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## THE RELATION BETWEEN MONEY, INCOME AND PRICES IN SOUTH AFRICA

Kevin S. Nell

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### Abstract

The main purpose of this paper is to determine whether inflation in South Africa has been caused by excessive monetary expansion over the period 1966-1997, or whether the money supply has merely been passive in the inflationary process. The analysis first draws on Friedman and Schwartz's (1982) theoretical exposition to transform South Africa's stable M3 money demand function into a theory of money, income and prices. Long-run price equations are then estimated with consumer price inflation as the relevant inflation variable, given that the M3 money demand function is deflated by consumer price inflation. To validate the econometric interpretation of the long-run price equations, causality tests based on the methodology developed by Pesaran *et al.* (1996) together with non-nested tests are used. These show that money and 'excess' money are endogenous to consumer price inflation and broad measures of inflation. The most important policy implication of an endogenously determined money supply is that a long-run analysis of inflation in South Africa should search beyond the realms of the Central Bank alone, and focus on the potential inflationary impact of structural and/or cost-push forces of inflation.

**JEL Classification:** C22, E31, E41

**Keywords:** exogenous/endogenous money supply, 'excess money', causality tests, non-nested tests

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## THE RELATION BETWEEN MONEY, INCOME AND PRICES IN SOUTH AFRICA

### I Introduction

The empirical results in Nell (1999) showed that the demand for real M3 money balances over the period 1965-1997 satisfies the theoretical propositions of a stable money demand function, while the demand for real M1 and M2 display instability features following financial reforms since 1980<sup>1</sup>. From a policy point of view a stable money demand function becomes more relevant when the parameter estimates entering the money demand function are relatively small<sup>2</sup> in order to depict a close relationship between money and money income and, more importantly, when the direction of causation runs from the money supply to money income, i.e. the money supply is exogenously determined.

In South Africa it has been argued that the Reserve Bank achieved more success over the period 1970-1979 (of direct monetary control measures) to moderate money supply and credit growth and hence maintain price stability, compared to the period 1980-1997 when monetary policy was based on a more market oriented approach (see Botha, 1997)<sup>3</sup>. An argument of this nature is somewhat premature and ignores the inflationary impact of cost-

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<sup>1</sup> According to Goodhart (1982), a suitable definition of money demand should clearly distinguish money from other assets. Such a distinction can be made by searching for a money demand definition that primarily reflects the role of money as a means of payment, which strongly favours an M1 definition. However, given the instability of M1 and M2 since 1980, M3 is the chosen money demand function.

<sup>2</sup> An income elasticity ranging between 0.5 and 1.0 or a little greater, and an interest rate elasticity between -0.1 and -0.5 (see Laidler, 1982).

<sup>3</sup> Direct control measures over the period 1970-1979 were mainly based on credit ceilings, cash reserve requirements, liquid asset reserve requirements and interest rate control measures. More market oriented monetary control measures since 1980 witnessed the abolition of bank credit control measures and deposit rate controls, and lower liquid asset and cash reserve requirements.

push and structural forces in the South African economy<sup>4</sup>. The fact that credit and the money supply grew at a slower rate over the period 1970-1979, does not validate any inferences on the exogenous/endogenous nature of South Africa's money supply or the success of direct monetary control measures. A casual overview of South Africa's inflationary experience over the period 1966-1997 suggests that cost-push forces of inflation were more persistent during the 1980s and 1990s. Thus, higher money supply and credit growth since the early 1980s could be attributed to structural and/or cost-push forces of inflation, with little or no connection between movements in the relevant monetary aggregates and the monetary control system being implemented at the time.

The main purpose of this paper is to determine whether inflation in South Africa has been caused by excessive monetary expansion over the period 1966-1997<sup>5</sup>, or whether the money supply has merely been passive in the inflationary process. An analysis of this nature is important for monetary policy since it provides some guidance in determining the long-run causes of inflation in South Africa.

Section II draws on Friedman and Schwartz's (1982) theoretical exposition to transform South Africa's stable M3 money demand function into a theory of money, income and prices. The analysis will emphasise why the magnitudes of the parameter estimates in the money demand function are important to establish a close link between the money supply and money income. Given the magnitude of the parameter estimates in the money demand function and conditional on the money supply being exogenous, section III estimates long-run price equations over the period 1966-1997. Inferences on the inflationary impact of money in this

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<sup>4</sup> See Moore and Smit (1986) and Kantor (1989) for a theoretical and empirical exposition of possible cost-push forces of inflation during the 1980s.

<sup>5</sup> The data are annual and obtained from the South African Reserve Bank's Quarterly Bulletin (various issues).

section are only valid if the money supply is exogenous. To determine the exogenous/endogenous nature of the money supply, section IV discusses the relevant econometric methodology and section V presents the empirical results. The empirical results in section V will also consider the exogenous/endogenous nature of the money supply when broad definitions of inflation are included in the regressions, given that the original M3 money demand function is deflated by consumer price inflation. Section VI presents non-nested test results to determine whether the conclusions reached on the exogenous/endogenous nature of the money supply for broad definitions of inflation, are superior to the results and conclusions obtained for a narrow definition of inflation. Section VII ends with some summary remarks and policy implications.

## II The Relation between Money, Income and Prices<sup>6</sup>

To derive a theory of money, income and prices, the stable M3 money demand function estimated in Nell (1999) can be replicated<sup>7</sup>:

$$Lm3/p = -9.17 + 1.32Ly - 0.05Dum_{85} \quad (1)$$

where the interest rate elasticity is insignificantly different from zero<sup>8</sup> and the income elasticity significantly different from one.

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<sup>6</sup> In addition to Friedman and Schwartz's (1982) theoretical exposition, see also Friedman (1971).

<sup>7</sup> Definition of variables:  $Lm3/p$  = log-level of M3 money balances deflated by the consumer price index;  $Ly$  = log-level of real income; and  $Dum_{85}$  is a dummy variable that signifies the debt standstill in 1985 and takes the value of one for the period 1985-1997 and zero otherwise.

<sup>8</sup> The  $t$ -statistic of -0.67 indicates that the interest rate elasticity is insignificantly different from zero. From an empirical point of view, an insignificant interest rate elasticity is not surprising given that, for a broad definition of money, the interest rate effect is largely

Since our main interest is a theory of inflation, we transform the variables in equation (1) into rates of change and obtain the following estimation result<sup>9</sup>

$$gm3/p = 1.26gy, \quad (2)$$

where the null hypothesis of a unitary income elasticity is not rejected.

