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Econometric Analysis of Money, Price Expectations and Debt in the U.S.A. Economy

by

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Abstract:

This paper presents the empirical results of an econometric investigation of the demand and supply of real money with Livingston's price expectations and real Federal debt in the U.S.A. economy as a Vector Auto-Regressions System with subsequent 'Hendryfication'. This allows the study to focus on a partial equilibrium model of the money market that pinpoints the crucial variables of fiscal and monetary policies, specifically the debt (wealth creating instruments), the real monetary base, the relevant rates of interest as well as real income and expectations. The long and short run effects of these variables over the quarterly data, spanning from 1960 to 2007, are analysed. Clearly, this is a well-researched field, where others have published excellent work, although this investigation differs in its choice of variables, especially with the inclusion of price expectations to maintain stability of the system in real terms over the sample period. The idea is to explain the dynamics and mechanisms of adjustment, generally left unexplained by economic theory.

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Introduction

In general, economic theory does not dwell on the details of the interaction of crucial short and long run dynamics within the economy that influence the effects of fiscal and monetary policy instruments. The emphasis is on the long run, steady-state solutions, and less on the active path of adjustment resulting from Federal policies.

It is possible, however, with a combination of Vector auto-regressions (VARs) analysis[i], co-integration in the determination of long run relationships as well as employing the Hendry general-to-specific approach, to explain the short run dynamics of each of the variables that play a rôle in the field of money. In other words, the data-generating process is allowed to do the ‘talking’ within the econometric modelling methodology to reveal the long run processes and short run adjustment that directs the economy towards an equilibrium path of stability, the details of which are typically not explained by theorists. One of the major objectives of this paper is the combination of VARs analysis with Hendry’s methodology of econometric modelling. This approach removes the need for Granger’s causality tests with the aid of the F-statistic as a method for simplifying the empirical model (Granger, 1969). This overcomes some of the criticisms made of the VARs system in the form of ‘over fitting’[ii]. In fact, it is clear that the forces of change ‘come to life’ when examining the observations, because they embody the actions of the various agents that inter-act in the course of correction and adjustment to equilibrium. With this theme in mind, the intention of the empirical analysis is to replicate the forces acting in the money markets with expectations that inter-relate with the Federal decision-makers of fiscal and monetary policies.

The plan of the paper is to state and discuss the theoretical expressions of money demand and supply as well as real Federal debt with price expectations for stability because of the extreme effects of inflation during the 1970s and 1970s triggered by the oil shocks leading to instability. Unpredictability complicates the task of monetary policy. Other authors such as Ericisson, Hendry and Prestwich (1988) attributed it to technological innovations, financial regulations and changing definition of the money supply from 1974 onwards[1]. Money supply at one level links the monetary base with the short run rate of interest; at another level, it relates monetary policy to Federal government debt, which is an outcome of fiscal policy. Other economists suggest the movement away

[1] Empirical work undertaken by Friedman and Schwartz (1963) had shown a stable demand for money relationship before 1975 despite two World Wars.

from fixed exchange rates in the early 1970s was the cause of the problem. In fact, the problem of instability highlighted led to considerable research to explain the difficulty through improvements in econometric techniques such as the development of error correction models with co-integration (Bain and Howells, 2009). Given these techniques, the empirical investigation will evaluate a system of equations, which builds on such work as Schmidt (2007) with a major rôle for expectations to aid stability. The final part of the article discusses the contribution of each of the variables in terms of their short and long-term dynamic rôles in the system with stability.

The Theoretical Picture

The objective of this section of the paper is to identify the theoretical equations that encapsulate the variables of interest for the empirical investigation. First, there is the money demand, where the three motives for holding money in Keynes' *General Theory* (1936) imply a positive relationship to real income (Y) and an inverse relation to the long-term rate of interest (i_l). This links with money's 'own rate' (i_o), denoting a direct return on money holdings. A positive function comes from short run rate of interest (i_s), , which is a key instrument of policy through the money market. The added ingredient is the positive effect of inflationary expectations $(\hat{p})$ because expected inflation erodes future purchasing power and increases the real demand for money. The long run equilibrium equation that utilises these notions in log form is as follows[2]:

$$m^d - p = a + b\,y - c\,i_l - d\,i_o + e\,i_s + f\,\hat{p}, \text{ where } a, b, c, \text{d}, e, \text{ and f are } \rangle\, 0. \qquad [1]$$

In theory, this format of [1] is equalised with the real supply of money at the long run equilibrium position, denoted by the following log expression:

$$m^S - p = g + mm\,(h - p) - j\,i_l + k\,i_s + l\,\hat{p}, \text{ where } g, mm, j, k \text{ and } l \text{ are } \rangle\, 0. \qquad [2]$$

where mm equals the money multiplier, $(h-p)$, denotes the log of real supply of high-powered money (or the real monetary base) within the system. This interlinks with i_l representing the negative function of the long term interest rate with its coefficient of j whereas i_S denotes the short run rate of interest with a positive coefficient

[2] The interest rates included in this study are in the format of $\ln(1+i) \approx i.$

of k, partly determined by the direction of monetary instruments, dictated by fiscal decision-makers in the light of the positive coefficient of l on the expected rate of inflation $(\hat{p})$.[iii]

In fact, a change in real high-powered money may well be induced by the government borrowing requirement, which arises in the form of the monetary base to pay for some (or all) of the excess government expenditure, G over taxes, $t.Y$ by selling bonds to the Federal Reserve Banks to offset the negative effects on the cost of lending. This is like the Government writing a cheque on itself when the Federal authorities lend to the Government by buying its bonds [iv] $(P_B \Delta B_f)$, where P_B denotes the price and ΔB_f equals the number of government bonds purchased and held by the central bank authorities. In other words, it pays for the real debt by giving the Government a cheque on the Central Bank, explicitly creating high-powered money within the private sector along with the real supply of money. In real terms, this is denoted by $\partial(h-p) = \beta(G - t\,y)$, namely that part of the debt that may well be representing an alternation in the physical monetary base level. This arises from the Federal action to monetize part of the real debt, and therefore, to offset the long run consequences of an upward movement in the interest rate, i_l representing the 'negative' effects of crowding-out on investment and consumption expenditure.

