-run relationship. The final step is running a VECM between cointegrated variables, and by using tests of weak exogeneity, determining the direction of causality between them.

The question of whether the money supply is exogenous or endogenous has been rigorously debated in recent years. However, two schools of thought, Keynesian and Monetarism, agree that money supply is exogenous, and as such, this has become the dominant idea in economic teachings. Post-Keynesians have argued for an endogenous money supply which shall be tested for in this study.

3.2.1 UNIT ROOT TESTS

All the variables are required to undergo unit root tests in order to prepare them for cointegration testing and causality tests. Within cointegration procedure it is required that the variables be a similar order of integration. Therefore a validation of the stationarity properties of the variables is needed prior to testing for cointegration. The Augmented Dikey-Fuller (ADF) (1979) unit root test will be used to test for the order of integration and stationarity properties of the time series.

A stationary time series will have finite and time-independent mean, a finite and time-independent variance, and all autocovariances will be finite and time-independent. In contrast, a non-stationary time series will have a time variant mean or variance (Enders 2010: 60-61). The reason to check for stationarity is to avoid spurious regression whereby the regression shows t-statistics that are significant and a high R^2 statistic, but the regression has no economic meaning. Granger and Newbold (1974:117) show that if $R^2 > d$ this gives us strong reason to suspect that the regression is spurious.

The ADF test is specified as

$$\Delta Y_t = \beta_1 + \partial Y_{t-1} + \alpha_i \sum_{i=1}^{m} \Delta Y_{t-i} + \varepsilon_t \qquad (1)$$

Where;

ε_t , the errors, are assumed to be independent and have a constant variance,

And , ΔYt = (Y_t-Y_{t-1}) (Enders 2010: 215).

As can be seen this is a transformed standard random walk model with intercept and drift; however, other specifications of the model may exist, those being with or without an intercept and/or trend.

The null hypothesis is that there is a unit root (time series is non-stationary) tested as ∂ = 0. The alternative hypothesis is that there is no unit root (time series is stationary). It is important to select the right amount of lags when performing ADF tests. If too few lags are chosen then regression residuals will not behave like a white noise process, violating the assumptions of the ADF test's ϵ_t sequence. If too many lags are chosen the power of the test is reduced significantly (Enders 2010: 216). The Schwartz Information Criterion (SIC) will be used to select the appropriate lag length when performing the ADF test. Once the model has been estimated as in (1), if the value of the calculated t-statistic of the lagged coefficients is larger than the critical value of the t-statistic at various levels of significance, then there is a rejection of the null hypothesis it can be concluded that the time series is stationary. The ADF unit root test is one of the most popularly used tests in the literature and is appropriate for this study.

3.2.2 COINTEGRATION PROCEDURE

In order for cointegration testing to occur the order of integration of variables must be established. This is done within the ADF unit root tests. When a time series is stationary after being differenced *d* times then it is said to be integrated of order *d,* or I(d). If variables are of the same order of integration I(d) then there may be some linear combination of these variables that is stationary in the long-run and these variables are cointegrated of order d, b or CI(d,b) (Engle and Granger 1987:252-253).

Although Engle and Granger (1987) supply their own method of testing for cointegration, this study will make use of the Johansen (1988) Maximum Likelihood Procedure of testing for cointegration. The Johansen procedure is used because of a number of defects of the Engle-Granger method. The biggest problem with the Engle-Granger method is that it relies on checking the residual series for stationarity. This means that there is a two-step estimator method where the residual series must be obtained and then a second regression of the residuals is made (Enders 2010:385-386). Johansen (1988) discovered a way to circumvent the two-step linear estimation method that was characteristic of Engle-Granger, and test for the presence of multiple cointegrating vectors.

The Johansen estimation takes the form of

$$\Delta x_t = \Pi x_{t-1} + \varepsilon_t \tag{2}$$

where x_t and ε_t are (nx1) vectors,

Π = (A-I),

A is a (nxn) matrix, and

I is a (nxn) identity matrix.

This estimation relies heavily of the relationship between the rank of the matrix and its characteristic roots (Johansen 1988:233-234).

In order to determine the number of cointegrating vectors based on the likelihood ratio test Johansen and Juselius (1991) suggested two tests, the trace test (ƛ trace) and the maximum eigenvalue (ƛ max) test. The null hypothesis of the trace test is that the number of cointegrating vectors is less than or equal to r. The alternative hypothesis is that the number of cointegrating vectors is more than r. The trace test is specified as

$$\hat{\lambda}_{trace}(r) = -T \sum_{i=r+1}^{n} \ln(1 - \hat{\lambda}_i) \tag{3}$$

where T is the number of usable observations, and

$\hat{\lambda}_i$ is the estimated value of the characteristic roots obtained from the Π matrix in the estimate of equation (2).

For the max eigenvalue test the null hypothesis is that the number of cointegrating vectors is r whereas the alternative is that the number of cointegrating vectors is r+1. The max eigenvalue test is specificed as

$$\hat{\lambda}_{max}(r, r+1) = -T ln(1 - \hat{\lambda}_{r+1}) \tag{4}$$

From these two test statistics it will be possible to tell the number of cointegrating vectors between multiple variables, or if there is only one cointegrating vector between any two variables.

The starting point in the Johansen procedure is estimating an unrestricted Vector Autoregressive (VAR) model, as the estimation of equation (2) is derived from the VAR. As the trace test statistic and the max eigenvalue statistic are highly sensitive to the amount of lags used in the estimation of the equations, the SIC is used to test for the appropriate lag length in the unrestricted VAR before cointegration testing occurs (Enders 2010:395-396).

When variables are cointegrated it means that there is a stable long-run relationship between them and the variables, although individually following trends over time, when in a specific linear combination trend towards their long run equilibrium. For the purposes of this study, if the variables that are being tested for integration are both I(d) then an unrestricted VAR will be run. The SIC will be used to determine the appropriate lag length and then the trace test and max eigenvalue test will be used to see if the variables are cointegrated. The variables will be tested in pairs, following the theoretical causal relations as expressed in Table 1, and it will be seen whether there is a stable long-run relationship between them.

3.2.3 VECTOR ERROR CORRECTION MODEL (VECM) AND GRANGER CAUSALITY

Cointegration does not say anything about the direction of causality or the dynamics of the long-run relationship between the variables, only that a long-run relationship exists. Engle and Granger (1987:254) first showed that for any two variables X and Y, if they are cointegrated then they have a VECM representation which may be used to model the dynamics between the variables. This is known as the Granger representation theorem where error correction and cointegration are equivalent representations (Enders 2010:370). The purpose of this study is to determine the direction of causality between different variables and as such a logical starting point is a definition of Granger causality and then how this is interpreted within a VECM framework of cointegrated vectors.

Standard Granger causality:

If two variables are cointegrated then it is not appropriate to perform standard Granger causality tests (Granger 1969) because stationarity is one of the conditions for Granger causality tests. However, if they are stationary, then in a two variable system with Y_t and X_t the Granger causality estimation can be represented as

$$Y_t = \sum_{i=1}^{n} \alpha_i X_{t-i} + \sum_{j=1}^{n} \beta_j Y_{t-j} + u_{1t} \qquad (5)$$

and

$$X_t = \sum_{i=1}^{n} \lambda_i X_{t-i} + \sum_{j=1}^{n} \delta_j Y_{t-j} + u_{2t} \qquad (6)$$

where it is assumed that u_{1t} and u_{2t} are uncorrelated.

By ‘Granger causality’ is meant that past values of one variable, X_t, affect the current value of the other variable, Y_t (Granger 1979:428-429). If it is found that when (5) and (6) are estimated that $\sum \alpha_i \neq 0$, the estimated coefficients of the lagged X in (5) as a group are statistically different from zero and $\sum \delta_j = 0$, the set of estimated coefficients of the lagged Y in (6) is not statistically different from zero, it will be concluded that unidirectional causality runs from X to Y. If it is found that when (5) and (6) are estimated that $\sum \alpha_i \neq 0$, the estimated coefficients of the lagged X in (5) as a group are statistically different from zero and that $\sum \delta_j \neq 0$, the estimated coefficients of the lagged Y are also statistically different from zero then in can be concluded that there is bidirectional causality between X and Y. Because the variables in Granger causality tests are stationary, they adhere to the properties of a normal distribution and it is possible to use standard t-tests or F-tests on the variables.

