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Money, Credit and Interest: Searching For a Credit Channel in South Africa

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MONEY, CREDIT AND INTEREST: SEARCHING FOR A CREDIT CHANNEL IN SOUTH AFRICA

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Abstract

This paper examines whether or not a credit channel of monetary policy is present in South Africa. Following the warning by Bernanke and Gertler (1995) that the credit channel is not a separate channel, but rather the amplification of the existing interest rate channel of monetary policy, this paper models the credit channel within a broader model of the monetary transmission mechanism. Thus, using the Johansen procedure the paper estimates a vector error-correction model with two cointegrating vectors. One vector is normalised on money demand, the other on inflation, with the second containing variables representing the bank-lending and balance-sheet channels of the credit channel of monetary policy. While the paper finds evidence in support of the bank-lending channel, it finds little support for the balance-sheet channel.

JEL Classification: E51, E41

Keywords: Credit channel, balance-sheet channel, bank-lending channel, interest rate channel, money demand

INTRODUCTION

Since Bernanke and Blinder (1988; 1992), Gertler and Gilchrist (1993) and Bernanke and Gertler (1995) introduced the credit channel to economic literature, several papers, covering several countries, explore the existence of the credit channel and its two sub-channels, the bank-lending and balance-sheet channels (cf. Iacoviello and Minetti 2008, Garretsen and Swank 2003; Fountas and Papagapitos 2001, Tang 2001). Apart from a study by Lungu (2007) that explores the existence of the bank-lending channel (but not the balance-sheet channel), little, if anything, has been done on the topic for South Africa. Therefore, this paper attempts to address this shortcoming by exploring whether or not there is evidence of a credit channel in South Africa. Following a warning by Bernanke and Gertler (1995:28) that the credit channel is not really a separate channel, but rather the amplification of the existing interest rate (money) channel of monetary policy, this paper models the credit channel within a broader model of the monetary transmission mechanism that also models money demand and its determinants. In addition, the paper follows what by now is established convention in the literature on the credit channel by distinguishing between the bank-lending and the balance-sheet channels.

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1. THE EVOLUTION OF THE CREDIT CHANNEL VIEW

The literature on the credit channel originates in the work of Bernanke and Blinder (1988; 1992), Gertler and Gilchrist (1993) and Bernanke and Gertler (1995). In their 1988 paper Bernanke and Blinder presents a basic general equilibrium model that extends the IS-LM model. In the textbook IS-LM model there is a money market, bond market and goods market. As such, the IS-LM model accepts the perfect substitutability of bonds and bank loans. Bernanke and Blinder (1988: 435) drop this assumption, which allows them to model the supply and demand for bank loans separately from that of bonds. In their model the demand for bank loans, L^D, becomes a function of income, Y, and the interest rate on loans, ?, relative to the interest rate on bonds, i:

$$L^D = L(\rho, i, Y) \text{ where } dL^D/d\rho < 0,\ dL^D/di > 0 \text{ and } dL^D/dY > 0 \qquad (1)$$

Loan supply by banks, L^S, is a function of the interest rate on loans relative to the interest rate on bonds, and the volume of deposits that banks receive, D:

$$L^S = B(\rho, i, D) \text{ where } dL^S/d\rho > 0,\ dL^S/di < 0 \text{ and } dL^S/dD > 0 \qquad (2)$$

so that the loans market equilibrium is:

$$L(\rho, i, Y) = B(\rho, i, D) \qquad (3)$$

Bernanke and Blinder (1988:436) model the money market in the conventional manner, whereby the demand for money, M^D, is a function of income and the interest rate on bonds. In so far as banks change the amount of their excess reserves, R, in reaction to a change in the bond market rate, the money supply, M^S, is a function of the interest rate.

$$M^D = D(Y, i) \text{ where } dM^D/dY > 0 \text{ and } dM^D/di < 0 \qquad (4)$$

$$M^S = M(i)\mathrm{R} \quad \text{where } dM^S/di > 0 \qquad (5)$$

so that money market equilibrium is:

$$M(i)\mathrm{R} = D(Y, i) \qquad (6)$$

Lastly, Bernanke and Blinder (1988:436) model a goods market equilibrium where income is a function of the interest rates on bonds and bank loans:

$$Y = Y(i, \mathbf{r}) \text{ where } dY/di < 0 \text{ and } dY/d\mathbf{r} < 0 \quad (7)$$

With the above system Bernanke and Blinder (1988:436) derive what they call a negatively sloped Commodities and Credit (CC) curve. They do this by first substituting the money supply function for the deposits variable in the loan supply function. Then, through substitution and by assuming that the interest rate on loans is an increasing function of the bond market rate (Equation (8)) – thereby eliminating the rate on bank loans from their CC function – they collapse the goods and loans market functions into one equation. The result is the CC curve, represented by Equation (9), where income is a function of the bond market interest rate and excess reserves. The CC curve interacts with the positively sloped LM curve in interest-income space:

$$\mathbf{r} = \mathbf{f}(i, Y, R) \quad (8)$$

$$Y = Y(i, \mathbf{f}(i, Y, R)) \quad (9)$$

Using the above system Bernanke and Blinder (1988:437) consider whether or not credit in the US is a better indicator of the impact of monetary policy than money. If, relative to money, credit reacts faster to monetary policy action such as interest rate changes, and if credit is less volatile than money, credit might be a better indicator. To explore this possibility Bernanke and Blinder (1988:438-9) regresses first the log of nominal money and secondly the log of credit, each on one of their own lags, the interest rates on bank loans (in the case of credit) and bonds, as well as the logs of prices and income. By running these two regressions, Bernanke and Blinder (1988:439) estimate, so they argue, Equations (1) and (4) above. They subsequently compare the variance of the residuals of both regressions and come to a tentative conclusion that credit might indeed be less volatile, a finding that they interpret as support for the existence of the credit channel. Bernanke and Blinder (1992), as well as Bernanke and Gertler (1995) follow up on the 1988 study. Using a VAR analysis both papers consider the impact on the US economy (including unemployment and credit aggregates) of tighter monetary policy in the form of an interest rate increase.