Subtract  $gy$  from both sides of equation (2) and reverse signs. Since  $gV$  (rate of change of velocity) =  $gy - gm3/p$  (where  $gy$  is real income growth and  $gm3/p$  is the growth of demand for real money balances), then equation (2) can be written as:

$$gV = -0.26gy. \quad (3)$$

Replace  $gV$  by  $gY - gM$  where  $gY$  and  $gM$  are the rate of change of nominal income and nominal money respectively, and transfer  $gM$  to the right-hand side,

$$gY = gM - 0.26gy. \quad (4)$$

Equation (4) depicts a relationship between nominal income and the nominal money stock. More specifically from a monetarist point of view, an exogenous nominal money stock determines nominal income. A direct relationship is only observable if it is assumed that the coefficient estimate of  $gy$  (0.26) is close to zero, so that no large error can be made if it is dropped from the equation. Instead, Friedman and Schwartz (1982) prefer the following equation derived from equation (4),

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captured by movements between current and time deposits. From a theoretical viewpoint monetarists would argue that money is not a substitute for a small range of financial assets, but for a wider range of assets that include real and financial assets (Goodhart and Crockett, 1970).

<sup>9</sup> The rate of change equation (2) yielded a statistically insignificant intercept and dummy variable. The diagnostic tests for this equation together with tests for price homogeneity are discussed in section VI. The tests show that price homogeneity of degree one and a unitary income elasticity are not rejected by the data. It is noteworthy that the rate of change money demand function performs better than the level function where the null of a unitary income elasticity estimate was rejected at the 5% level of significance.

$$gY = \lambda gM + (1 - \alpha)gy \quad (5)$$

where  $\lambda$  is the parameter estimate of nominal income with respect to nominal money, and  $\alpha$  the parameter estimate of real income in the money demand function. If the parameter estimate of real income is set to one ( $\alpha=1$ ) in equation (5), then the rate of change of nominal income is solely determined by the rate of change of nominal money. Similarly, the relationship will be equiproportionate ( $\lambda=1$ ) only if the real income estimate in the money demand function is unity.

Figures 1-3 illustrate the relationship between the rate of change of nominal income and nominal money stock for the three different definitions of money in South Africa.

**[Figures 1-3 here]**

A close relationship between M1, M2 and money income is only observable before 1980, and accords with the close to unity income elasticities in the rate of change money demand equations of 0.84 and 1.13 for M1 and M2 respectively (see Nell, 1999)<sup>10</sup>. For the stable M3 money demand function the relationship between money and money income is fairly close over the whole period. Since the financial reforms in 1980, the high income elasticity estimates of 2.55 and 1.96 for M1 and M2 money demand respectively imply that the inflationary impact of increases in the rate of change of the M1 and M2 money stock were offset by an increase in the demand for money, so that the relationship between the relevant money stock and nominal income is less conspicuous compared to an M3 definition of money.

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<sup>10</sup> It is important to note that all the money demand functions were deflated by the consumer price index. The relation depicted between the money supply and money income, where money income is defined as nominal GDP, therefore assumes that consumer price inflation is closely related to inflation measured by the GDP deflator. We will return to this important issue in section V.

Thus, changes in the M1 and M2 money stock will not be reliable predictors of the inflation rate.

To derive a price equation consider the following identity:

$$gP = gY - gy, \quad (6)$$

where  $gP$  is the rate of change of prices,  $gY$  the rate of change of nominal income and  $gy$  the rate of change of real income. Substitute (5) into (6):

$$gP = \lambda gM - \alpha gy \quad (7)$$

If it is assumed that the money supply is exogenously determined, equation (7) reflects a positive relationship between the rate of change of prices and the nominal money stock. However, setting  $\alpha=1$  will not eliminate the real income (output) variable as was the case with equation (5). From an extreme monetarist point of view output (unemployment) is determined by real factors in the long-run, so that deviations from its natural rate will only be transitory (Friedman, 1970; Friedman, 1977).

From a monetarist perspective, equation (7) states that inflation will be equiproportional to the rate of change of the money stock if it is assumed that real output growth is constant over the long-run. If output growth does not vary, it means that the income elasticity of money demand remains constant, so that the inflationary impact of changes in the money supply are not offset by an increase in money holdings. When real output growth is allowed to vary, it becomes more important to determine whether the income elasticity in the money demand function is unity, since a variable output growth rate implies that a higher than unity elasticity estimate in the money demand function offsets some of the inflationary impact of money supply growth. Friedman and Schwartz (1982) do not actually estimate real income (output) directly in their price equations since they expect simultaneity problems between prices and real income. Equation (7) can therefore simply be rewritten as:



$$gP = \lambda gM \quad (8)$$

Separately they show that for the United Kingdom there is a negative relationship between prices and output. However, according to Friedman and Schwartz (1982) a negative long-run correlation between prices and output could be explained by statistical and economic reasons without invalidating the monetarist belief of money neutrality. The negative correlation can mainly be attributed to measurement errors, while adverse supply shocks could also account for the negative relationship<sup>11</sup>.

### III Long-run Price Equations

To avoid spurious regressions for the long-run price equations in (7) and (8), Table 1 reports standard Dickey Fuller (DF) and Augmented Dickey Fuller (ADF) test statistics. Test statistics based on Perron (1989, 1990) are also reported since we suspect that the inflation time series may contain a structural break following the oil price shock in 1973. If this is the case, standard DF and ADF tests may be biased by not rejecting the null hypothesis of a unit root. The third unit root test statistic reported is the non-parametric correction to the DF test proposed by Phillips and Perron (1988).

[Table 1 here]

The DF and ADF tests reject the null hypothesis of a unit root at the 5% level of significance for all the variables except the inflation variables. The Perron (1990) test rejects

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<sup>11</sup> Essentially, equation (7) reflects a theory of 'excess money' even though real output growth enters independently. To endogenise output we may write (7) as

$$gP = \lambda_1 egM \quad (7a)$$

where  $egM = gM - gy$ . A variable output growth rate will therefore absorb some of the inflationary impact of money supply growth. If output growth varies, then equation (8) is misspecified.

the null hypothesis of a unit root for consumer price inflation as well as the GDP deflator when a trend is included. When we conduct ADF tests (not reported here) over the period 1973-1997 for consumer price inflation and the GDP deflator, the ADF tests reject the null hypothesis of a unit root at the 5% level of significance. The rejection of a unit root for the two inflation series over this period, seems to confirm our prior belief that there is a structural break in the inflation series following the oil price shock in 1973.