The problem arises that when variables are non-stationary, Granger causality tests are not applicable as there is no longer a normal distribution. However, if variables are not stationary and are of order I(1) then it is possible to specify the VAR in (5) and (6) in first differences and perform standard t-tests and F-tests. If there is a case where variables are cointegrated, then just a VAR in first differences is inappropriate because there is necessarily an error-correction representation (Enders 2010:321-367).

Error correction models and re-interpretation of Granger causality:

An implication of the Granger representation theorem is that if there is a cointegrating relationship between two variables then, in the least, one must Granger cause the other i.e. X_t must either Granger cause Y_t, or Y_t must Granger cause X_t. This is not always detectable in standard Granger causality tests (Jafar 2011:73)

For any two variables X and Y the VECM model can be expressed as

$$\Delta Y_t = \alpha_0 + \alpha_1 U_{t-1} + \sum_{i=1}^{m} \delta_{1i} \Delta Y_{t-i} + \sum_{j=1}^{n} \delta_{2i} \Delta X_{t-j} + \varepsilon_t \quad (7)$$

and

$$\Delta X_t = \alpha_0 + \alpha_2 U_{t-1} + \sum_{i=1}^{m} \delta_{1i} \Delta Yt_{t-i} + \sum_{j=1}^{n} \delta_{2i} \Delta X_{t-j} + \varepsilon_t \quad (8)$$

where U_{t-1} is the error correction terms, and

α_1 and α_2 are the speed of adjustment parameters.

As can be seen, this is a standard VAR in first differences with the addition of the error-correction term. The appropriate number of lags to use when estimating the VECM will be decided by using the SIC statistic, this will ensure that the error terms follow a white noise process. The speed of adjustment coefficient shows the time it takes for a variable to respond to a discrepancy from long-run equilibrium and the dynamics of the short-run disequilibrium are estimated.

Standard Granger causality tests in first difference can be done using the lagged coefficients in (7) and (8). The null hypothesis that X does not Granger Cause Y can be tested by seeing if the δ_{2i}'s of the lagged coefficients of X are jointly significant based on the standard Wald F-test. If the lagged coefficients are significant then X Granger causes Y. Equivalently, the null hypothesis that Y does not Granger cause X can be tested by whether the δ_{1t}'s of the lagged Y terms are jointly significant with a standard Wald F-test (Nell 1999:13).

The error-correction term can be used to test for a useful alternative to the standard Granger causality test. As Nell (1999:13) notes, the standard Granger causality test is based on *past* changes in one variable explaining *current* changes in another. If, however, there is cointegration and a stable long-run relationship exists then causality can be detected using the error-correction term which models the adjustment back to equilibrium. The result is that a test to see whether *current* adjustments in one variable back to long-run equilibrium are partly the result of *current* changes in the other variable can be done.

The VECM model can be used to test for direction of causality if disequilibrium were to occur from the stable long-run relationship, i.e. which variables adjust to return to the stable long run relationship. The error-correction term shows the short-run response to disequilibrium and as such it is possible to test if a variable is weakly exogenous (Enders 2010:407). In the case of X_t and Y_t as shown in (7), if α_1 = 0, or were not to be statistically different from zero (i.e. statistically insignificant), then Y_t is weakly exogenous. If this is the case then in the short-run X_t does not adjust to restore equilibrium when there is a discrepancy in the long-run relationship, making Y_t weakly exogenous to changes in X_t. In terms of Granger causality within a VECM framework, in a cointegrated system it can be said that X_t does not Granger cause Y_t if Y_t is weakly exogenous (Enders 2010:371).

3.3 BRIEF OVERIEW OF SOUTH AFRICAN MONETARY HISTORY

A brief review of South African monetary history is required in order to justify the period of testing. According to Aron and Meullbaur (2007), within South Africa monetary history there have been three broad monetary policy regimes, the first from the 1960s to the 1980s, the second from the 1980s to the late 1990s and the third one from 2000 until the present. The first regime is characterised by liquid asset ratio requirements, the second by monetary aggregate growth targets, and the third by an inflation targeting framework.

The first regime in the 1960's was a liquid asset ratio system which was based on direct control measures such as a credit ceiling, cash reserve requirements and controls of interest rates This was a largely unsuccessful as a means to monetary policy as the liquid asset reserve requirement did not prevent large amount of credit expansion during this period (Nell 1999:8).

A range of reforms were enacted in the early 1980's after recommendations from the de Kock Commission reports on monetary policy (Aron and Meulbauer 2007:709). There was a move away from direct control measures toward a more market orientated control with the abolition of credit ceilings in 1980 and lower cash reserve requirements. The South African Reserve Bank's (SARB's) monetary policy was based on the cost of borrowing from the discount window (Nell 1999:10-11). By 1985 the regime was in full swing and the SARB had begun announcing monetary target growth rates based on M3, however, this was never a rigid monetary target as recommended by Monetarists. Any usefulness of these monetary targets was diminished by extensive financial liberalisation during the 1980's and a more open capital account by 1995. From the 1990's a new set of eclectic financial indicators was added to the announcement of a monetary growth target in order to ensure better monetary policy, these being exchange rate, asset prices, output gap, balance of payments, wage settlements, credit growth and fiscal balance (Aron and Meulbauer 2007:709).

Van der Merwe (2004) describes the period of the 1990's as an informal attempt at inflation targeting, hence the reason for adoption of a new set of indicators. In this period developments in the monetary aggregates were regarded as important elements in the inflation process and the SARB closely monitored other sets of real and financial indicators in reaching a decision on the appropriate level of the short-term interest rate. Nell (1999:11) believes that the measures adopted from the 1980's strongly reflect an Accommodationist viewpoint of monetary policy whereby the cost of credit is determined by the setting of the short-term interest rates and lending rates are some mark-up over that.

In 2000 the SARB officially adopted a formal inflation targeting framework. The first reason for doing this is that policy in the 1990s was very uncertain, and it was not always clear what the SARB would do or what their monetary policy stance would be, as the public were not familiar with the models or goals of the SARB. Secondly, the announcement of an inflation target allows a formalisation broad economic policy and co-ordination between other economic bodies, their policies, and the SARB. Finally, inflation targeting disciplines the SARB and makes them accountable for their policy decisions and initiatives. When inflation targets are credible goals that the SARB is likely to achieve, this forms the basis for future price and wage setting (van der Merwe 2004:1). In order to implement inflation targeting the SARB can use any of the tools at its disposal to achieve its required inflation target.

Nell (1999) carried out a similar study to that described above for the first two monetary policy regimes within South Africa. He finds that money supply is endogenous determined in both of the sample sub-periods periods (1966-1979 and 1980-1997). Nell comes to the conclusion that the failure of the SARB to reach its monetary growth targets in the 1980's is because the money supply is endogenously determined and, as such, the SARB does not control the growth rate of money.

The purpose of this study is to test whether the money supply is endogenously or exogenously determined from the implementation of the inflation targeting framework in the early 2000. The SARB uses numerous indicators to determine what their monetary policy stance will be. Although the repo rate is one tool that is used in order to signal the stance of the SARB to the conditions of the economy, as Accommodationists would argue, the SARB may also use monetary aggregate targets or even some other variables to manipulate monetary policy, as Structuralists would say.

3.4 DATA

The data sets used should be able to accurately reflect the variables under consideration so that results obtained from the aforementioned statistical procedure will lead to correct results. All data for this study is obtained and constructed from the South African Reserve Bank (SARB) website. The tests are done on quarterly data and where the data obtained from the SARB website is monthly it has been converted to quarterly data. The period under consideration is from 2000Q1 to 2010Q4.

3.5 CONCLUSION

The aim of this research is to determine whether the money supply in South Africa is exogenous or endogenous in the most recent monetary policy regime, and if it is endogenous, whether it follows an Accommodationist, Structuralist or Liquidity Preference discourse. This will be done by testing the data series described above. Firstly, the data will be tested for stationarity using the ADF test for a unit root. If the variables are found to be non-stationary then their order of integration will be determined. If the variables are of the same order of integration then it is valid to carry out cointegration testing. The Johansen Maximum Likelihood Procedure is used to test for cointegration and the trace test and max eigenvalue test are used to determine whether the variables as described in Table 1 are cointegrated. If there is confirmed cointegration then a VECM is run. Tests for weak exogeneity are used to determine the direction of causality between variables. This is followed by standard Granger causality tests in first difference to see whether the results from the tests for weak exogeneity are supported.