As long as the interest rate sensitivity of money supply (i.e. the extent to which banks change their excess reserves in reaction to interest rate changes) is assumed to be small or negligible, the regressing of (real) money on the set of variables that includes income and interest rates, can be interpreted as an estimation of the money demand function. Thus, in essence one is busy estimating both Equations (4) and (6) if the parameter on the interest rate in Equation (5) equals zero. This is standard practice in virtually all papers estimating money demand. However, the estimation of Equation (1), the credit demand function, is problematic as the supply of credit (Equation (2)) might not be interest inelastic (as the supply of money is assumed to be). This gives rise to a textbook example of a supply and demand identification problem, where a regression of credit on one of its own lags as well as income, interest rates and prices, cannot be denoted as a credit *demand* relationship. Addressing this problem in the literature gave rise to different approaches to establish the presence of the credit channel (cf. Iacoviello and Minetti 2008, Garretsen and Swank 2003; Fountas and Papagapitos 2001, Kashyap, Stein and Wilcox 1993).

The first is to distinguish between the size of either borrowers or lenders, based on the idea that small borrowers and lenders have less access to open financial markets (cf. Kashyap, Stein and Wilcox 1993, Garretsen and Swank 2003). The second approach to establish the presence of the credit channel, which is also the one pursued in this paper, augments Equation (2) by introducing the quality spread or external finance premium (EFP), *s*, that represents the balance-sheet channel:

$$L^S = B(\rho, i, s, D) \text{ where } dL^S/d\rho > 0,\ dL^S/di < 0,\ dL^S/ds < 0 \text{ and } dL^S/dD > 0 \quad (2')$$

With the necessary substitutions, the use of Equation (2) yields an augmented version of Equation (9):

$$Y = Y(i, \phi(i, s, Y, R)) \quad (9')$$

In Equation (9'), s is an external finance premium (EFP) that banks (and other investors) require when borrowers seek external finance. EFP is levied by lenders and results from a combination of information asymmetries, the resultant potential for moral hazard on the part of borrowers and adverse selection difficulties on the part of lenders when faced by the information asymmetries. In addition, as Bernanke and Gertler (1995:34-7) argue, when interest rates increase, causing balance sheets to weaken and moral hazard and adverse selection problems to increase, EFP might also increase. Thus, just as interest rates increase, EFP might also increase in reaction to a tighter monetary policy. Because EFP is levied by lenders, it is a loan supply-side phenomenon that results from the weaker balance sheets of borrowers (hence, it is named the balance-sheet channel). The balance-sheet channel augments the predominantly loan demand-side phenomenon of the bank-lending channel, represented by the bond rate, *i*, in Equation (9'). The bank-lending channel is very similar, though not synonymous given its theoretical focus on banks, with the traditional interest rate transmission mechanism. Empirically, though, the bank-lending channel and the interest rate channel of monetary policy are very often indistinguishable, particularly when both can be represented as a relationship between output and a short-term interest rate.

A variation of Equation (9') can also be specified with inflation as dependent variable, thereby allowing for a specification that serves as indicator of how monetary policy impacts inflation (the ultimate objective of monetary policy in many countries) when transmitted through the credit channel. Because Equation (9') specifies an equilibrium in the commodities and credit markets (with output as dependent variable), it can be inserted in a Phillips curve relationship where inflation is related to an output gap. The resultant Phillips curve/CC curve is a version of Equation (9') with inflation as dependent variable. In this variation of Equation (9), prices depend negatively on the bond interest rate, EFP and long-run output.

Instead of attempting to estimate Equations (1) and (4), authors such as Iacoviello and Minetti (2008) and Fountas and Papagapitos (2001) rather estimate output or price versions of Equation (9'), and then consider the size and significance of the parameters of *i* and *s* as indications of the presence and significance of the bank-lending and balance-sheet channels. Some of the estimations of the variations of Equation (9') also include a credit aggregate variable as explanatory variable. The credit aggregate variable can now be included because the inclusion of an interest rate or the distinction between categories of lenders or borrowers controls for some of the credit supply and demand identification problems mentioned above.

However, note that the inclusion of EFP in estimates of Equation (9') is premised on the assumption that monetary policy, through interest rate changes, does impact EFP, and that a change in EFP will lead to an opposite change in output or the price level. As such, EFP becomes very much like an intermediate monetary target. To be used as such, it needs to fulfil the usual requirements for an intermediate target variable: i.e. it needs to be under control of the central bank and it must be closely correlated with the ultimate target. However, there is also the possibility that changes in risk and therefore balance sheets, occur independent of changes in monetary policy. Thus, changes in EFP might occur independently of central bank-orchestrated changes in short-term interest rates. (cf. Alvarez, Atkeson and Kehoe 2008:6 who mention the possibility, also see the substantial increases in the TED rate (difference between the US Treasury and Eurodollar rates), and the spread between the US$-LIBOR rate and the Fed Funds rate (both indicators of the risk premium) between August 2007 and August 2008 (Brown 2008:36-7). These changes did not occur as a result of increases in the Fed Funds rate, in fact, the Fed Funds rate decreased from 5.25% in August 2007 to 2% in August 2008.)

In addition, it is also possible that in a regression with inflation as dependent variable EFP has a positive sign. The positive sign might occur when, in the face of an increase in risk and thus in EFP, balance sheets weaken and because of the weaker balance sheets the central bank becomes reluctant to combat inflation. This means that at the prevailing nominal interest rate the central bank tolerates higher inflation rates because dealing with the inflation rates through higher interest rates might further weaken balance sheets. Thus, it is not possible on *a priori* grounds to predict what sign EFP will have.

Given that low inflation has been the stated objective of the South African Reserve Bank since the 1980s, this paper estimates a price version of Equation (9'). Furthermore, as Equation (9') represents the CC curve (and hence a goods and credit markets equilibrium), estimating it on its own and leaving out the money market component, might leave out an important part of the model. Thus, to have a complete model, this paper also estimates Equation (4) (and by extension, Equation (6) under the assumption that the interest rate parameter in Equation (5) equals zero)) as part of the total model. The next section provides a brief overview of the literature on money demand.

2. THE LITERATURE ON MONEY DEMAND

In terms of the sheer number of articles, the literature on money demand might be one of the largest within the economics discipline (see Sriram (2000) for international literature covering most of the 1990s). With a modern literature that traces its heritage back to Keynes (1930), Cagan (1956) and Friedman (1957) the form in which authors estimate money demand functions has become highly standardised (see the brief overview of selected papers in Table 1 below).