The final test proposed by Phillips and Perron (1988) rejects the unit root hypothesis for the GDE deflator. Overall the unit root tests indicate that all the variables are  $I(0)$ , although some uncertainty exists about the exact order of integration of inflation measured by the GDE deflator.

All the estimations of the long-run price equations will be based on the Auto-Regressive Distributed Lag (ARDL) procedure proposed by Pesaran and Shin (1999), where the optimal the lag-length is chosen by the Akaike Information Criterion (AIC) and Schwartz Bayesian Criterion (SBC). According to Pesaran and Shin (1999), the ARDL procedure yields consistent estimates of the long-run coefficients irrespective of whether the underlying regressors are  $I(1)$  or  $I(0)$  (also see Pesaran, 1997).

Similar to the M3 money demand function, Table 2 reports parameter estimates when consumer price inflation is the dependent variable. All the long-run price equations are well-determined and the ARDL models pass all the diagnostic tests with ease. The first long-run price equation reflects an extreme monetarist version where real output growth is held to be constant and inflation is perceived to be solely determined by the rate of change in nominal money. From Table 2, the long-run parameter estimate in equation (8) shows that a one percent increase in the nominal money stock will lead to a 0.82 percent increase in the inflation rate. However, the Wald test shows that the null hypothesis of a unitary parameter estimate for nominal money is not rejected.

**[Table 2 here]**

On a more intuitive level, it seems unrealistic to regard real output growth as constant in a developing country like South Africa. Since the early 1970s the country has been suffering from severe unemployment, while the economy has historically been extremely vulnerable to external factors such as the dollar gold price and agricultural commodity prices. Real output growth therefore varies on a regular basis in reaction to technological development and external factors.

Although equation (7) essentially reflects the inflationary impact of ‘excess’ money, real output growth yielded an insignificant result when entered independently. This result strongly supports a monetarist theory of inflation, where inflation is perceived to be solely determined by the rate of change in the money supply. However, the result could be misleading and may merely indicate that real output growth does not exert an independent exogenous influence on inflation. For example, when real output growth enters the equation independently the insignificant result could capture a Phillips curve-type relationship subject to various structural breaks over the sample period. Thus, ‘excess money’ may still be an important explanatory variable, but only if we endogenise real output growth as in equation (7a) (see footnote 11). Relaxing the assumption that real output growth is constant over the long-run and assuming that the income elasticity in the money demand function is unity, Table 2 shows that the inflationary impact of ‘excess money’ ( $egM$ ) is almost equiproportionate. The corresponding Wald test statistic indicates that the null hypothesis of a unitary parameter estimate for ‘excess money’ is not rejected. Moreover, with the exception of the encompassing test, the non-nested tests<sup>12</sup> all show that we can reject equation (8) in favour of equation (7a) at the 5% level of significance, while we cannot reject equation (7a) in favour of

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<sup>12</sup> See Pesaran and Pesaran (1997, 359-370) for a description of all the non-nested tests.

equation (8). Two inferences can be drawn from the non-nested test results. First, that ‘excess’ money is the relevant variable despite an insignificant result when real output growth enters the equation independently. Second, that real output growth is not constant in South Africa and that equation (8) may be misspecified.

#### IV Econometric Methodology

In order to interpret equations (7a) and (8) econometrically, it is first necessary to establish whether money and ‘excess money’ are at the very least *weakly exogenous* to inflation<sup>13</sup>. Hendry and Ericsson (1991) base their approach on instrumental variable methods to show that inflation is super-exogenous<sup>14</sup> to money in a money demand equation. Given the super exogenous nature of prices for the United Kingdom over the period 1878 to 1970, they argue that it is invalid to invert the money demand equation conditional on money being exogenous.<sup>15,16,17</sup> The methodology and analytical approach followed in this paper will primarily be based on causality tests to determine the exogenous/endogenous nature of money in South Africa<sup>18</sup>.

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<sup>13</sup> A formal definition of *weak exogeneity* states that a variable  $y$  is said to be *weakly exogenous* for estimating a set of parameters ( $\lambda$ ), if inference on  $\lambda$  conditional on  $y$  involves no loss of information (see Charemza and Deadman, 1997; Maddala, 1988, p.328).

<sup>14</sup> Super exogeneity means that the variables used for instruments should not have been used in model design (Hendry and Ericsson, 1991, p.30).

<sup>15</sup> See Friedman and Schwartz (1991) for their reply.

<sup>16</sup> Applying the same methodology, Macdonald and Taylor (1992) reach the same conclusion for the United States over the period 1871-1975.

<sup>17</sup> See Brown (1983) for a descriptive evaluation of the Friedman and Schwartz (1982) analysis.

<sup>18</sup> One of the main criticisms levelled against the Friedman-Schwartz analysis was the absence of Granger-Sims causality tests (see Goodhart’s 1982 book review of *Monetary Trends in the United States and the United Kingdom*).

The most popular method employed over the years has been causality tests based on the standard Granger procedure, while more recently, Miller and Russek (1990) show how the standard Granger procedure can be incorporated into an error correction model (also see Miller, 1991). The main advantage of this procedure is that it not only detects causality through the standard Granger procedure, but also explores an additional channel through cointegration analysis (see Engle and Granger, 1987; Granger, 1988).

Tests for cointegration unequivocally support or repudiate the prior belief that the long-run movements of the relevant variables are related. So, if cointegration tests indicate that there exists a long-run relationship between two variables, causality must exist at least in one direction which is not always detectable if results are only based on standard Granger causality tests (Granger, 1988). Such causality can be detected if the error term in the error correction model is statistically significant. However, standard cointegration tests such as Engle and Granger's (1987) two-step procedure and the full information maximum likelihood systems procedure developed by Johansen and Juselius (1990), require variables to be  $I(1)$ .