Chapter 4

EMPIRICAL RESULTS

4.1 UNIT ROOT RESULTS

As mentioned in the previous chapter the time series for the four variables being LGDP, LMB, LM3 and LDCE need to be tested to see if they are stationary. If they are non-stationary then they need to be tested to see what order of integration they are. The ADF unit root test is used to discover the variables order of integration. It is appropriate for this study because it is the most popular test used in the literature.

The null hypothesis in this test is that there is a unit root, i.e. the time series is non-stationary. If the calculated value from the ADF test exceeds the critical value then the null hypothesis can be rejected and it can be concluded that the time series does not have a unit root, i.e. it is stationary. The optimal lag length selection was done by EViews and was based on the best Schwarz information criteria (SIC) estimate of the appropriate lag length. The results of the ADF unit root tests from 2000Q1 to 2010Q4 are given in the table 4.1 below.

Table 4.1: ADF Unit Root Tests

	With Intercept				**With Intercept and Trend**			
Variable	**Level**	**Lag Length**	**1st Difference**	**Lag Length**	**Level**	**Lag Length**	**1st Difference**	**Lag Length**
LGDP	-1.374787	6	-8.145144***	1	-3.329665*	8	-8.037778***	1
LM3	-1.524746	1	-3.810967***	0	-3.979516**	5	-4.066814**	0
LDCE	-0.743957	1	-3.838353***	0	-1.443837	1	-3.825404**	0
LMB	-2.592635	0	-6.179453***	0	-2.689580	0	-6.027090***	0

1. *significant at 10% level
2. **significant at 5% level
3. ***significant at 1% level

Table 4.1 shows all the variables ADF unit root test calculated values, and the level of significance. The ADF unit root test is specified with an intercept only and then with intercept and trend. When the ADF test was specified with an intercept only, LGDP, LM3, LDCE and LMB were all found to have non-critical values. This means a failure to reject the null hypothesis of a unit root and in all cases it can be concluded that the variables are non-stationary. However, when the ADF unit root test was done after first differencing these variables it was found that the ADF test values were highly significant at the 1% level. Therefore, reject the null hypothesis of a unit root and conclude that LGDP, LM3, LDCE and LMB are all stationary time series at first difference and are integrated of order one, I(1).

When the ADF unit root test is specified with an intercept and trend term the results are not as straight forward. LGDP is only just significant at the 10% level and at this level reject the null hypothesis and conclude the series is stationary in level terms. However, 10% level of significance is generally not regarded as a strong enough level of significance to be comfortable with the result. When LGDP is retested at first difference then the ADF test value becomes highly significant and rejection of the null hypothesis at the 1% level of significance is possible. It would seem then that LGDP is I(1), or stationary at first difference according to ADF unit root tests specified with an intercept only, and an intercept and trend.

The unit root tests results with and intercept and trend are slightly more difficult to interpret with the LM3 variable. It would appear that in level terms the ADF value is significant at the 5% level and rejection the null hypothesis of a unit root occurs, making it an I(0) variable. However, at first difference the ADF test value becomes slightly more significant but is still not significant at the 1% level. Based on the ADF unit root test with intercept only, and the improvement of significance in the ADF test with intercept and trend when differenced once, it is safe to conclude that LM3 is an I(1) variable.

The ADF test for the variables LDCE and LMB with an intercept and trend do not present any difficulties in interpretation. In level terms neither LDCE nor LMB are significant and there is failure to reject the null hypothesis of a unit root. Once both of these variables have been differenced LDCE becomes significant at the 5% level and LMB becomes significant at the 1% level. This means that the null of a unit root can be rejected. This result, along with the results from the ADF test with intercept only, can be used to safely conclude that LDCE and LMB are integrated of the first order I(1).

After the ADF unit root tests it can be concluded that all the variables are I(1). It is now possible to perform cointegration tests to discover whether there is a stable long-run relationship between the variables.

4.2 COINTEGRATION TESTING

When variables are of the same order of integration, in this case I(1), then it is possible to test to see whether they are cointegrated with one another. When variables are cointegrated it means that although they may be individually non-stationary but there is a linear combination of them that exists forming a stable long-run relationship over time. The benefit of this is that it is then possible to estimate this long-run relationship and adjustments back to equilibrium with a Vector Error-Correction Model (VECM).

The Johansen maximum likelihood cointegration procedure is used with the trace and max eigenvalue test for the number of cointegrating vectors discovering whether there is cointegration. The null hypothesis of the trace test (λ trace) is that the number of cointegrating vectors is less than or equal to r and the alternative is that it is more than r. The null hypothesis of the max eigenvalue (λmax) test is that the number of cointegrating vectors is r and the alternative is that it is r+1. The results for the λtrace and λmax test are given in the tables below. The SIC was used to select the lag structure of the unrestricted VAR in each case, on which the cointegration tests are based, and the lag length selection criteria can be found in Appendix B.

Table 4.2: Cointegration between LM3 and LMB with intercept and tend				
Null hypothesis	λtrace	λmax	95% crit value	95% crit value

			for trace test	for max eigenvalue
r= 0	33.31919	28.53361	25.87211	19.38704
r≤1	4.785580	4.785580	12.51798	12.51798

Based on table 4.2, between the variables LM3 and LMB rejection of the the null hypothesis of the trace test and the max eigenvalue test when r=0 occurs because the calculated statistic exceeds the 95% critical value. From the trace test at r=0 it is possible to say that the number of cointegrating vectors is more than r and from the max eigenvalue test it can be said that the number of cointegrating vectors is r+1. When these tests are done again with r=1 there is a failure to reject the null hypothesis in both cases as the λtrace and λmax value are smaller than the 95% critical value. It can be concluded that there is a cointegrating relationship between LM3 and LMB and in a linear combination these two variables have a stable long-run relationship. The SIC selected one lag as the appropriate lag length for the unrestricted VAR used in the cointegration test.

Table 4.3: Cointegration between LM3 and LDCE no intercept or trend

Null hypothesis	λtrace	λmax	95% crit value for trace test	95% crit value for max eigenvalue
r= 0	14.64514	12.35601	12.32090	11.22480
r≤1	2.289130	2.289130	4.129906	4.129906

Table 4.3 shows the results of the λtrace and λmax tests for the number of cointegrating vectors between LM3 and LDCE. It is found that the null hypothesis of the trace and max eigenvalue test can be rejected when r=0 because the λtrace and λmax calculated value exceed that of the 95% critical value. When r=1 there is a failure to reject the null hypothesis in both tests and it can concluded that there is one cointegrating vector between

LM3 and LDCE. Therefore, LM3 and LDCE are cointegrated. The lag length selected was two lags based on the SIC.

Table 4.4: Cointegration between LM3 and LGDP intercept and trend

Null hypothesis	λtrace	λmax	95% crit value for trace test	95% crit value for max eigenvalue
r= 0	31.24547	20.89497	25.87211	19.38704
r≤1	10.35050	10.35050	12.51798	12.51798

Table 4.4 shows the results of the λtrace and λmax tests for the number of cointegrating vectors between LM3 and LGDP. It is found that when r=0 reject the null hypothesis in both the trace and max eigenvalue tests but when r=1 fail to reject the null hypothesis. It can be concluded that there is cointegration between LM3 and LGDP. Four lag lengths were selected by the SIC.

4.3. VECTOR ERROR CORRECTION MODELS

Granger Representation Theorem states that if there is cointegration then there is necessarily an error-correction representation of the relationship. The importance of the VECM is that it is able to model the short-run dynamics of the long-run relationship and how adjustment toward the long-run equilibrium occurs. By testing the error correction term in these VECM's it can be seen whether current adjustments in one variable towards long-run equilibrium are partly the result of current changes in the other variable. These are known as tests for weak exogeneity and will be done to determine the direction of causality between the cointegrated variables. The null hypothesis is that the error-correction term=0. If the null hypothesis is true then there is evidence of weak exogeneity and current adjustment towards long-run equilibrium is not the result of current changes in the other variable. The estimates of the VECM regressions are summarised below in table 4.5. More detailed estimates of the VECMs can be found in Appendix D.