As Table 1 indicates, estimating a money demand function usually takes the form of regressing a real money aggregate on a scale variable, which in most cases is real income, as well as the opportunity cost of holding money. The opportunity cost is usually proxied by a long-run interest rate and/or inflation. Because money balances also earn interest, one should ideally consider the net opportunity cost. Hence, the regressions often include an own rate of interest. Usually a short-term interest rate such as the TB rate is taken as a good proxy for the own rate of interest. Furthermore, estimates include either the long-term and short-term interest rate separately or the difference between them. *A priori* income and the own rate of interest should have positive signs, while inflation and the long-term interest rate should have negative signs. In addition, with a constant velocity of money, the parameter on real income would equal one. However, beginning with study by Friedman (1957:337) that found an income parameter equals to 1.8, many studies find a parameter larger than one (see Table 1).

Money demand studies in South Africa during the last decade include Moll (2000), Jonsson (2001), Wesso (2002), Tlelima and Turner (2004), Ziramba (2007), Hall, Hondroyiannis, Swamy and Tavlas (2007) and Todani (2007), with Moll (2000) providing an overview of earlier literature on money demand in South Africa. Moll (2000) estimates a model covering the period 1966:4-1998:3. Using OLS Moll (2000:204) finds that real income has a long-run parameter of 1.11, while using the Johansen cointegration procedure, results in a parameter for real income that equals 1.16.

Table 1 – Money demand – Some international evidence

Author	**Country**	**Method**	**Variables**	**Parameter value of Y**
Drake and Chrystal (1994)	UK	Cointegration and ECM (Johansen)	M, Y, p, i^L, i^S	2.576-3.223
Melnick (1995)	Israel	OLS and principle component (the latter used in the analysis of financial services)	M, Y, p, i, fin services	0.52-0.72
Haug and Lucas (1996)	Canada	DOLS, Johansen as well as Phillips-Hansen estimations of long-run relationships	M, Y, i^L or i^S	0.12-1.78
Ericsson and Sharma (1998)	Greece	Cointegration and ECM (Johansen)	M, Y, p, interest rates on time deposits, repos and TB bills	1.22 (not stat sig diff from 1)
Ericsson, Hendry and Mizon (1998)	UK	Cointegration and ECM (Johansen)	M, Y, p, i	1 (imposed)
Ericsson, Hendry and Prestwich (1998)	UK	Cointegration and ECM (EG)	M, Y, p, i^L, i^S	1 (imposed)
Ghartey (1998)	Jamaica	Cointegration and ECM (OLS, Cochrane-Orcutt iterative estimation to correct for autocorrelation, DOLS, IV ML and Johansen)	Nom M, Y, p, i^S, exchange rate, exchange rate risk (variance of exchange rate)	0.99-1.11
Ghartey (1998)	Ghana	Cointegration and ECM (OLS, Cochrane-Orcutt iterative estimation to correct for autocorrelation, DOLS, IV ML and Johansen)	Nom M, Y, p, i^S, exchange rate, exchange rate risk (variance of exchange rate)	1.08-1.94
Fagan and Henry (1998)	EU	Cointegration (Johansen)	M, Y, i^L, i^S	0.86-1.61 for EU -052-2.85 for indiv countries
Eitrheim (1998)	Norway	Cointegration (ARDL)	M, Y, p, i^L, i^S and wages	0.76
Juselius (1998)	Denmark	Cointegration and ECM (Johansen)	M, Y, p, i^L, i^S	1 (fail to reject unity assumption)
Deng and Liu (1999)	China	Cointegration and ECM (EG) for linear model, also combined with artificial neural network to estimate non-linear model	M, Y, p, i on deposits	1.29
Choudhry (1998)	Russia	Cointegration and ECM (Johansen)	M, p, real exchange rate, currency depreciation	
Hayo (2000)	Austria	Cointegration and ECM (Johansen)	M, Y, p, i^L	1(fail to reject unity assumption)
Baltensperger, Jordan and Savioz (2001)	Switzerland	Cointegration and ECM (EG, DOLS, Fully modified OLS, Johansen and ARDL)	M, Y, p, i^L	1.053-1.725
Bahmani-Oskooee (2001)	Japan	Cointegration (ARDL)	M, Y, i^L	1.072-1.174
Buch (2001)	Hungary and Poland	Cointegration (ARDL)	M, industrial production, p, i^S, exchange rate	0.95-1.14
Coenen and Vega (2001)	Euro area	Cointegration and ECM (Johansen) & General-to-specific modeling	M, Y, p, i^L, i^S	1.111-1.163
Dutkowsky and Atesoglu (2001)	US	Cointegration and ECM (Johansen and DOLS)	M, consumption , i^L	
Juselius (2001)	Italy	Cointegration and ECM (Johansen)	M, Y, p, i^L, i^S	1(fail to reject unity assumption)
Hwang (2002)	Korea	Cointegration and ECM (Johansen)	M, Y, i^L	0.69
Gabriel, Da Silva Lopes and Nunes (2003)	Portugal	Cointegration and ECM (OLS and FM-OLS)	M, Y, p, i^S	1.027-1.3
Juselius and Toro (2005)	Spain	Cointegration and ECM (Johansen)	M, Y, p, i^L, i^S	0.44
Georgepoulos (2006)	Canada	Cointegration and ECM (Johansen)	M, Y, p, i^S (compares estimates with and without own rate)	0.88-2.153
Haug (2006)	Canada	Cointegration and ECM (Johansen)	M, Y, i^L	1.04
Haug and Tam (2007)	US	Cointegration and ECM, testing for non-linearity in model (Johansen and DOLS)	M, Y, i^L or i^S	

M; Real money, Y: Real income, p: Inflation, i^L:, Long-run interest rate, i^S: Short-run interest rate

Using data for the period 1970-2000 Wesso (2002) estimates both a single equation fixed-coefficient error-correction model as well as a varying-parameter model. He finds that the results of the two models are broadly in line. In the single equation fixed-coefficient error-correction model Wesso (2002) obtains a parameter of 1.84 on income. Though the results are broadly similar, Wesso (2002:12) finds that the parameter on income in his varying-parameter model tends to increase slightly in the period after 1994. Like Wesso (2002), Hall *et al.* (2007) estimate a single equation fixed-coefficient error-correction model as well as a varying-parameter model for the period 1970:1 to

2006:4. Unlike Wesso, Hall *et al.* (2007) include a wealth indicator in the form of the ratio of the All Share Index of the Johannesburg Stock Exchange to nominal income. Hall *et al.* (2007:16) argue that the inclusion of the wealth variable is needed to yield a stable estimate of the money demand function. Hall *et al.* (2007:16-17) also argue that based on a comparison of the results of the single equation fixed-coefficient error-correction model and the varying-parameter model, and given the stability of the parameters in the varying-parameter model, that the money demand relationship is a stable relationship. The real income parameter of the fixed-coefficient error-correction model of Hall *et al.* (2007:21) equals 1.457, while that of the wealth variable equals 0.311. The average income elasticity that Hall *et al.* (2007:15) estimate for their varying-parameter model is 1.26 and it is stable over the course of the sample period.