Since all the variables in Table 1 are  $I(0)$ , standard cointegration tests are inappropriate to test whether there exists a long-run relationship between variables. Alternatively, causality tests can exclusively be based on the standard Granger procedure. The main drawback of this procedure is that it only detects short-run causality but fails to capture long-run causality effects (see Hall and Wickens, 1993). Standard Granger causality tests are only indicative whether one variable *precedes* another. Although it is useful as a descriptive device it says nothing about the exogenous status of a variable (Maddala, 1988; Urbain, 1992; Wu, 1983).

A useful alternative approach is the unrestricted error correction procedure developed by Pesaran *et al.* (1996) and discussed in Pesaran and Pesaran (1997). The main advantage of this procedure is that, irrespective of the order of the regressors, it is nevertheless possible to determine whether the variables are related over the long-run and at the same time to infer

which variables are the ‘long-run forcing’<sup>19</sup> variables in a given equation. It is therefore possible to draw valid inferences on the exogenous/endogenous nature of inflation measured by the GDE deflator, even though some uncertainty exists about the exact order of integration of this variable (see section III).

For example, the first step of this procedure involves estimating equation (7a) as a dynamic error correction model (i.e., the short-run part of the model),

$$\Delta gP = a_0 + \sum_{i=1}^n b_i \Delta gP_{t-i} + \sum_{i=1}^n c_i \Delta egM_{t-i} + \lambda U_{t-1} + \varepsilon_t, \quad (9)$$

where all the variables are defined as before;  $\varepsilon_t$  is the short-run random disturbance term and  $U_{t-1}$  is the lagged value of the long-run random disturbance term<sup>20</sup>. The parameter  $\lambda$  is the error correction coefficient. Thus far, equation (9) is almost similar to the causality procedure adopted in Miller and Russek (1990) if it is assumed that all the variables are I(1) and that cointegration tests reject the null hypothesis of no-cointegration. The  $U_{t-1}$  term then reflects the lagged values of the residuals obtained from the cointegrating vector. If the coefficient ( $\lambda$ ) of the error correction term ( $U_{t-1}$ ) is statistically significant and correctly signed, then it is an indication that the endogenous variable adjusts towards its long-run equilibrium value in reaction to changes in the exogenous variables. In many studies, causality through the error correction term is used as a test for *weak exogeneity*, since the error term shows how the short-run coefficients adjust towards their long-run equilibrium values (see e.g., Demetriades and

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<sup>19</sup> The term ‘long-run forcing’ implies that the tests indicate whether the variables are related over the long-run and, if the variables are related, which variables are the long-run exogenous variables.

<sup>20</sup> According to Pesaran and Pesaran (1997, p.309), due to the high levels of cross-sectional and temporal aggregations involved, it is not possible to know *a priori* whether  $egM$  is the ‘long-run forcing’ variable for  $gP$ , so the current values for  $\Delta egM$  are excluded from equation (9).

Hussein, 1996; Engle and Granger, 1987; Harris, 1995; Urbain, 1992). However, since the rate of change variables are  $I(0)$ , it is not possible to use standard cointegration tests to ascertain whether the variables are related over the long-run, and hence to determine whether a significant error correction term in equation (9) is indicative of adjustment in one variable towards its long-run equilibrium value.

Alternatively, the second step of the unrestricted error correction procedure is to replace the  $U_{t-1}$  term in equation (9) by the lagged levels of the variables (the long-run part of the model) to obtain a model that estimates the long-run and short-run parameters jointly (also see Mehra, 1991),

$$\Delta gP = a_0 + \sum_{i=1}^n b_i \Delta gP_{t-i} + \sum_{i=1}^n c_i \Delta egM_{t-i} + \delta_1 gP_{t-1} + \delta_2 egM_{t-1} + \varepsilon_t, \quad (10)$$

where  $H_0 : \delta_1 = \delta_2 = 0$

and  $H_a : \delta_1 \neq 0, \delta_2 \neq 0$

To test the  $H_0$  that the lagged levels of the variables are not jointly significant, the statistic is the standard F-test. However, since this statistic has a non-standard distribution the critical value bounds given in Pesaran and Pesaran (1997, p.484) are used. If the F-statistic rejects  $H_0$ , we can conclude that there exists a long-run relationship between  $gP$  and  $egM$  with  $egM$  as the ‘long-run forcing’ variable<sup>21</sup>. By treating each variable in equation (9) as the

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<sup>21</sup> The joint significance of the variables in lagged levels implies that the error correction coefficient ( $\delta_1$ ) shows that there is adjustment in the endogenous variable towards its long-run equilibrium value in reaction to changes in the exogenous variables. It is also possible to derive long-run parameter estimates directly from equation (10), by dividing  $\delta_2$  through by  $\delta_1$  (see Mehra, 1991, p.5).

dependent variable we can repeat the procedure and draw some inferences on the conditions necessary for efficient estimation.

## V Causality Tests

Table 3 reports the causality tests based on the unrestricted error correction procedure. The first set of tests for equations (8) and (7a) include consumer price inflation as the relevant inflation measure. The results show that the interpretation attached to the long-run price equation (8) in section II is invalid if we condition on money being exogenous. Consumer price inflation on the other hand determines an endogenous money supply, where the null hypothesis is rejected at the 1% level of significance. Money seems to have an exogenous element, but only when we use 'excess' money as the exogenous variable. The results for consumer price inflation essentially point to bi-directional causality between consumer price inflation and 'excess' money and further show that the econometric interpretation attached to equation (7a) in section III is valid. Moreover, the results also support the non-nested tests reported in section III which rejected equation (8) in favour of equation (7a).

**[Table 3 here]**

The most striking feature of the results in Table 3 is uni-directional causality from inflation to money and 'excess' money when broad measures of inflation are used. In contrast to the results for consumer price inflation, the results suggest that 'excess' money is completely endogenous to broad measures of inflation. It may be argued that the absence of long-run causality conditional on 'excess' money being exogenous could be the result of structural instability features over the period 1966-1997 rather than providing conclusive evidence that money is not exogenously determined. Table 4 provides structural stability tests for equation (7a) based on standard Chow tests, together with Wald test statistics to infer



whether the intercept and slope dummy variables are statistically significant for the potential breakpoints. In addition, the Akaike Information and Schwartz Bayesian selection criteria showed that an ARDL (1,0) version of equation (7a) is the correct specification for both measures of inflation. Nevertheless, the stability tests are all based on the static version of equation (7a) which we believe is more sensitive to the potential breakpoints compared to the dynamic model. In addition, stability tests on the static model allows us to test directly the stability of the long-run parameters.