Table 4.5. Estimates for the VECM Regressions			
Equation	**Error Correction Term**	**T-Statistic**	**Conclusion**
LM3 – LMB LMB – LM3	0.047736 -1.043153	1.03503 -5.88945**	LM3 →LMB
LM3 – LDCE LDCE –LM3	-0.115285 0.040085	-2.81081* 0.72538	LDCE → LM3
LM3 –LGDP LGDP –LM3	0.063032 0.098255	2.34773 3.66847	No SR relationship between LM3 LGDP

1. *indicates significance at 5% level
2. **indicates significance at 1% level
3. Ericson and MacKinnon values are used to test significance or error-term

Between the variables LM3 and LMB it is found that the error correction terms the LMB equation is significant at the 1% level. This means a rejection of the null hypothesis of an error correction term = 0 and conclude LMB is not weakly exogenous of changes in LM3. However, the error correction term in the LM3 equation is not significant at any level. These results indicate evidence of unidirectional causality from LM3 towards LMB. When there is a disturbance to the long-run equilibrium of LMB then current changes in LMB back to its long-run equilibrium are a result of current changes in LM3, and current changes in LM3 back to its long-run equilibrium are not a result of current changes in LMB.

Between the variables LM3 and LDCE it is the error correction term in the LM3 equation of VECM that is significantly different from zero at the 5% level of significance. This means that LM3 is not weakly exogenous of LDCE. In the LDCE equation there is a failure to reject the null hypothesis of an error correction term equal to zero and it must concluded that LDCE is weakly exogenous of changes in LM3. So, when there is a discrepancy from long-run equilibrium for LDCE, none of the adjustment towards equilibrium is the result of current adjustments in LM3. However, when there is a deviation from long-run equilibrium in LM3 some of the adjustment towards long-run equilibrium are the result of current changes in LDCE. This, in effect, demonstrates that there is unidirectional causality from LDCE towards LM3.

Between the variables LM3 and LGDP there are no significant t-statistics for both error correction terms. This means a failure to reject the null hypothesis of a significant error correction term and both variables are weakly exogenous. Current adjustments in LGDP back to long run equilibrium are not the result of current changes in LM3, and current adjustments back towards long-run equilibrium in LM3 are the not the result of current changes in LGDP. There is evidence that the short-run dynamics of the cointegrated relationship are not significant.

4.4 POST-HOC TESTS

In order to ensure that the results of the VECMs are consistent with assumptions regarding the model numerous post-hoc tests are done on the residuals of the VECMs testing for autocorrelation, normality, and heteroskedasticity. The Eviews test results can found in Appendix E.

The LM test for autocorrelation has a null hypothesis that there is no autocorrelation. The results show that in all three VECMs there is a failure to reject the null hypothesis at the 5% level of significance. Only in the LM3-LDCE VECM is there a rejection of the null hypothesis of no autocorrelation at one lag at the 10% level of significance. At all other lags there is no evidence of autocorrelation. Based on this evidence it must be concluded that there is no significant autocorrelation in any of the VECMs.

The Cholskey residual normality test was used to investigate whether the residuals of the VECMs displayed any significant signs of skewness or kurtosis. The null hypothesis is that the residuals are normal. In the LM3-LMB and the LM3-LGDP VECMs there is a failure to reject the null hypothesis as the Jaqrue-Bera statistics are not significant at any level. However, in LM3-LDCE VECM there is a rejection of the null hypothesis at the 1% level of significance indicating that there is skewness and kurtosis in the residuals of the VECM. However, it is the tests for autocorrelation that are of most importance when assessing the VECM model.

The White test of heteroskdaticity has a null hypothesis that there is no heteroskedaticity. In all VECMs it was found that it was not possible to reject the null hypothesis at any meaningful level of significance and it must be concluded that there is no heteroskedasticity in any of the VECMs.

4.5 GRANGER CAUSALITY TESTS

The VECM estimates the current changes in one variable towards long-run equilibrium as the direct result of current changes in the other variable. Granger causality tests can be used to see how current values realised of one variable are affected by past changes in the other variable and is a representation of the short-run dynamics between the variables. A series of pairwise Granger causality tests are conducted with the results summarised in table 4.6 below.

Table 4.6. Granger Causality Tests

Relation	F-stat	Lags	F-stat	Lags
D(LMB) to D(LM3)	0.19549	2	0.82783	4
D(LM3) to D(LMB)	4.97406**	2	3.46308**	4
D(LDCE) to D(LM3)	5.46610***	2	2.35100*	4
D(LM3) to D(LDCE)	4.01683**	2	3.21741**	4
D(LGDP) to L(LM3)	0.95327	2	1.30145	4
D(LM3) to	2.96842*	2	1.53820	4

D(LGDP)				

1. * significant at 10% level
2. **significant at 5% level
3. ***significant at 1% level

All the variables are differenced because they are I(1) and are therefore non-stationary. The Granger causality test is run at 2 and 4 lags in each instance. For the pair wise Granger test between LMB and LM3 it can be seen that in the case of 2 and 4 lags reject the null hypothesis that LM3 does not Granger Cause LMB and conclude that past values of LM3 have an effect on current realisations of LMB. However, the null that LMB does not Granger Cause LM3 cannot be rejected at the 1% level of significance at 2 and 4 lags. This means that there is causality from past values of LM3 to LMB but not the other way around.

Between the variables LDCE and LM3 at all lags it is possible to reject the null hypothesis that LDCE does not Granger Cause LM3 and the null hypothesis that LM3 does not Granger cause LDCE. This means that past values of LDCE affect current values of LM3 and past values of LM3 affect current values of LDCE.

At 2 lags reject the null hypothesis that LM3 does not Granger cause LGDP, but only at the 10% level of significance which is not highly significant. In all other cases reject the null hypothesis that either LM3 Granger causes LGDP or that LGDP Granger causes LM3.

4.6 ANALYSIS

The period of analysis is from 2000Q1 to 2010Q4. An inflation targeting regime was implemented in South Africa in this period and it is important to determine the correct money supply process under this regime. The purpose of this statistical procedure is to determine whether money supply is exogenous or endogenous and, if it is endogenous to determine whether it is characterised by an Accommodationist, Structuralist or Liquidity Preference framework.

The Monetarist/exogenous money position states that there is unidirectional causality from LMB to LM3, from LM3 to LDCE and from LM3 to LGDP. This is because the Reserve Bank, by controlling the level of the MB is able to influence the money stock in the economy. If there is money creation by the Reserve Bank, through an increase in MB, then this affects DCE and GDP. Based on the results of the VECM models and the Granger causality tests this position on money supply is clearly not supported, and the money supply is endogenous.

The endogenous money position maintains that money supply is started on the production side of the economy whereby economic agents apply for bank loans which then may or may not be granted by commercial bank. This, the basis of endogenous money, is confirmed by the VECM between LDCE and LM3 where there is a unidirectional relationship from LDCE to LM3. The Accommodationist position implies causality from LGDP to LM3 and LDCE to LM3. When banks grant loans the Reserve Bank accommodates their requests for reserves at the repo rate. This means a causal link from M3 towards the MB. The Granger causality tests show that past values of LM3 affect current values of LMB. The LM3-LMB VECM supports this where LM3 is weakly exogenous but LMB is not. This means there is a unidirectional relationship from LM3 towards LMB. This is fully consistent with the Accommodationist position. The LM3-LGDP VECM and the Granger causality tests show that there does not appear to be any sort of significant short-run causal dynamics between LM3 and LGDP even though they are cointegrated. The LM3-LGDP VECM passes all the post-hoc tests so there is no cause to doubt this result.

The view on endogenous money that is best supported by the empirical results is that of Accommodationism. The Reserve Bank is able to target the money supply through the repo rate and fully accommodates all demands for credit at the current repo rate. Accommodationists hypothesize a unidirectional relationship from LM3 to LMB as the change in the stock of money created is accommodated at all times and the monetary base changes as a result. The VECM models show that there is a unidirectional causal relationship from LM3 to LMB at the 1% level of significance. Furthermore, this view endorses a unidirectional causal relationship from LDCE towards LM3 which is prevalent in the VECM at the 5% level of significance.

4.7 CONCLUSION

Based on section 4.1 and the ADF unit root tests all the variables LM3, LGDP, LMB and LDCE showed signs of first order integration, and were I(1). This then allowed the tests for cointegration. It was found in section 4.2, using the trace and max eigenvalue test for the number of cointegrating vectors, that there was cointegration between LM3 and LMB, LM3 and LDCE and LM3 and LGDP.

In section 4.3 numerous VECM models were specified and it was discovered that in the LM3-LMB VECM, LM3 was weakly exogenous but LMB was not and a unidirectional relationship existed at 1% level of significance from LM3 towards LMB. In the VECM between LM3 and LDCE it was found that LDCE was weakly exogenous of LM3 at the 5% level of significance but LM3 was not weakly exogenous of LDCE. This means there is a unidirectional relationship from LDCE towards LM3. In the VECM between LM3 and LGDP it was discovered that both variables were weakly exogenous of each other and there are no significant short-run dynamics. In section 4.4 Granger causality tests were done between the variables, however, the VECM tests for weak exogeneity is the stronger test as it shows how current adjustments in one variable are the result of current adjustments in another variable. Granger causality tests show whether past values of a variable affect another. Either way the Granger tests gave no reason to cast doubt on the results of the VECMs.