Using the Johansen technique Jonsson (2001) estimates a money demand relationship for the period 1970:1-1998-2. His estimates for the income parameter range between 1.1 and 1.9, with a final constrained model yielding an estimate of 1.22 (Jonsson 2001:253; 255). Tlelima and Turner (2004) estimate two money demand functions for the period 1970:1 2002:3, one using GDP as scale variable, the other using consumption. In estimating their models, Tlelima and Turner (2004:28-32) use a general-to-specific approach and estimate an ARDL model. On income and consumption they find parameter values of 1.2 and 0.83 (Tlelima and Turner 2004:30). Similar to Tlelima and Turner (2004), Ziramba (2007:416) uses consumption. However, he also includes investment and exports in the same regression. Ziramba (2007:416) uses annual data for the period 1970-2005. The most recent contribution is that of Todani (2007), who estimates a money demand function for the period 1980:1 2003:4. Using the Johansen cointegration method, Todani obtains a rather large real income parameter of 3.2.

3. A CREDIT CHANNEL/ MONEY DEMAND MODEL FOR SOUTH AFRICA

According to the above literature review on the South African money demand function there is a stable money demand relationship. There is also a study by Lungu (2007) that finds evidence in support of the bank-lending channel. However, is there evidence of a credit channel, i.e. both the bank-lending and the balance-sheet channels, in South Africa? This section specifies and estimates such a model to explore whether or not there is evidence of a credit channel in South Africa. However, Bernanke and Gertler (1995:28) warn that the credit channel is not really a separate channel, but rather the amplification of the existing interest rate and money channel of monetary policy. Heeding this warning this section models the credit channel (both the bank-lending channel and the balance-sheet channel) within a broader model of the monetary transmission mechanism that also models the money channel in the form of the money demand and its determinants. This is equivalent to estimating Equations (4) above (and by implication Equation (6) as it is assumed that the interest rate sensitivity of money supply equals zero) together with an inflation version of Equation (9').

To test for the existence of a credit channel within a broader model of the monetary transmission mechanism the analyses will look for a model that contains a money demand relationship and a credit channel relationship. Variables considered for use in the money demand relationship include real M3 (money demand), real income (a scale variable), CPI inflation and the 10-year government bond rate (the opportunity cost of holding money) as well as the TB rate (the own rate of money). The use of the TB and 10-year government bond rate follows Jonsson (2002). With regard to the credit channel, the analysis considers the inclusion of CPI inflation (the ultimate target variable of monetary policy), the TB rate (a short term interest rate to represent the bank-lending channel) and an indicator of EFP (the balance-sheet channel). The EFP that the paper uses follows Iacoviello and Minetti (2008:4) and is the spread between the mortgage rate and the 10-year government bond rate, with the latter serving as a safe rate.[2] Following Garretsen and Swank (2003), and with the short-term interest rate controlling for demand effects, the analysis will also consider including a credit variable. The credit variable used is real private sector credit extension. Therefore, the variables used in the analysis below are:

m3 = log of real M3,

GDP = log of real GDP,

DCPI = quarterly inflation rate multiplied by four to match interest rates calculated on an annual basis,

[2] The analysis below was also carried out using a spread between the Eskom rate and the government bond rate. The results are not reported as they are very similar to the results obtained by using the spread between the mortgage and bond rate.

TB rate = TB rate,

Bond rate = 10-year government bond rate,

EFP = spread between the mortgage rate and the 10-year government bond rate.

Credit = log of real private sector credit extension

Table 2 - KPSS Stationarity test

	Quarterly data		
	t-values		I(*)
	Level	First dif	
m3*	0.31	0.09	**I(1)**
GDP*	0.30	0.08	**I(1)**
Credit*	0.27	0.09	**I(1)**
DCPI**	1.04	0.03	**I(1)**
EFP**	0.15		**I(0)**
TB rate**	0.50	0.14	**I(1)**
Bond rate**	0.93	0.37	**I(1)**

Null hypothesis: Variable is stationary
* Intercept and trend: Critical t (5%): 0.15
** Intercept: Critical t (5%): 0.46
All the data used in the analysis, with the exception of the TB rate, was obtained from the SARB (2008) download facility. The TB rate was obtained from the Quantec (2008) download facility.

Unlike other studies that include data as far back as 1970, the sample period in this study is 1982:1 to 2007:3. The reason for this is to limit the sample to the period characterized by financial market liberalisation (the 1980s) and financial market deepening (the period since the mid 1990s). The analysis uses the by now standard Johansen cointegration technique, which is suitable for use when time-series data are non-stationary. The technique also allows for the use of weak exogeneity tests, as well as impulse-response and variance decomposition analyses. To test for the stationary of variables the analysis uses the KPSS test, which, unlike the often-used ADF test, does not suffer from small sample problems. Table 2 reports the results of the stationarity test. It indicates that all variables, with the exception of EFP, are I(1).

The vector error-correction model estimated below using the Johansen procedure is:

$$DX_t = PX_{t-1} + \sum_{t=i}^{k} G_i DX_{t-i} + e_{kt} \quad (10)$$

where X_t = (m3, GDP, DCPI, TB rate, Bond rate, EFP) is a 6x1 vector that includes the I(1) variables (but it may also include I(0) variables, such as EFP), G_i are 6x6 short-run coefficient matrices; e_{kt} are normally and independently distributed error terms. The trace test is used to determine the number of cointegrated vectors. It indicates the presence of two cointegrating vectors (see Table 1A in the Appendix). The first vector is normalised on money demand, while the second is normalised on inflation. To identify the relationship, the parameter on EFP is set to zero in the first vector, while the parameter of money demand is set equal to zero in the second vector. Therefore, the first vector specifies a money demand relationship containing m3, GDP, DCPI, TB rate and Bond rate, while the second vector specifies a credit channel relationship containing DCPI, GDP, TB rate, Bond rate and EFP. The inclusion of GDP in log-level in the second vector allows for the possibility that when the trend at which GDP increases becomes steeper, possibly as a result of a higher productivity growth rate, there might also be downward pressure on inflation. The pressure on inflation occurs if higher productivity does not translate fully into higher real wages, something which seems to be the case in South Africa given the negative relationship between the growth rates of unit labour cost and productivity. Exploring this relationship between GDP and inflation follows the argument made by Ball and Mankiw (2002:129-132) who considered the importance of productivity change for the US Phillips curve relationship. However, it should be noted that as GDP usually displays a continuous upward trend while one would not expect inflation to display a continuous downward trend, one would expect the negative impact of GDP on inflation to be transitory. The analysis will explore whether or not this is the case with the impulse-response function that analyses the impact of a change in GDP on inflation. The inclusion of the TB rate and EFP in the second vector allows for the bank-lending channel and the balance-sheet channel, while the inclusion of the Bond rate may serve as an indicator of expected inflation. In addition, note that the inclusion of both the TB rate and the Bond rate also introduces the yield curve into the specification. With two cointegrating vectors, the normalisation on money demand and inflation and the identification of the two relationships, ? $_i$ in Equation (10) can be decomposed as the following a and ß’ matrices:

$$P X_{t-1} = a b' X_{t-1} = \begin{bmatrix} a_{11} & a_{12} \\ a_{21} & a_{22} \\ a_{31} & a_{32} \\ a_{41} & a_{42} \\ a_{51} & a_{52} \\ a_{61} & a_{62} \end{bmatrix} \begin{bmatrix} 1 & b_{21} & b_{31} & b_{41} & b_{51} & 0 \\ 0 & 1 & b_{23} & b_{42} & b_{52} & b_{62} \end{bmatrix} \begin{bmatrix} m3_{t-1} \\ DCPI_{t-1} \\ GDP_{t-1} \\ TB\,rate_{t-1} \\ Bond\ rate_{t-1} \\ EFP_{t-1} \end{bmatrix} \quad (11)$$

where a is a 6x2 matrix (six variables and 2 cointegrating relationships) that contains the error-correction (adjustment) parameters, and ß’ is a 2x6 matrix that contains the long-run parameters. The results of estimating Equation (11) are reported as Model 1 in Table 3. The number of lags to include in the VAR was determined using information criteria. The information criteria indicate that one lag is sufficient. Note that the signs of the cointegrating equation (the ßs) are reported in Table 3 as they would appear in Equation (11). Thus, a *minus* in front of a parameter means a *positive relationship* between the variable to which the parameter applies and the variable on which the vector is normalized.

Table 3 – Money demand, inflation and the interest and credit channels of monetary policy

	Model 1		**Model 2**		**Model 3**	
Cointegrating Eq:	**Coint Eq 1**	**Coint Eq 2**	**Coint Eq 1**	**Coint Eq 2**	**Coint Eq 1**	**Coint Eq 2**
m3	1	0	1	0	1	0
DCPI	*1.11*	1	0.22	1	*0.75*	1
	[4.57]		[1.51]		*[7.08]*	
GDP	*-3.19*	*-0.25*	*-1.87*	*0.45*	*-1.90*	*0.43*
	[-13.36]	*[-2.67]*	*[-9.42]*	*[2.76]*	*[-9.16]*	*[2.91]*
EFP	0	*-0.96*	0	-1.59	0	*-1.59*
		[-3.15]		[-4.57]		*[-4.38]*
TB rate	*-1.28*	*0.94*	*-0.95*	*1.73*	*-0.75*	*1.72*
	[-4.41]	*[4.06]*	*[-5.80]*	*[6.50]*	*[-7.08]*	*[6.31]*
Bond rate	0.68	*-1.34*	*1.27*	*-1.72*	*0.75*	*-1.72*
	[1.33]	*[-4.87]*	*[4.76]*	*[-5.67]*	*[7.08]*	*[-6.31]*
Credit			*-0.40*	*-0.27*	*-0.47*	*-0.26*
			[-5.34]	*[-4.29]*	*[-5.76]*	*[-4.28]*
Trend	*0.00*	0.00	*0.00*	0.00	*0.00*	*0.00*
	[2.98]	[1.76]	*[3.67]*	[1.50]	*[4.62]*	[1.55]
C	30.16	3.33	17.43	-2.72	18.65	-2.60
Error Correction:	**M3**	**DCPI**	**M3**	**DCPI**	**M3**	**DCPI**
EC 1	-0.11	0.06	-0.23	-0.14	-0.17	-0.16
	[-3.05]	[0.78]	[-3.85]	[-1.05]	[-3.38]	[-1.48]
EC 2	-0.10	-0.64	-0.13	-0.54	-0.05	-0.49
	[-1.26]	[-3.56]	[-1.97]	[-3.66]	[-0.74]	[-3.51]
Adj. R-squared	0.51	0.46	0.53	0.46	0.51	0.47
Weak exog: ?^{2} (prob)	0.00	0.00	0.00	0.00	0.03	0.01
Autocor LM(2) (prob)	0.70		0.44		0.52	
Autocor LM(4) (prob)	0.96		0.81		0.77	

Weakly exogenous ?^{2} (prob):
Model 1: GDP (0.00), EFP (0.37), TB rate (0.03), Bond rate (0.14)
Model 2: GDP (0.00), EFP (0.27), TB rate (0.01), Bond rate (0.25), Priv sector credit (0.77)
Model 3: GDP (0.00), EFP (0.37), TB rate (0.03), Bond rate (0.16), Priv sector credit (0.84)
Notes:
t-values in square brackets, statistically significant values (at a 5% level) in the cointegrating relationships are in italics.
Dummies included: 1984:3 (instability caused by first election and introduction of tri-cameral parliament), 1985:4 (instability following Rubicon speech), 1993:3 (instability just prior to acceptance of interim constitution and following Hani assassination), 1990:1-1994:1 = 1 (period of political transition), 1990:1-2007:3 = 1 (Stals and Mboweni anti-inflationary regime), and 1998:3 = 1, 1998:4 = -1 (transitory dummy for exchange rate instability in 1998).
All cointegrating relationships were estimated with a constant and trend.

With the exception of the bond rate, all variables in the cointegrating relationships of Model 1 are statistically significant (at a 5% level), while the statistically significant and negative error-correction terms of money demand (-0.11) and inflation (-0.64) with respect to disturbances in their own long-run relationships indicate that both adjust to these disturbances. The weak exogeneity tests also indicate that both money demand and inflation are endogenous. This justifies the normalisation of the long-run relationships on money demand and inflation. In terms of sign, all variables have the expected sign as postulated by money demand and the credit channel literature, with the exception of the positive signs of EFP and GDP in the second vector. According to the theory on the balance-sheet channel one would expect that a tighter monetary policy would cause a deterioration in balance sheets, that, in turn, would cause EFP to increase, and thereby dampen inflation further. However, as argued above the positive sign may indicate that at the prevailing nominal interest rate and in the face of higher risk the central bank tolerates higher inflation rates because dealing with the inflation rates through higher interest rates might further weaken balance sheets. What is also notable is that the weak exogeneity test indicates that EFP is weakly exogenous and therefore not influenced by the other variables in the estimation, including the short-term interest rate that serves as indicator of monetary policy.