**[Table 4 here]**

The null hypothesis of structural stability cannot be rejected for all the potential breakpoints except for the breakpoint in 1972<sup>22</sup>. However, the most important result for the GDE deflator is that the slope dummy is statistically insignificant while both the slope and intercept dummy variables are insignificant for the GDP deflator. On the evidence presented by the structural stability tests and the causality tests presented earlier, the conclusion can be reached that the absence of a long-run relationship between broad measures of inflation conditional on ‘excess’ money being exogenous is not the result of structural instability features, but simply because ‘excess’ money is not exogenous to broad measures of inflation.

The contradictory evidence presented on the endogenous/exogenous nature of ‘excess’ money for consumer price inflation and the two broad measures of inflation necessitates further evidence to determine which measure of inflation depicts the closest relation with the money supply, and hence whether the conclusions reached on the endogenous/exogenous nature of ‘excess’ money should be based on a broad or narrow definition of inflation.

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<sup>22</sup> Structural stability tests on the dynamic models could not reject the null hypothesis of structural stability for all the potential breakpoints including 1972.

## **VI Further Evidence on the Endogenous/Exogenous Nature of ‘Excess’ Money**

This section attempts to distinguish between three different money demand functions, where each money demand function is deflated by a different inflation measure. Once we have identified our statistically ‘superior’ money demand function, a theoretical transformation of the statistically ‘superior’ money demand function into a theory of money, income and prices (as discussed in section II), implies that the relation between the money supply and the inflation measure used in this particular money demand function, is closer compared to other measures of inflation. The interpretation of the exogenous/endogenous nature of ‘excess’ money based on the causality tests in the previous section will therefore depend on which money demand function is identified as being statistically ‘superior’.

For all the money demand functions in Table 5, the null hypotheses of price homogeneity of degree one and a unitary income elasticity are not rejected. It is therefore not possible to use these criteria to distinguish between the different money demand functions. Alternatively, the non-nested test statistics in Table 5 all reject model 1 against model 2 at the 1% significance level and none reject model 2 against model 1. In addition, all the non-nested test statistics reject model 2 in favour of model 3 at the 5% significance level and none reject model 3 in favour of model 2. The non-nested tests are unambiguous insofar as all the tests favour money demand functions which include broad measures of inflation. Moreover, the tests are also used to discriminate between the two broad measures of inflation, where all the tests favour the money demand function that includes the GDE deflator as against the GDP deflator. The visual displays in Figures 4-5 tend to support the main findings of the non-nested test results, where the relation between broad measures of inflation and ‘excess’ money in Figure 4 seems to be closer compared to the relationship between consumer price inflation and ‘excess’ money depicted in Figure 5.

**[Table 5 and Figures 4-5 here]**

Because the non-nested tests tend to favour money demand functions which include broad measures of inflation, a theoretical transformation of these money demand functions into a theory of money, income and prices, implies that more weight should be attached to the causality results (section V) when broad measures of inflation are used.

## **VII Conclusions and Policy Implications**

The main findings of this paper have shown that money and ‘excess’ money are endogenous to broad and narrow measures of inflation. The endogenous nature of money over the period 1966-1997 suggests that any long-run analysis of inflation in South Africa should search beyond the realms of the Central Bank alone, and focus on the potential inflationary impact of cost-push and/or structural forces of inflation. The rapid growth of monetary aggregates over the period 1980-1997 (see Botha, 1997) could therefore be the result of more persistent cost-push and/or structural forces of inflation without necessarily implying that monetary policy was more effective under direct control measures compared to a more market oriented approach over the period 1980-1997.

Although the causality results showed that ‘excess’ money is not only endogenous but also exogenous to consumer price inflation, the non-nested tests indicated that money demand functions which include broader measures of inflation perform better than the money demand function deflated by consumer price inflation. The non-nested test results therefore indicate that more weight should be attached to the economic interpretation of the causality tests for broad measures of inflation, where we have uni-directional causality from broad measures of inflation to ‘excess’ money.

It follows that the exogenous nature of ‘excess’ money to consumer price inflation need not necessarily be indicative of direct control by the monetary authorities, but could be the

result of a process where 'excess' money may come into existence even under an endogenously determined money supply<sup>23</sup>. Future research on South Africa could develop and extend the main findings of this paper by focusing on the direct control monetary authorities have on high powered money, in order to determine whether 'excess' money may come into existence under an endogenous money supply.