In conclusion, the evidence from the statistical procedure done above have shown that over the time period 2000Q1 to 2010Q4 the money supply in South Africa is endogenously determined rather than exogenously determined with the VECM between LDCE and LM3 showing unidirectional causality from LDCE towards LM3. However, the endogenous money view that is best supported is that of Accommodationism rather than Structuralism or Liquidity Preference views because of the unidirectional causality from LM3 to LMB and LDCE to LM3.

Chapter 5

SUMMARY AND RECOMMENDATIONS FOR FUTURE RESEARCH

5.1 INTRODUCTION

Monetary policy in South Africa has been evolving over the years with numerous monetary policy regimes being implemented by the South African Reserve Bank. The method of money creation and how money is supplied to the economy is of importance in that policy prescriptions will differ depending on which approach to money creation is in effect. The goals of this study were to test whether money supply is exogenous or endogenous, and if endogenous whether the Accommodationism, Structuralism or Liquidity Preference models of money creation holds for South Africa. The time period under study is from the implementation of the current monetary policy regime, inflation-targeting, and spans the time period 2000Q1 to 2010Q4.

The exogenous money view, which is heavily influenced by Monetarist thinking, holds that the money creation process starts with the Central Bank. The Central Bank is able directly control the quantity of money supplied within the economy by having direct control over the monetary base. By influencing the monetary base, through the money multiplier the quantity of money in the economy can either be increased or decreased by a fixed multiple [equal to the reciprocal of the reserve requirement (RR) ratio (r), that is, $1 / r$]. When banks have excess reserves they are induced to extend more loans and thereby increase domestic credit extension. The increase in consumption and investment is a result of the increase in money supply which has been institutionally determined by the Central Bank by increasing the amount of high-powered money in circulation. The policy prescription under this viewpoint is that when there is an economic downturn the Central Bank should increase the monetary base which will stimulate the economy.

The endogenous money position is characterised by three distinct, yet not dissimilar, positions, those being Accommodationism, Structuralism and Liquidity Preference.

Accommodationism is the purist form of endogenous money supply. Accommodationism argues that the money supply process starts on the opposite end of the spectrum and results in a credit-driven money supply. The demand for credit in order to finance consumption and expenditure results in economic agents approaching commercial banks for loans. When these loans are granted the money supply is increased. Commercial banks are then accommodated by the Central Bank for all the reserves that are required, at the current short-term interest rate. The policy prescription towards an economic downturn under Accommodationist thinking would be to adjust short-term interest rate downwards. All other interest rates in the economy take their cue from the short-term lending rate between the Central Bank and commercial banks because this is the most expensive finance that commercial banks can obtain. If this rate is lowered then prime lending rate of the banks will be decreased. This will result in greater lending from banks to finance consumption and expenditure, stimulating the economy.

Structuralism accepts the core of money endogeneity theory, that is, a credit-driven money supply; however this view argues that Accommodationism is too simple to correctly describe the complex inter-relations of real world economic processes. Rather, Structuralists consider Accommodationism a special case of money creation. Structuralists believe that the Central Bank can target short-term interest rates, the quantity of money, or even some third economic variable. This position holds that there is a dual causal process from the monetary base to money supply and from the money supply to the monetary base. Also there is dual causality from output to the money supply and from the money supply to output. However, at the heart of this position exists a credit-driven money supply.

The Liquidity Preference view stems from the implicit assumption made by Accommodationism that money supplied is always equal to money demanded. This implicit assumption comes about because money creation is the result of demand for credit money to finance consumption and expenditure. So then necessarily all money supplied is equalled by demand. The Liquidity Preference model disputes this because it is not always the people who make the loans that end up with the money; therefore money demanded is not always equal to money supplied. If this is the case the liquidity preferences of economic agents can affect the money supply.

The study has conducted empirical tests in order to establish the direction of causality between differing variables and has determined that the Accommodationist position is best supported by the evidence in South Africa from 2000Q1 to 2010Q4.

5.2 SUMMARY OF CONCLUSIONS

The econometric testing followed a three step procedure to determine the direction of causality between variables in an attempt to establish which theoretical position correctly describes money creation in South Africa. Unit root tests were done in order to establish the order of integration of the variables, cointegration testing was done and then error correction model estimates were run. Tests for weak exoenegity and Granger causality were done between variables to discover direction of causality.

The ADF unit root tests found that the variables LMB, LGDP, LM3 and LDCE were all integrated of order one, I(1). Individually these variables are non-stationary in levels but if they are cointegrated then there may be a stable-long run relationship between them. The Johansen procedure of cointegration was used in order to test for cointegration between LMB and LM3, LGDP and LM3 and LDCE and LM3. In all cases it was found that there was cointegration between the variables. The Vector Error-Correction Model was run between the cointegrated variables and tests for weak exogeneity were done. If a variable is weakly exogenous of the other variable then it means that none of the *current* adjustment towards long run equilibrium of the variable is a result of *current* changes in the other variable, and there is no causality.

The results showed that there is unidirectional causality from LM3 to LMB at the 1% level of significance. Between the variables LM3 and LDCE it was found that LDCE was weakly exogenous of LM3, however, at the 5% level of significance LM3 was not weakly exogenous of LDCE. This means that current adjustments in LM3 towards long-run equilibrium are partially the result of current changes in LDCE. This result supports a unidirectional causal relationship from LDCE towards LM3. Between the variable LM3 and LGDP it was found that both variables were weakly exogenous of the other variable at all meaningful levels of significance.

These results were followed by Granger causality tests because tests for weak exogeneity within the Vector Error-Correction Model tested for whether adjustments back to long-run equilibrium were the result of *current* changes in the other variable. Granger causality tests test whether *current* values of the one variable are affected by *past* values of the other variable. It was found that D(LM3) Granger-causes D(LMB) and at the 5% level of significance past values of D(LM3) affect current values of D(LMB). Also there D(LM3) Granger-causes D(LDCE) at the 5% level of significance and D(LDCE) Granger-causes D(LM3) at the 1% level of significance. There was no Granger causality between LM3 and LGDP at any highly significant levels.

Based on the results of the Vector Error-Correction Models and the tests for weak exogeneity the results support the Accommodationist viewpoint on endogenous money creation. The core idea of endogenous money is supported by the unidirectional causality from LDCE towards LM3. However, the Accommodationist position is supported by unidirectional causality between from LM3 towards LMB. The results of the Granger causality tests indicate that money supply is endogenous because there is Granger causality from D(LM3) towards D(LMB). Also there is Granger causality at a stronger level of significance from D(LDCE) towards D(LM3) than there is from D(LM3) towards D(LDCE).

Based on all empirical testing it must be concluded that the money supply is endogenously determined in South Africa over the period 2000Q1 to 2010Q4. Furthermore, the results indicate that over this period Accommodationism is the best supported theory for money supply in the South African Economy.

5.3 RECOMMENDATIONS FOR FUTURE RESEARCH

Over all similar economic studies there does not seem to be all that much consistency in results with many different researchers finding different results. The consensus seems to be that the money supply is endogenously determined with very little empirical evidence supporting the exogenous money position. However, within the endogenous money position there is not a consistent result as to whether the Accommodationist, Structuralist or Liquidity Preference view prevails. Following the approach of this study there is need for someone to pursue a cumulative result collection study to compare results and see what view point on endogenous money has the most support.

The reason that there is not that much consistency in results could also be that the models are not quite correct. The money creation process is not entirely understood and exogenous money may not be the antithesis of endogenous money that it is portrayed to be. Although under exogenous money the Central Bank may be able to influence the credit creation process by changing the monetary base, the fact remains that economic agents still need to apply for loans in order for money to be created. Therefore, perhaps exogenous money has been portrayed incorrectly. This is another avenue of research to pursue.

Finally, which endogenous money position is truly correct may remain an unknown unless more research is carried out and new, more comprehensive, models are created in order to describe the money supply process. Although the broad process is understood by many, the intricate details are still up for debate and by researching new models some further clarification may be attainable.