With regard to size, GDP in vector 1 of Model 1 has a rather large size, equaling 3.19, indicating that a 1% increase in real GDP will give rise to a 3.19% increase in real money demand. In terms of the old quantity theory one would expect a value of one. However, many studies internationally as well as in SA, find values in excess of one, though rarely in excess of two. The value of 3.19 is essentially the same as the 3.2 that Todani (2007:687) finds. A review of the literature on money demand in South Africa indicates that those studies with lower income parameters are studies with samples that stretch back to 1970 or even earlier. The model estimated by Todani, as well as Model 1 reported above, starts in the early 1980s. In addition, with the exception of Hall *et al.* (2007) and Tlelima and Turner (2004), all the studies with lower income parameters run only up to the late 1990s or the year 2000, while Todani's study runs up to 2003:4. This evidence, together with Wesso's finding (Wesso 2002) that the parameter of income in his varying-parameter model tended to increase slightly from the mid 1990s, points to the possibility that the large parameter of 3.19 might result from the change in the velocity of money that has occurred since the mid 1990s.

Prior to the mid 1990 M3 velocity remained fairly stable. However, since the mid 1990s velocity has been continuously decreasing (from more than 2.1 to less than 1.3), meaning that real money is increasing relative to real income. The decrease in velocity can in general be ascribed to financial market development. Given that the data of the late 1990s comprise a relatively small part of a sample that runs from the 1970s to only the late 1990s, means that studies using these samples might not pick up on the effect of the drop in velocity. Though the sample of Hall *et al.* (2007) runs from 1970:1-2006:4, they argue, with reference to an earlier paper by Todani that also reports the 3.2 parameter value, that the large parameter on income might be symptomatic of an omitted variable that creates a bias in the income parameter. This explains the inclusion of the wealth variable in the Hall *et al.* (2007) study.

Therefore, Model 1, reported in Table 3, might also suffer from an omitted variable problem. This raises the question which variable to include. A wealth variable, as Hall *et al.* (2007) include, is one option. However, given that the problem relates to the change in direction and the continuous decrease of velocity since the mid 1990s, one could also include a variable that reflects financial market deepening and development. Melnick (1995), in his study of money demand in Israel found a parameter on income that had the wrong sign on *a priori* grounds. He argues that this contratheoretical finding might reflect a biased parameter due to the omission of a financial development indicator. Therefore, Melnick (1995) develops such an indicator and with its inclusion, the parameter on income yields the expected sign and size.

There are several reasons to consider the inclusion of a variable that reflects financial market development. Given that since the mid 1990s there is an upcoming Black middle class in South Africa, many previously disadvantaged individuals for the first time are able to gain access to financial services and credit. In addition, South Africa reintegrated into international financial markets after 1994, opening up further possibilities of access, portfolio risk diversification and financial market development. These developments may explain a significant part of the increase in private sector credit extension relative to income observed since the mid 1990s. Given that bank credit and deposits constitute the main items on opposite sides of the balance sheets of banks, higher levels of credit creation by banks can be expected to translate into a higher demand for deposits. Thus, Model 1 is augmented by including real private sector credit extension by banks.

Given that the inclusion of the short-term interest rate controls for demand effects, and following Garretsen and Swank (2003), the credit variable can also be included in the credit channel relationship. Iacoviello and Minetti (2008:75) argue that when the default probability of a borrower increases, the bank may, instead of increasing an interest rate, increase the amount of collateral required, which, in effect, reduces the supply of credit. In addition Iacoviello and Minetti (2008:75) argue that there might be non-price rationing by banks in the credit market. The inclusion of the credit variable in addition to an interest rate variable can control for these non-price steps taken by banks.

Given the seven-variable VAR (m3, GDP, DCPI, TB rate, Bond rate, EFP, Credit), the trace test is again conducted to establish the number of cointegrated vectors. The trace test (reported in Table 2A of the appendix) indicates the presence of two cointegrating vectors. Placing the same restrictions on this model as on Model 1, yields Model 2, reported in Table 3. The first point to note with regard to Model 2, is that the parameter of GDP in vector 1 (i.e. the money demand relationship), is 1.87. This is in line with the value of 1.8 found by Wesso (2002) and is much lower than the initial 3.19. In addition, with the inclusion of credit the sign of GDP in vector 2 turns from positive into negative, with the negative sign being in accordance with *a priori* expectations. As with Model 1, the statistically significant and negative error-correction terms of money demand (-0.23) and inflation (-0.54) with respect to disturbances in their own long-run relationships indicate that both adjust to these disturbances. In addition, the weak exogeneity tests again indicate that both money demand and inflation are endogenous. This justifies the normalisation on money demand and inflation.

As in Model 1, EFP in Model 2 has a positive sign and is weakly exogenous. Thus again, at the prevailing nominal interest rate and in the face of higher risk the positive sign might be an indication that the central bank tolerates higher inflation rates when risk increases and balance sheets weaken because dealing with the inflation rates through higher interest rates might further weaken balance sheets. Credit extension has the expected positive sign in both vectors, with values of 0.4 and 0.27 in vectors 1 and 2 of Model 2. In the credit channel relationship this indicates the use of non-price steps and credit rationing by banks, while in the money demand relationship it indicates the impact of financial market deepening and development. Inflation (DCPI) is statistically insignificant in vector 1 of Model 2.