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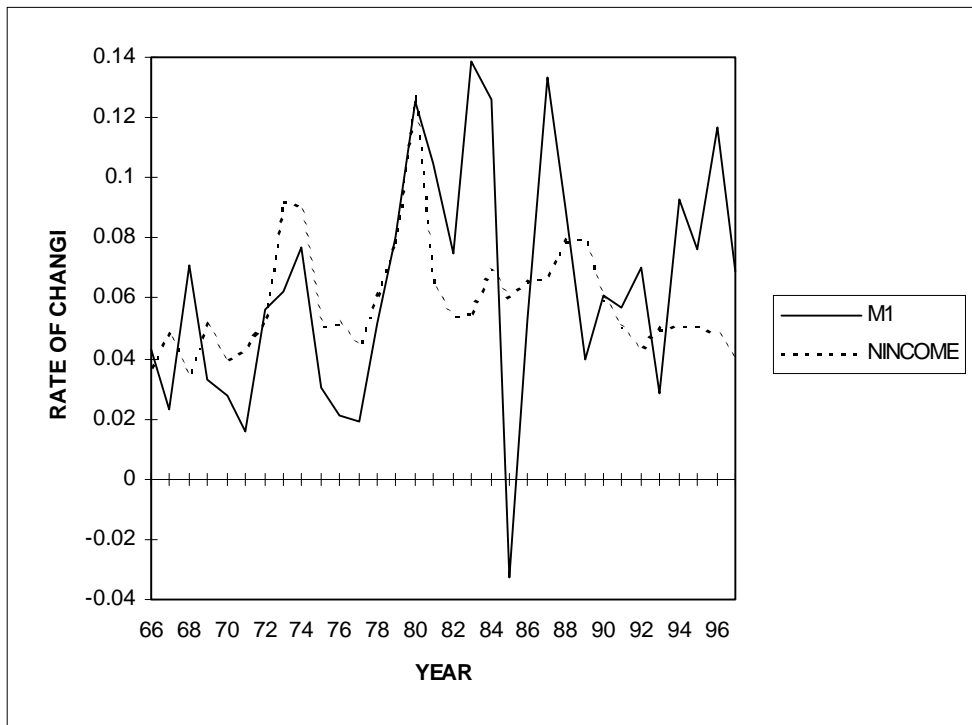
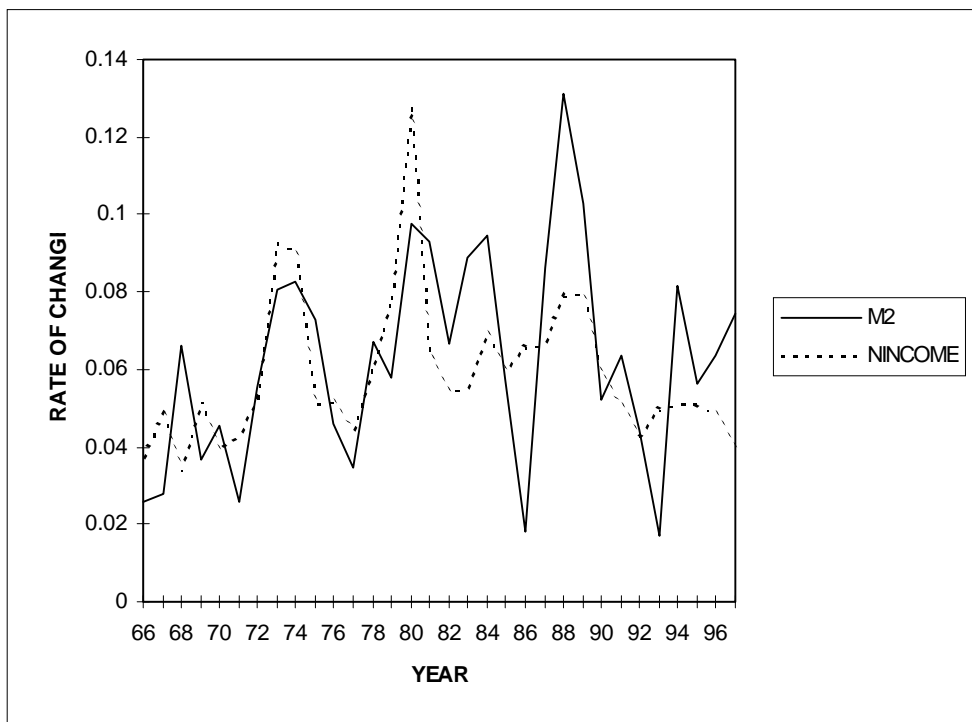
<sup>23</sup> For a comprehensive theoretical discussion of this process see Howells (1995, 1997) and for an empirical application, see Howells and Hussein (1998).

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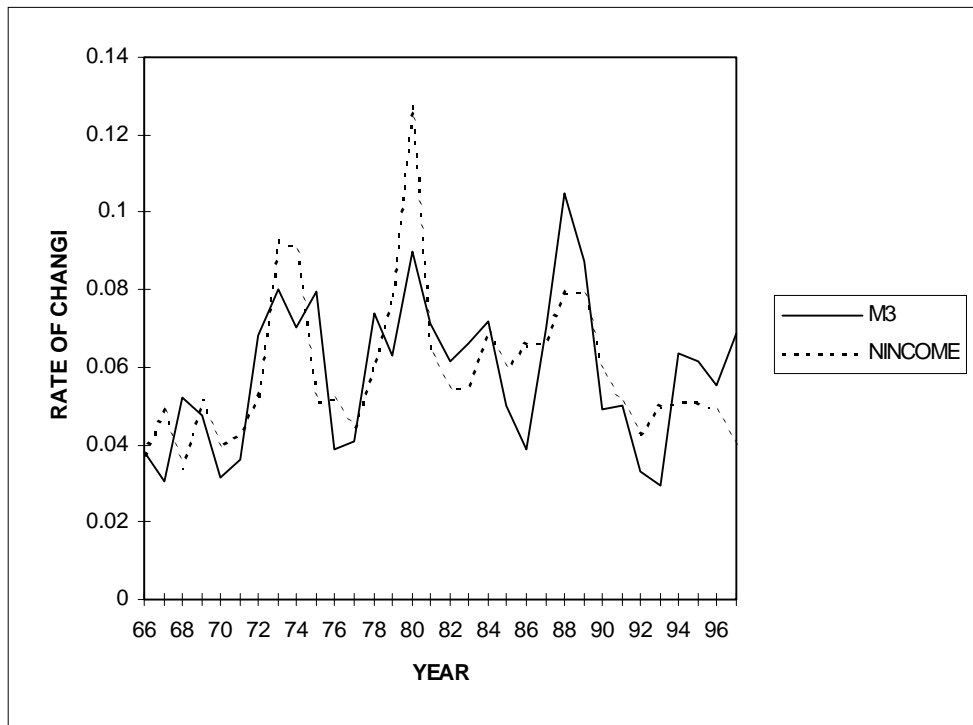
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**Figure 1****Rate of change of nominal M1 and nominal income, 1966-1997****Figure 2****Rate of change of nominal M2 and nominal income, 1966-1997**