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Appendix A - Unit Root Test Results

Null Hypothesis: LGDP has a unit root
Exogenous: Constant
Lag Length: 6 (Automatic - based on SIC, maxlag=9)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-1.374787	0.5840
Test critical values:	1% level	-3.621023	
	5% level	-2.943427	
	10% level	-2.610263	

*MacKinnon (1996) one-sided p-values.

Null Hypothesis: D(LGDP) has a unit root
Exogenous: Constant
Lag Length: 1 (Automatic - based on SIC, maxlag=9)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-8.145144	0.0000
Test critical values:	1% level	-3.600987	
	5% level	-2.935001	
	10% level	-2.605836	

*MacKinnon (1996) one-sided p-values.

Null Hypothesis: LGDP has a unit root
Exogenous: Constant, Linear Trend
Lag Length: 8 (Automatic - based on SIC, maxlag=9)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-3.329665	0.0781
Test critical values:	1% level	-4.243644	
	5% level	-3.544284	
	10% level	-3.204699	

*MacKinnon (1996) one-sided p-values.

Null Hypothesis: D(LGDP) has a unit root
Exogenous: Constant, Linear Trend
Lag Length: 1 (Automatic - based on SIC, maxlag=9)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-8.037778	0.0000
Test critical values:	1% level	-4.198503	
	5% level	-3.523623	

	10% level	-3.192902	

*MacKinnon (1996) one-sided p-values.

Null Hypothesis: LM3 has a unit root
Exogenous: Constant
Lag Length: 1 (Automatic - based on SIC, maxlag=9)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-1.524746	0.5115
Test critical values:	1% level	-3.596616	
	5% level	-2.933158	
	10% level	-2.604867	

*MacKinnon (1996) one-sided p-values.

Null Hypothesis: D(LM3) has a unit root
Exogenous: Constant
Lag Length: 0 (Automatic - based on SIC, maxlag=9)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-3.810967	0.0057
Test critical values:	1% level	-3.596616	
	5% level	-2.933158	
	10% level	-2.604867	

*MacKinnon (1996) one-sided p-values.

Null Hypothesis: LM3 has a unit root
Exogenous: Constant, Linear Trend
Lag Length: 5 (Automatic - based on SIC, maxlag=9)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-3.979516	0.0180
Test critical values:	1% level	-4.219126	
	5% level	-3.533083	
	10% level	-3.198312	

*MacKinnon (1996) one-sided p-values.

Null Hypothesis: D(LM3) has a unit root
Exogenous: Constant, Linear Trend
Lag Length: 0 (Automatic - based on SIC, maxlag=9)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-4.066814	0.0138
Test critical values:	1% level	-4.192337	
	5% level	-3.520787	
	10% level	-3.191277	

*MacKinnon (1996) one-sided p-values.

Null Hypothesis: LMB has a unit root
Exogenous: Constant
Lag Length: 0 (Automatic - based on SIC, maxlag=9)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-2.592635	0.1023
Test critical values:	1% level	-3.592462	
	5% level	-2.931404	
	10% level	-2.603944	

*MacKinnon (1996) one-sided p-values.

Null Hypothesis: D(LMB) has a unit root
Exogenous: Constant
Lag Length: 0 (Automatic - based on SIC, maxlag=9)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-6.179453	0.0000
Test critical values:	1% level	-3.596616	
	5% level	-2.933158	
	10% level	-2.604867	

*MacKinnon (1996) one-sided p-values.

Null Hypothesis: LMB has a unit root
Exogenous: Constant, Linear Trend
Lag Length: 0 (Automatic - based on SIC, maxlag=9)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-2.689580	0.2458
Test critical values:	1% level	-4.186481	
	5% level	-3.518090	
	10% level	-3.189732	

*MacKinnon (1996) one-sided p-values.

Null Hypothesis: D(LMB) has a unit root

Exogenous: Constant, Linear Trend
Lag Length: 0 (Automatic - based on SIC, maxlag=9)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-6.027090	0.0001
Test critical values:	1% level	-4.192337	
	5% level	-3.520787	
	10% level	-3.191277	

*MacKinnon (1996) one-sided p-values.

Null Hypothesis: LDCE has a unit root
Exogenous: Constant
Lag Length: 1 (Automatic - based on SIC, maxlag=9)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-0.743957	0.8243
Test critical values:	1% level	-3.596616	
	5% level	-2.933158	
	10% level	-2.604867	

*MacKinnon (1996) one-sided p-values.

Null Hypothesis: D(LDCE) has a unit root
Exogenous: Constant
Lag Length: 0 (Automatic - based on SIC, maxlag=9)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-3.838353	0.0053
Test critical values:	1% level	-3.596616	
	5% level	-2.933158	
	10% level	-2.604867	

*MacKinnon (1996) one-sided p-values.

Null Hypothesis: LDCE has a unit root
Exogenous: Constant, Linear Trend
Lag Length: 1 (Automatic - based on SIC, maxlag=9)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-1.443837	0.8328
Test critical values:	1% level	-4.192337	
	5% level	-3.520787	
	10% level	-3.191277	

*MacKinnon (1996) one-sided p-values.

Null Hypothesis: D(LDCE) has a unit root
Exogenous: Constant, Linear Trend
Lag Length: 0 (Automatic - based on SIC, maxlag=9)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-3.825404	0.0248
Test critical values:	1% level	-4.192337	
	5% level	-3.520787	
	10% level	-3.191277	

*MacKinnon (1996) one-sided p-values.

Appendix B - Lag Length Criteria from Unresticted VARs

VAR Lag Order Selection Criteria
Endogenous variables: LM3 LMB
Exogenous variables: C
Date: 08/22/12 Time: 09:07
Sample: 2000Q1 2010Q4
Included observations: 40

Lag	LogL	LR	FPE	AIC	SC	HQ
0	73.20099	NA	9.75e-05	-3.560050	-3.475606	-3.529517
1	219.7674	271.1479*	7.82e-08*	-10.68837*	-10.43504*	-10.59677*
2	223.0049	5.665538	8.14e-08	-10.65024	-10.22802	-10.49758
3	227.2939	7.076902	8.06e-08	-10.66470	-10.07359	-10.45097
4	230.2231	4.540215	8.58e-08	-10.61115	-9.851158	-10.33636

* indicates lag order selected by the criterion
LR: sequential modified LR test statistic (each test at 5% level)
FPE: Final prediction error
AIC: Akaike information criterion
SC: Schwarz information criterion
HQ: Hannan-Quinn information criterion

VAR Lag Order Selection Criteria
Endogenous variables: LM3 LDCE
Exogenous variables: C
Date: 08/22/12 Time: 09:08
Sample: 2000Q1 2010Q4
Included observations: 40

Lag	LogL	LR	FPE	AIC	SC	HQ
0	132.8806	NA	4.93e-06	-6.544029	-6.459585	-6.513497
1	284.5864	280.6557	3.06e-09	-13.92932	-13.67599	-13.83772
2	295.5953	19.26555*	2.16e-09*	-14.27976*	-13.85754*	-14.12710*
3	297.5894	3.290342	2.40e-09	-14.17947	-13.58836	-13.96575
4	298.6519	1.646846	2.80e-09	-14.03260	-13.27260	-13.75780

* indicates lag order selected by the criterion
LR: sequential modified LR test statistic (each test at 5% level)
FPE: Final prediction error
AIC: Akaike information criterion
SC: Schwarz information criterion
HQ: Hannan-Quinn information criterion

VAR Lag Order Selection Criteria
Endogenous variables: LM3 LGDP
Exogenous variables: C
Date: 08/22/12 Time: 09:09
Sample: 2000Q1 2010Q4
Included observations: 40

Lag	LogL	LR	FPE	AIC	SC	HQ
0	124.3502	NA	7.56e-06	-6.117509	-6.033065	-6.086977
1	272.7082	274.4624	5.54e-09	-13.33541	-13.08208	-13.24381
2	278.7307	10.53925	5.02e-09	-13.43653	-13.01431	-13.28387
3	288.4669	16.06479	3.79e-09	-13.72334	-13.13224	-13.50962
4	296.4113	12.31382*	3.13e-09*	-13.92056*	-13.16057*	-13.64577*

* indicates lag order selected by the criterion
LR: sequential modified LR test statistic (each test at 5% level)
FPE: Final prediction error
AIC: Akaike information criterion
SC: Schwarz information criterion
HQ: Hannan-Quinn information criterion

Appendix C - Cointegration Results

Date: 08/22/12 Time: 10:39
Sample (adjusted): 2000Q3 2010Q4
Included observations: 42 after adjustments
Trend assumption: Linear deterministic trend (restricted)
Series: LM3 LMB
Lags interval (in first differences): 1 to 1