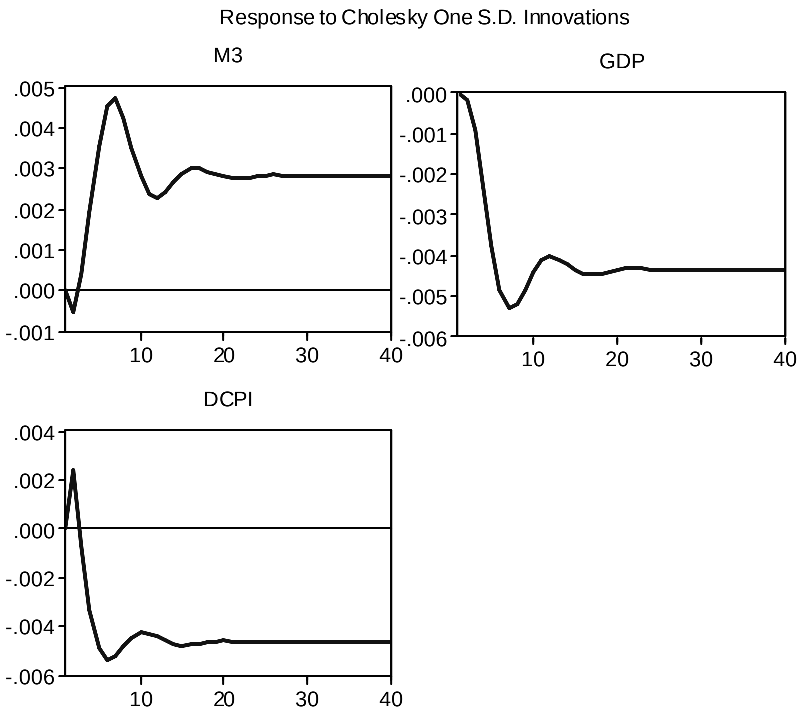
Following the estimation of Model 2, the analysis tested several addition restrictions on the parameter values of Model 2. Table 4 reports the probabilities of the $?^2$ values of the LR test for binding restrictions. The restrictions are first each tested separately within the context of Model 2, before they are tested jointly. As a result of these tests the parameters of inflation and the long and short-term interest rates in vector 1 of the final model (Model 3) are equal, with the long and short-term interest rate parameters having opposite signs. The long and short-term interest rates in vector 2 of the final model (Model 3) are also equal, but opposite in sign. The $?^2$ probability of the final model (with the joint hypothesis that all the above restrictions jointly hold) is 0.66, indicating that the model can be accepted. Finally, as a separate hypothesis, the parameter of GDP in vector 1 of Model 2 was set equal to 1 to test the old (i.e. pre-Friedman) quantity theory notion that velocity is stable. This hypothesis is clearly rejected with a $?^2$ probability of 0.00.

In vector 1 of Model 3 GDP has a parameter value of 1.9, which is slightly higher than the 1.87 of Model 2. Furthermore, the parameters of inflation and the bond rate equal -0.75, while that of the TB rate equals 0.75. In vector 2 the parameter of EFP equals 1.59, while the parameters of the bond rate and the TB rate equal 1.72 and -1.72. Private sector credit extension has parameters equal to 0.47 and 0.26 in the two vectors. As would be expected given that money demand is an upward trending variable over time, while inflation is not, the trend variable is statistically significant in vector 1, but statistically insignificant in vector 2. The statistically significant and negative error-correction terms of money demand (-0.17) and inflation (-0.49) with respect to disturbances in their own long-run relationships indicate that both adjust to these disturbances. The weak exogeneity tests again indicate that both money demand and inflation are endogenous, while EFP is still weakly exogenous. Credit is also weakly exogenous.

Table 4 – LR test for binding restrictions (prob of ?^{2})

Hypotheses tested	?^{2} (prob)
H_{01}: Parameters of long and short-term interest rate in vector 1 are equal with opposite signs	0.37
H_{02}: Parameter of inflation and long-term interest rate in vector 1 are equal with same sign	0.21
H_{03}: Parameters of inflation and long and short-term interest rate in vector 1 are equal, but long and short-term interest rate parameters have opposite signs	0.45
H_{04}: Parameters of long and short-term interest rate in vector 2 are equal with opposite signs	0.96
H_{05}: H_{01} to H_{04} jointly hold	0.66
H_{06}: Parameter of GDP in vector 1 equals one	0.00

Figure 1 – Impulse-response functions of M3, DCPI and GDP to a change in the TB rate



The analysis now uses Model 3 to conduct an impulse-response analysis and to examine the variance decomposition of money demand, inflation and GDP (the three variables that consistently came out as endogenous in the weak exogeneity tests). The impulse-response analysis is done for a one standard deviation increase in the TB rate, which serves as indicator of tighter monetary policy. It indicates that money demand, inflation and GDP act as expected on *a priori* grounds to the increase in the TB rate. While money demand increases in response to the increase in the TB rate (recall that the analysis uses the TB rate as an indicator of the own rate of money and one would thus expect money demand to increase), GDP and inflation decreases (tighter monetary policy leads to a contraction in output and a decrease in inflation). These effects peak at about seven to eight quarters, which also complies with conventional wisdom and experience in monetary and financial circles. The analysis also conducts an impulse-response analysis of inflation to a change in GDP. Table 3 above shows the negative long-run relationship between inflation and the level of GDP, a relationship that might result from an increase in productivity. However, given that GDP usually displays an upward trend, while one would not expect a continuous decreasing trend in inflation, one would not expect that the negative impact of GDP on inflation to be permanent, but rather to be transitory. This *a priori* expectation is borne out by the impulse-response function of inflation to a change in GDP, portrayed in Figure 2. Figure 2 shows that a one standard deviation increase in GDP causes inflation to decrease, but this effect disappears by the second quarter following the shock.

Figure 2 – Impulse-response functions of DCPI to a change in GDP

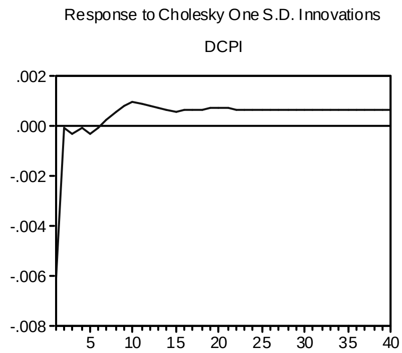


Table 5 – Variance decomposition – 20 quarters

		Variance explained by:						
		m3	**DCPI**	**GDP**	**EFP**	**TB rate**	**Bond rate**	**Credit**
Variance explained	**M3**	11.50	19.95	11.23	11.21	0.77	2.69	42.66
	DCPI	3.36	34.29	1.40	2.70	10.80	33.24	14.20
	GDP	3.92	16.40	35.56	7.31	22.08	3.78	10.96

Cholesky Ordering: TB rate, Credit, EFP, Bond rate, GDP, DCPI, M3. The policy variable is placed first, with the most endogenous variables, M3 and DCPI, placed last.