**Figure 3**

**Rates of change of nominal M3 and nominal income, 1966-1997**



**Figure 4**

**The relation between 'excess' money and broad measures of inflation, 1966-1997**

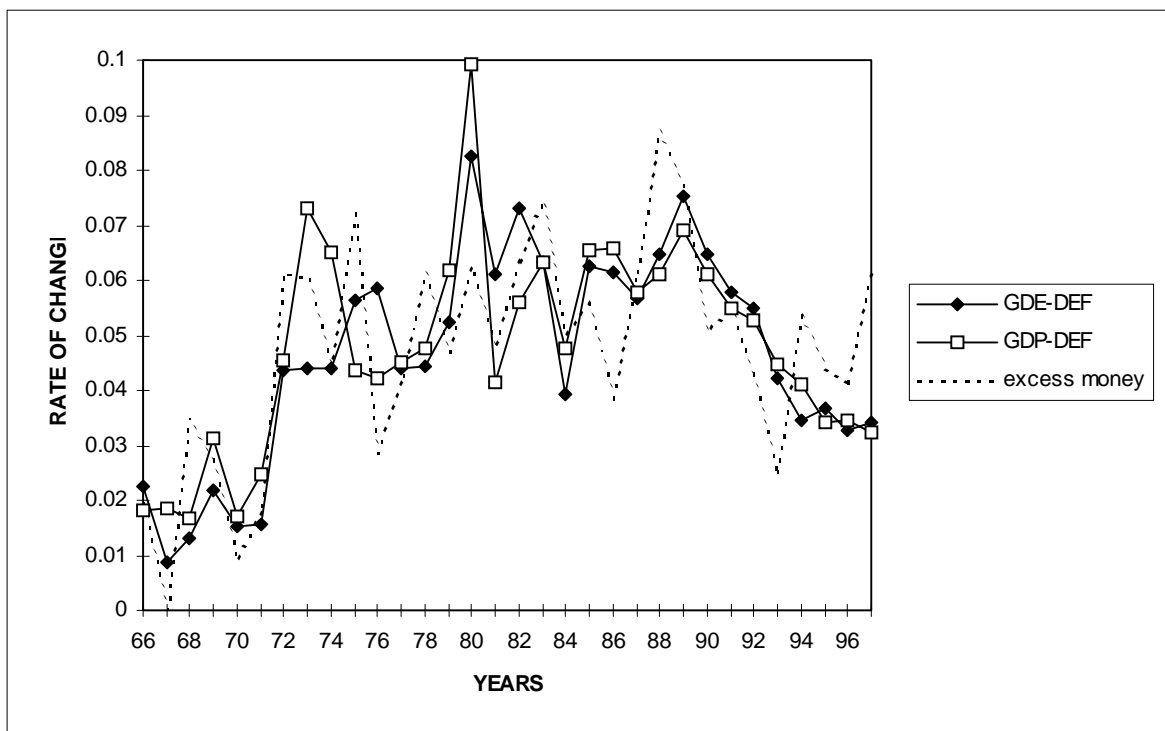


Figure 5

The relation between 'excess' money and consumer price inflation (cinfl), 1966-1997

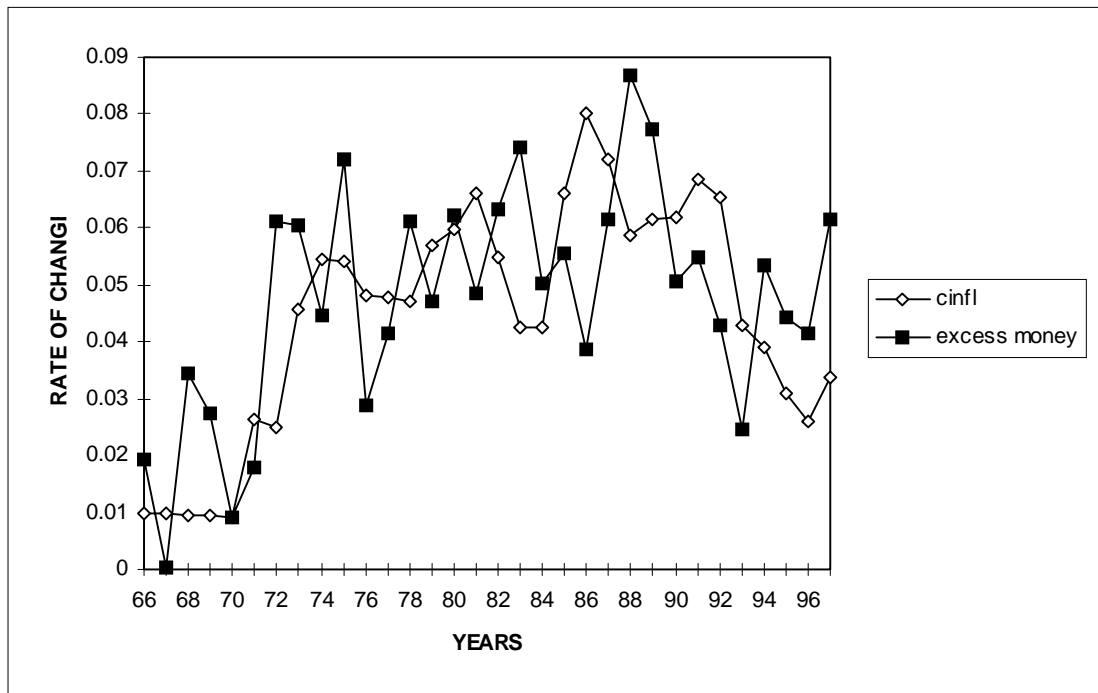


Table 1

## Unit root test statistics, 1966-1997

VARIABLES	DF-TEST	ADF-TEST	PERRON TEST (1989) NO TREND	PERRON TEST (1990) WITH TREND	PHILLIPS-PERRON TEST (1988)
$gP_{CPI}$	-1.79	-2.10	-3.77	-3.51*	-2.74
$gP_{GDP\ def}$	-2.90	-2.45	-3.18	-3.40*	-2.34
$gP_{GDE\ def}$	-2.21	-2.03	-2.18	-2.16	-2.97*
$gM$	-3.61*	-4.16*			
$gy$	-3.73*	-3.27*			
$egM$	-4.13*	-3.38*			

Notes:

- All the variables are in log-difference form, i.e. the first difference of the log-level variables.
- Definition of variables:
  - $gP_{CPI}$  = the inflation rate as measured by the consumer price index (CPI).
  - $gP_{GDP\ def}$  = the inflation rate as measured by the gross domestic product (GDP) deflator.
  - $gP_{GDE\ def}$  = the inflation rate as measured by the gross domestic expenditure (GDE) deflator.
  - $gM$  = the rate of change of the M3 money stock.
  - $gy$  = the rate of change of real income (output).
  - $egM$  = 'excess' money which is defined as  $gM - gy$ .
- \* denotes that the null hypothesis of a unit root is rejected at the 5% level of significance.