Unrestricted Cointegration Rank Test (Trace)

Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	0.05 Critical Value	Prob.**
None *	0.493065	33.31919	25.87211	0.0049
At most 1	0.107691	4.785580	12.51798	0.6274

Trace test indicates 1 cointegrating eqn(s) at the 0.05 level
* denotes rejection of the hypothesis at the 0.05 level
**MacKinnon-Haug-Michelis (1999) p-values

Unrestricted Cointegration Rank Test (Maximum Eigenvalue)

Hypothesized No. of CE(s)	Eigenvalue	Max-Eigen Statistic	0.05 Critical Value	Prob.**
None *	0.493065	28.53361	19.38704	0.0018
At most 1	0.107691	4.785580	12.51798	0.6274

Max-eigenvalue test indicates 1 cointegrating eqn(s) at the 0.05 level
* denotes rejection of the hypothesis at the 0.05 level
**MacKinnon-Haug-Michelis (1999) p-values

Unrestricted Cointegrating Coefficients (normalized by b'*S11*b=I):

LM3	LMB	@TREND(00Q2)
-41.90150	-20.45928	0.752322
25.77297	-10.53916	-0.359369

Unrestricted Adjustment Coefficients (alpha):

D(LM3)	-0.001139	-0.002194
D(LMB)	0.024895	-0.002121

1 Cointegrating Equation(s): Log likelihood 243.8424

Normalized cointegrating coefficients (standard error in parentheses)

LM3	LMB	@TREND(00Q2)
1.000000	0.488271	-0.017955
	(0.09592)	(0.00038)

Adjustment coefficients (standard error in parentheses)

D(LM3)	0.047736
	(0.04612)
D(LMB)	-1.043153

(0.17712)

Date: 08/22/12 Time: 09:14
Sample (adjusted): 2001Q2 2010Q4
Included observations: 39 after adjustments
Trend assumption: Linear deterministic trend (restricted)
Series: LM3 LGDP
Lags interval (in first differences): 1 to 2, 3 to 4

Unrestricted Cointegration Rank Test (Trace)

Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	0.05 Critical Value	Prob.**
None *	0.414781	31.24547	25.87211	0.0097
At most 1	0.233099	10.35050	12.51798	0.1121

Trace test indicates 1 cointegrating eqn(s) at the 0.05 level
* denotes rejection of the hypothesis at the 0.05 level
**MacKinnon-Haug-Michelis (1999) p-values

Unrestricted Cointegration Rank Test (Maximum Eigenvalue)

Hypothesized No. of CE(s)	Eigenvalue	Max-Eigen Statistic	0.05 Critical Value	Prob.**
None *	0.414781	20.89497	19.38704	0.0300
At most 1	0.233099	10.35050	12.51798	0.1121

Max-eigenvalue test indicates 1 cointegrating eqn(s) at the 0.05 level
* denotes rejection of the hypothesis at the 0.05 level
**MacKinnon-Haug-Michelis (1999) p-values

Unrestricted Cointegrating Coefficients (normalized by b'*S11*b=I):

LM3	LGDP	@TREND(00Q2)
26.21645	-268.8330	2.721038
-136.5057	278.7177	-0.972120

Unrestricted Adjustment Coefficients (alpha):

D(LM3)	0.002404	0.002278
D(LGDP)	0.003748	-0.001561

1 Cointegrating Equation(s): Log likelihood 295.1767

Normalized cointegrating coefficients (standard error in parentheses)

LM3	LGDP	@TREND(00Q2)
1.000000	-10.25436	0.103791
	(1.78182)	(0.02104)

Adjustment coefficients (standard error in parentheses)

D(LM3)	0.063032
	(0.02685)
D(LGDP)	0.098255
	(0.02678)

Appendix D – VECMs

Vector Error Correction Estimates
Date: 08/22/12 Time: 10:40
Sample (adjusted): 2000Q3 2010Q4
Included observations: 42 after adjustments
Standard errors in ( ) & t-statistics in [ ]

Cointegrating Eq:	CointEq1
LM3(-1)	1.000000
LMB(-1)	0.488271
	(0.09592)
	[5.09032]
@TREND(00Q1)	-0.017955
	(0.00038)
	[-47.1396]
C	-7.612700

Error Correction:	D(LM3)	D(LMB)
CointEq1	0.047736	-1.043153
	(0.04612)	(0.17712)
	[1.03503]	[-5.88945]
D(LM3(-1))	0.371457	2.622012
	(0.18308)	(0.70311)
	[2.02893]	[3.72916]
D(LMB(-1))	0.012571	0.036919
	(0.03103)	(0.11917)
	[0.40513]	[0.30981]
C	0.009472	-0.032314
	(0.00297)	(0.01142)
	[3.18551]	[-2.82971]
R-squared	0.279765	0.478103
Adj. R-squared	0.222904	0.436901
Sum sq. resids	0.001934	0.028518
S.E. equation	0.007133	0.027395
F-statistic	4.920186	11.60379
Log likelihood	150.1120	93.59717
Akaike AIC	-6.957713	-4.266532
Schwarz SC	-6.792221	-4.101039
Mean dependent	0.015101	0.007062
S.D. dependent	0.008092	0.036507

Determinant resid covariance (dof adj.)	3.79E-08
Determinant resid covariance	3.11E-08
Log likelihood	243.8424
Akaike information criterion	-11.08773
Schwarz criterion	-10.63263

Vector Error Correction Estimates
Date: 08/22/12 Time: 09:16
Sample (adjusted): 2000Q4 2010Q4
Included observations: 41 after adjustments
Standard errors in ( ) & t-statistics in [ ]

Cointegrating Eq:	CointEq1	
LM3(-1)	1.000000	
LDCE(-1)	-0.998379	
	(0.00255)	
	[-392.122]	
Error Correction:	D(LM3)	D(LDCE)
CointEq1	-0.115285	0.040085
	(0.04101)	(0.05526)
	[-2.81081]	[0.72538]
D(LM3(-1))	0.245906	0.069203
	(0.15919)	(0.21449)
	[1.54469]	[0.32264]
D(LM3(-2))	0.379847	0.603567
	(0.13263)	(0.17869)
	[2.86403]	[3.37768]
D(LDCE(-1))	0.415625	0.455338
	(0.12041)	(0.16223)
	[3.45173]	[2.80668]
D(LDCE(-2))	-0.189707	-0.195665
	(0.13483)	(0.18166)
	[-1.40699]	[-1.07708]
R-squared	0.474311	0.361532
Adj. R-squared	0.415901	0.290592
Sum sq. resids	0.001357	0.002464
S.E. equation	0.006140	0.008273
F-statistic	8.120374	5.096253
Log likelihood	153.2981	141.0748
Akaike AIC	-7.234053	-6.637796
Schwarz SC	-7.025081	-6.428824
Mean dependent	0.015345	0.013403
S.D. dependent	0.008034	0.009822
Determinant resid covariance (dof adj.)		2.08E-09
Determinant resid covariance		1.61E-09
Log likelihood		298.7679
Akaike information criterion		-13.98868
Schwarz criterion		-13.48715

Vector Error Correction Estimates
Date: 08/22/12   Time: 09:18
Sample (adjusted): 2001Q2 2010Q4
Included observations: 39 after adjustments
Standard errors in ( ) & t-statistics in [ ]

Cointegrating Eq:	CointEq1	
LM3(-1)	1.000000	
LGDP(-1)	-10.25436	
	(1.78182)	
	[-5.75500]	
@TREND(00Q1)	0.103791	
	(0.02104)	
	[4.93348]	
C	49.05027	
Error Correction:	**D(LM3)**	**D(LGDP)**
CointEq1	0.063032	0.098255
	(0.02685)	(0.02678)
	[2.34773]	[3.66847]
D(LM3(-1))	0.060924	0.146840
	(0.19038)	(0.18993)
	[0.32001]	[0.77315]
D(LM3(-2))	0.232296	0.131930
	(0.17264)	(0.17222)
	[1.34556]	[0.76604]
D(LM3(-3))	0.393179	0.100618
	(0.17421)	(0.17379)
	[2.25698]	[0.57898]
D(LM3(-4))	0.009927	0.155324
	(0.18658)	(0.18613)
	[0.05321]	[0.83448]
D(LGDP(-1))	0.565737	0.499088
	(0.25057)	(0.24997)
	[2.25779]	[1.99661]
D(LGDP(-2))	0.468550	0.151800
	(0.22030)	(0.21977)