The variance decomposition (Table 5) shows that inflation explains 34% of its own variation, while the TB rate and the bond rate explain a further 11% and 33%. GDP explains 36% of its own variance, with DCPI and the TB rate explaining a further 16% and 22%. Credit explains 43% of money demand, but only 14% and 11% of DCPI and GDP. EFP contributes very little, explaining only 3% and 7% of DCPI and GDP. The role of the TB rate and to a smaller extent credit in explaining the variances of DCPI and GDP and the very small roles of EFP, serves as evidence in support of the existence of the bank-lending channel, but not for the existence of the balance-sheet channel.

Lastly, the analysis conducted VEC Granger causality tests (Table 6). These differ from the standard Granger causality tests in that they take account of the cointegrating relationship between the variables. The VEC Granger causality tests are conducted on the short-run part of the model, i.e. between *changes* in the variables included in the cointegrating relationships. Table 6 indicates that in the short run and at a 5% level of significance changes in all variables jointly Granger cause changes in DCPI, while changes in the TB rate and EFP individually and jointly Granger causes changes in GDP. In addition, the TB rate individually and jointly Granger causes changes in EFP, while change in GDP individually and jointly Granger causes changes in the TB rate.

Table 6 – VEC Granger Causality/Block Exogeneity Wald Tests

Causal variable	Dependent variable	Prob	Causal variable	Dependent variable	Prob
DCPI	**m3**	0.12	**m3**	**TB rate**	0.20
GDP	**m3**	0.58	**DCPI**	**TB rate**	0.67
EFP	**m3**	0.40	**GDP**	**TB rate**	**0.02**
TB rate	**m3**	0.87	**EFP**	**TB rate**	0.32
Bond rate	**m3**	0.64	**Bond rate**	**TB rate**	0.54
Credit	**m3**	0.24	**Credit**	**TB rate**	*0.07*
All	**m3**	0.17	**All**	**TB rate**	**0.02**
m3	**DCPI**	0.74	**m3**	**Bond rate**	0.44
GDP	**DCPI**	0.84	**DCPI**	**Bond rate**	0.40
EFP	**DCPI**	0.93	**GDP**	**Bond rate**	0.98
TB rate	**DCPI**	0.19	**EFP**	**Bond rate**	0.45
Bond rate	**DCPI**	0.19	**TB rate**	**Bond rate**	0.28
Credit	**DCPI**	0.67	**Credit**	**Bond rate**	*0.09*
All	**DCPI**	**0.03**	**All**	**Bond rate**	0.13
m3	**GDP**	0.19	**m3**	**Credit**	0.13
DCPI	**GDP**	*0.06*	**DCPI**	**Credit**	0.31
EFP	**GDP**	**0.03**	**GDP**	**Credit**	0.43
TB rate	**GDP**	**0.04**	**EFP**	**Credit**	0.67
Bond rate	**GDP**	0.30	**TB rate**	**Credit**	0.56
Credit	**GDP**	0.55	**Bond rate**	**Credit**	0.99
All	**GDP**	**0.00**	**All**	**Credit**	0.32
m3	**EFP**	0.63			
DCPI	**EFP**	0.92			
GDP	**EFP**	0.30			
TB rate	**EFP**	**0.03**			
Bond rate	**EFP**	0.77			
Credit	**EFP**	0.91			
All	**EFP**	**0.01**			

Null hypothesis: Changes in left-hand variable does not Granger cause changes in right-hand variable.
Values in bold: Changes in left-hand variable Granger causes changes in right-hand variable at 5% level of significance
Values in italics: Changes in left-hand variable Granger causes changes in right-hand variable at 10% level of significance

4. CONCLUSION

This paper set out to establish whether or not there is evidence that the credit channel exists in South Africa. The international literature distinguishes between two sub-channels, the one being the bank-lending channel, the other being the balance-sheet channel. While Model 3, its impulse-response function and its variance decomposition analysis support the existence of a bank-lending channel, there is very limited evidence for the existence of a balance-sheet channel in South Africa. Instead of causing inflation to decrease and being endogenous (and thus susceptible to influence by monetary policy in the form of an increase in the short-term interest rate), EFP is weakly exogenous and an increase in it is associated with an *increase* in inflation. The positive sign is an indication that when balance sheets weaken in the face of an increase in risk and thus in EFP, the weaker balance sheets may render the central bank relatively reluctant to combat inflation. Therefore, at the prevailing nominal interest rate and in the face of higher risk the central bank tolerates higher inflation rates because dealing with the inflation rates through higher interest rates might further weaken balance sheets. In defence of South African monetary policy the relatively small role of EFP in the variance decomposition of inflation indicates that this reluctance is relatively small. However, this reluctance of the central bank renders the balance-sheet channel of monetary policy impotent. Should the central bank wish to use this channel, it should not become more tolerant of inflation in the face of higher risk affecting balance sheets. Reducing its tolerance might turn the external finance premium into a variable that displays very much the characteristics of an intermediate monetary target: i.e. it might be largely under the control of the central bank and be highly correlated (with the correct negative sign) with inflation.

APPENDIX

Table 1A – Unrestricted Cointegration Rank (Trace) Test (Variables: M3, DCPI, GDP, EFP, TB rate, Bond rate)

Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	0.05 Critical Value	Prob.**
None *	0.48	183.00	117.71	0.00
At most 1 *	0.41	115.35	88.80	0.00
At most 2	0.20	60.40	63.88	0.09
At most 3	0.16	37.59	42.92	0.15
At most 4	0.10	19.96	25.87	0.23
At most 5	0.09	9.56	12.52	0.15

Trend assumption: Intercept, no trend in Cointegrating equation and test VAR
Trace test indicates 2 cointegrating eqn(s) at the 0.05 level
* denotes rejection of the hypothesis at the 0.05 level
**MacKinnon-Haug-Michelis (1999) p-values

Table 2A – Unrestricted Cointegration Rank (Trace) Test (Variables: M3, DCPI, GDP, EFP, TB rate, Bond rate, Credit)

Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	0.05 Critical Value	Prob.**
None *	0.50	209.25	150.56	0.00
At most 1 *	0.41	138.12	117.71	0.00
At most 2	0.25	83.77	88.80	0.11
At most 3	0.18	54.79	63.88	0.23
At most 4	0.12	34.68	42.92	0.26
At most 5	0.10	21.00	25.87	0.18

Trend assumption: Intercept, no trend in Cointegrating equation and test VAR
Trace test indicates 2 cointegrating eqn(s) at the 0.05 level
* denotes rejection of the hypothesis at the 0.05 level
**MacKinnon-Haug-Michelis (1999) p-values

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