Table 2

## Long-run price equations, 1966-1997

VARIABLES	EQN 8 ARDL (1, 1)	EQN 8 LONG-RUN SOLUTION	EQN 7A ARDL (2, 2)	EQN 7A LONG-RUN SOLUTION
$gP_{CPI,t-1}$	0.79 (9.22)		0.95 (5.66)	
$gP_{CPI,t-2}$			-0.44 (-2.74)	
$gM$	-0.002 (-0.02)	0.82** (6.11)		
$gM_{t-1}$	0.17 (1.89)			
$egM$			0.12 (1.39)	0.98** (16.00)
$egM_{t-1}$			0.15 (1.62)	
$egM_{t-2}$			0.20 (2.18)	
<b>Diagnostic Tests</b>				
LM-test	$\chi^2(1) = 2.19$		$\chi^2(1) = 2.46$	
Ramsey's Reset	$\chi^2(1) = 0.47$		$\chi^2(1) = 0.00$	
Normality	$\chi^2(2) = 1.64$		$\chi^2(2) = 2.48$	
Heteroscedasticity	$\chi^2(1) = 0.03$		$\chi^2(1) = 0.49$	
<b>Wald Tests</b>				
Wald test $\chi^2(1): (\lambda = 1)$		1.59		
Wald test $\chi^2(1): (\lambda_1 = 1)$				0.07
<b>Non-Nested Tests</b>				
<b>Test statistic</b>	<b>EQN (8) versus EQN (7a)</b>		<b>EQN (7a) versus (8)</b>	
N-test	-5.71**		0.24	
NT-test	-2.39*		0.34	
W-test	-2.09*		0.35	
J-test	3.14**		-0.22	
Encompassing F(1, 29)	2.20		0.02	

Notes:

1.  $t$ -statistics in parentheses.
2. \*\* denotes significance at the 1% level and \* at the 5% level.

Table 3

Causality tests based on the unrestricted error correction model, 1966-1997

REGRESSION	F-TEST	CAUSALITY RESULTS
<i>With <math>gP_{CPI}</math> as the inflation variable</i>		
$gP$ on $gM$	4.46	$gP \Rightarrow gM$
$gM$ on $gP$	9.49**	
$gP$ on $egM$	6.99*	$gP \Leftrightarrow egM$
$egM$ on $gP$	9.02**	
<i>With <math>gP_{GDE\ def}</math> as the inflation variable</i>		
$gP$ on $gM$	4.10	$gP \Rightarrow gM$
$gM$ on $gP$	7.68**	
$gP$ on $egM$	2.83	$gP \Rightarrow egM$
$egM$ on $gP$	6.66*	
<i>With <math>gP_{GDP\ def}</math> as the inflation variable</i>		
$gP$ on $gM$	3.50	$gP \Rightarrow gM$
$gM$ on $gP$	9.82**	
$gP$ on $egM$	4.64	$gP \Rightarrow egM$
$egM$ on $gP$	7.19**	

Notes:

1. In all the regressions equation (9) is estimated as a first-differenced model of order one.
2. Similar results were obtained when a time variable was included in the unrestricted error correction model.
3. \*\* denotes significance at the 1% level and \* at the 5% level.

**Table 4****Structural stability tests, 1966-1997**

$gP_{GDP-DEF} = \alpha_0 + \alpha_1 DUM + \alpha_2 (DUM * egM) + \alpha_3 egM + \varepsilon_{1t} \quad (11)$							
$gP_{GDE-DEF} = \alpha_4 + \alpha_5 DUM + \alpha_6 (DUM * egM) + \alpha_7 egM + \varepsilon_{2t} \quad (12)$							
Breakpoint	Description	Chow test (eqn 11)	Chow test (eqn 12)	Wald test: ( $\alpha_1=0$ )	Wald test: ( $\alpha_2=0$ )	Wald test: ( $\alpha_5=0$ )	Wald test: ( $\alpha_6=0$ )
1972	Oil price shock.	3.36*	5.39*	2.59	0.05	4.44*	0.14
1979	Financial reforms.	0.68	2.26	0.97	0.47	1.32	0.16
1983	Market oriented exchange rate system.	1.08	0.89	1.97	2.16	1.78	1.65
1984	Debt standstill.	1.09	1.04	2.03	2.17	2.06	1.69

Notes:

1. *DUM* is the dummy variable and takes the value of one for the year after the breakpoint and zero otherwise.
2. \* denotes significance at the 5% level.

Table 5

## Non-nested test statistics

Money demand models deflated by different inflation measures		
MODEL 1:	$gM = 0.91gP_{CPI} + 1.40gy$	MODEL 1(a): $gM - gP_{CPI} = 1.26gy$
MODEL 2:	$gM = 0.95 gP_{GDP-DEF} + 0.96gy$	MODEL 2(a): $gM - gP_{GDP-DEF} = 0.88gy$
MODEL 3:	$gM = 0.94 gP_{GDE-DEF} + 1.22gy$	MODEL 3(a): $gM - gP_{GDE-DEF} = 1.13gy$
Non-nested tests of Model 1 and Model 2		
Test Statistic	Model 1 versus Model 2	Model 2 versus Model 1
N-test	-3.78**	-1.08
NT-test	-3.62**	-1.03
W-test	-2.76**	-0.94
J-test	3.04**	0.94
Encompassing F(1, 29)	9.24**	0.90
Non-nested tests of Model 2 and Model 3		
Test Statistic	Model 2 versus Model 3	Model 3 versus Model 2
N-test	-3.35**	-0.79
NT-test	-3.22**	-0.75
W-test	-2.54*	-0.71
J-test	2.77**	0.71
Encompassing F(1, 29)	7.70**	0.50

## Notes:

1. The AI and SB criteria selected an AR(1) process for models 1 and 2 and a static process for model 3. However, the results are very similar irrespective of whether we use a static or dynamic process. All the models are in their static versions.
2. All the money demand models are well-determined and pass diagnostic tests such as first and higher order serial correlation, functional form specification, normality and heteroscedasticity at the 5% significance level.
3. In models 1, 2 and 3 the null of price homogeneity is not rejected.
4. In models 1(a), 2(a) and 3(a) the null of a unitary income elasticity estimate is not rejected.
5. All the results in notes 2, 3 and 4 are available on request.
6. For a description of the non-nested test statistics see Pesaran and Pesaran (1997, 359-370).
7. \*\* denotes significance at the 1% level and \* at the 5% level.