	[2.12684]	[0.69071]
D(LGDP(-3))	0.536729	0.077485
	(0.17427)	(0.17385)
	[3.07994]	[0.44571]
D(LGDP(-4))	0.182543	0.415336
	(0.18392)	(0.18348)
	[0.99252]	[2.26370]
C	-0.015629	-0.009835
	(0.00822)	(0.00820)
	[-1.90053]	[-1.19883]
R-squared	0.536190	0.622969
Adj. R-squared	0.392249	0.505959
Sum sq. resids	0.001186	0.001180
S.E. equation	0.006395	0.006380
F-statistic	3.725069	5.324085
Log likelihood	147.4729	147.5669
Akaike AIC	-7.049893	-7.054713
Schwarz SC	-6.623339	-6.628159
Mean dependent	0.015180	0.011716
S.D. dependent	0.008204	0.009077
Determinant resid covariance (dof adj.)		1.65E-09
Determinant resid covariance		9.14E-10
Log likelihood		295.1767
Akaike information criterion		-13.95778
Schwarz criterion		-12.97671

Appendix E – Post Hoc Testing Results

LM3-LMB ECM

LM test

VEC Residual Serial Correlation LM Tests
Null Hypothesis: no serial correlation at lag order h
Date: 08/22/12 Time: 10:49
Sample: 2000Q1 2010Q4
Included observations: 42

Lags	LM-Stat	Prob
1	1.181716	0.8811
2	4.084424	0.3947
3	3.106616	0.5401
4	2.070727	0.7228
5	9.428404	0.0512
6	2.053003	0.7260
7	3.255252	0.5161
8	2.014842	0.7330
9	1.594915	0.8097
10	6.080456	0.1932
11	6.485550	0.1657
12	10.41367	0.0340

Probs from chi-square with 4 df.

Normality

VEC Residual Normality Tests
Orthogonalization: Cholesky (Lutkepohl)
Null Hypothesis: residuals are multivariate normal
Date: 08/22/12 Time: 10:50
Sample: 2000Q1 2010Q4
Included observations: 42

Component	Skewness	Chi-sq	df	Prob.
1	0.451392	1.426282	1	0.2324
2	-0.597418	2.498355	1	0.1140
Joint		3.924637	2	0.1405

Component	Kurtosis	Chi-sq	df	Prob.
1	3.114334	0.022877	1	0.8798
2	4.424538	3.551289	1	0.0595

Joint	3.574166	2	0.1674

Component	Jarque-Bera	df	Prob.
1	1.449158	2	0.4845
2	6.049644	2	0.0486
Joint	7.498802	4	0.1118

VEC Residual Heteroskedasticity Tests: No Cross Terms (only levels and squares)
Date: 08/22/12 Time: 10:50
Sample: 2000Q1 2010Q4
Included observations: 42

Joint test:

Chi-sq	df	Prob.
18.66861	18	0.4125

Individual components:

Dependent	R-squared	F(6,35)	Prob.	Chi-sq(6)	Prob.
res1*res1	0.030507	0.183559	0.9795	1.281308	0.9727
res2*res2	0.185913	1.332160	0.2692	7.808357	0.2525
res2*res1	0.320896	2.756417	0.0267	13.47764	0.0360

VEC Residual Heteroskedasticity Tests: Includes Cross Terms
Date: 08/22/12 Time: 10:51
Sample: 2000Q1 2010Q4
Included observations: 42

Joint test:

Chi-sq	df	Prob.
27.54673	27	0.4346

Individual components:

Dependent	R-squared	F(9,32)	Prob.	Chi-sq(9)	Prob.
res1*res1	0.088958	0.347182	0.9514	3.736257	0.9279
res2*res2	0.277386	1.364850	0.2447	11.65020	0.2338

res2*res1	0.400741	2.377694	0.0345	16.83111	0.0514

LM3-LDCE

VEC Residual Serial Correlation LM Tests
Null Hypothesis: no serial correlation at lag order h
Date: 08/22/12 Time: 09:26
Sample: 2000Q1 2010Q4
Included observations: 41

Lags	LM-Stat	Prob
1	8.021463	0.0908
2	2.848434	0.5835
3	4.232759	0.3754
4	6.090876	0.1925
5	2.434202	0.6565
6	2.149525	0.7083
7	3.388232	0.4951
8	5.986571	0.2002
9	4.718565	0.3174
10	3.210345	0.5233
11	5.679799	0.2244
12	7.150114	0.1282

Probs from chi-square with 4 df.

VEC Residual Normality Tests
Orthogonalization: Cholesky (Lutkepohl)
Null Hypothesis: residuals are multivariate normal
Date: 08/22/12 Time: 09:27
Sample: 2000Q1 2010Q4
Included observations: 41

Component	Skewness	Chi-sq	df	Prob.
1	0.418549	1.197086	1	0.2739
2	0.979055	6.550082	1	0.0105
Joint		7.747168	2	0.0208

Component	Kurtosis	Chi-sq	df	Prob.
1	2.896011	0.018473	1	0.8919
2	5.321916	9.210129	1	0.0024

Joint	9.228602	2	0.0099

Component	Jarque-Bera	df	Prob.
1	1.215560	2	0.5446
2	15.76021	2	0.0004
Joint	16.97577	4	0.0020

VEC Residual Heteroskedasticity Tests: No Cross Terms (only levels and squares)
Date: 08/22/12 Time: 09:28
Sample: 2000Q1 2010Q4
Included observations: 41

Joint test:

Chi-sq	df	Prob.
27.25141	30	0.6100

Individual components:

Dependent	R-squared	F(10,30)	Prob.	Chi-sq(10)	Prob.
res1*res1	0.160931	0.575393	0.8207	6.598190	0.7628
res2*res2	0.263038	1.070765	0.4137	10.78455	0.3745
res2*res1	0.159713	0.570211	0.8248	6.548253	0.7673

VEC Residual Heteroskedasticity Tests: Includes Cross Terms
Date: 08/22/12 Time: 09:28
Sample: 2000Q1 2010Q4
Included observations: 41

Joint test:

Chi-sq	df	Prob.
56.56384	60	0.6021

Individual components:

Dependent	R-squared	F(20,20)	Prob.	Chi-sq(20)	Prob.
res1*res1	0.381436	0.616647	0.8560	15.63887	0.7388
res2*res2	0.452470	0.826385	0.6630	18.55129	0.5511
res2*res1	0.372798	0.594384	0.8734	15.28473	0.7599

LGDP-LM3

VEC Residual Serial Correlation LM Tests
Null Hypothesis: no serial correlation at lag order h
Date: 08/22/12 Time: 09:29
Sample: 2000Q1 2010Q4
Included observations: 39

Lags	LM-Stat	Prob
1	2.196815	0.6996
2	5.868358	0.2092
3	4.421701	0.3519
4	5.607650	0.2304
5	3.226167	0.5207
6	3.982572	0.4084
7	0.939707	0.9188
8	1.736273	0.7841
9	4.099977	0.3926
10	4.702733	0.3192
11	4.765051	0.3123
12	2.059838	0.7248

Probs from chi-square with 4 df.

VEC Residual Normality Tests
Orthogonalization: Cholesky (Lutkepohl)
Null Hypothesis: residuals are multivariate normal
Date: 08/22/12 Time: 09:29
Sample: 2000Q1 2010Q4
Included observations: 39

Component	Skewness	Chi-sq	df	Prob.
1	0.075273	0.036829	1	0.8478
2	0.436664	1.239391	1	0.2656
Joint		1.276220	2	0.5283

Component	Kurtosis	Chi-sq	df	Prob.
1	2.714047	0.132875	1	0.7155
2	4.372795	3.062419	1	0.0801
Joint		3.195294	2	0.2024

Component	Jarque-Bera	df	Prob.

1	0.169704	2	0.9186
2	4.301810	2	0.1164
Joint	4.471513	4	0.3459

VEC Residual Heteroskedasticity Tests: No Cross Terms (only levels and squares)
Date: 08/22/12 Time: 09:29
Sample: 2000Q1 2010Q4
Included observations: 39

Joint test:

Chi-sq	df	Prob.
54.84656	54	0.4423

Individual components:

Dependent	R-squared	F(18,20)	Prob.	Chi-sq(18)	Prob.
res1*res1	0.518399	1.196009	0.3472	20.21757	0.3207
res2*res2	0.356897	0.616623	0.8464	13.91898	0.7344
res2*res1	0.518003	1.194115	0.3484	20.20213	0.3216