When the budget is in deficit, the National debt increases and creates instruments of wealth, and as a result, the stock of claims against the Government enlarges. The difficulty, however, is that this represents part of the debt management, which is not only concerned with financing the current budget shortfall but also affects how previous deficits are held. In fact, the accumulation of previous budget deficits form the Federal debt, representing the total claims against the Federal government, and for that reason, corresponds to the total private sector's holding of relevant bonds, which represent wealth generating instruments. In the context of this study, the total real debt held by the public corresponds to the real national debt of the Federal Government and hence, another source of real wealth.

The real wealth variable above in log form $(wl - p)$ is essentially the holding of government bonds (or debt) by the public, which represents an alternative to money that is interest-bearing assets within their portfolio choice, in the face of a negative, expected rate of inflation. In fact, the analysis of the speculative demand for money by Tobin (1958) reveals the importance of the level of real wealth (or debt), which can be formulated in log form as[v]:

$$wl - p = z + m\, y + n\, i_l - v\, i_s + w\, i_o - x\, \hat{p}, \text{ with } z, m, n, v, w \text{ and } x \rangle 0. \quad [3]$$

In the short run, there may be downward pressure on short term interest rate in expression [3] with respect to real wealth because of the monetizing of part of the debt that expands the money supply to offset the crowding-out effect on income, although the pressure on long run rate is clearly upward with money's 'own rate'. These theoretical, long run equilibrium expressions are the focus of attention in the following empirical analysis. They indicate a mix of fiscal and monetary instruments to offset the depressing effects of crowding-out, and consequently, lead to a positive stimulus on real income *via* lower short-term rate of interest that manifests from the manipulation of the real monetary base (or high-powered money) in the midst of inflationary expectations.

Empirical Analysis

The first step is to choose various data variables to relate to those identified by the previous, theoretical discussion. The real money demand/supply variable is denoted by $m - p$, measured by taking the logarithm of the definition of M2 (m) minus the logarithm of the Consumer Price Index (p). Furthermore, the investigation employed a number of interest rates to capture the trade-off and opportunity cost of holding money along with the M2 'own rate', that is

i_s equals short term rate of interest, based on three-month Treasury Bill rate,

i_l represents long term rate of interest, derived from thirty- year Treasury Bill rate[vi],

i_o denotes the M2 'own rate' of interest.

The format of $\ln(1+i) \approx i$ was imposed on the raw data.

In the case of real high-powered money[vii] this was derived as the log of the monetary base, (h), minus the log of the Consumer Price Index, (p), $(h - p)$. The real wealth (or debt) variable, $wl - p$, was measured by taking the log of the total government debt held by the public (wl) minus the log of the Consumer Price Index (p). Real income (y) is the log of real gross domestic income. In the case of Inflationary Expectations, the estimation is in log form $(\hat{p})$, derived from the Livingston Survey of the direction of the Consumer Price Index over the six months. The detailed estimation of the expectations series is in Bywaters and Thomas, 2009, based on data from the website of the Federal Reserve Bank of Philadelphia. All the other raw observations collected are seasonally adjusted before inclusion into the econometric study, apart from the rates of interest variables. The Source was the 'Fred' database of the Federal Reserve Bank of St. Louis.

The decision to use real versions of monetary and debt variables was tested individually within a single co-integrating vector, although it was not in the case of the rates of interest. This is to adopt the "real-balance effect" of Patinkin's analysis (1965). Furthermore, the study found, using the Dickey-Fuller statistics that all the variables were stationary on first-difference, although it should be pointed out that the expectations series is the future change in the Consumer Price Index, which is being treated as a level within the co-integrating vectors, which represent the undertaking of the long run, theoretical equations in the empirical picture.

The 'list' of variables mentioned above could be expressed in the general matrix format (Davidson, 2000) as

$$\Delta Z_t = V + B_1 \Delta Z_{t-1} + B Z_{t-1} + B_2 \Delta Z_{t-2} + ... + B_K \Delta Z_{t-k} + \phi d_t + \varepsilon_t ,$$

or

$$\Delta Z_t = V + B_1 \Delta Z_{t-1} + \alpha \beta' Z_{t-1} + B_2 \Delta Z_{t-2} + ... + B_K \Delta Z_{t-k} + \phi d_t + \varepsilon_t . \qquad [4]$$

where $Z_t = \left[(m-p), i_s, i_l, i_o, (h-p), (wl-p), y \text{ and } \hat{p} \right]$ which are the explanatory variables; d_t represents a vector of non-stochastic variables such as dummies, but not the intercept, which can be included separately as V, or within the co-integrating vector Z_{t-1}.

The next stage in the development of a system of equations was to investigate the possible number of co-integrating vectors (or error-correction mechanisms) existing between the variables of interest in $\alpha \beta' Z_{t-1}$. The 'own rate' of M2, the Treasury's short and long run rates of interest along with the real income and expectations variables are made exogenous in the process of calculation. Interest rates are determined by term structure whereas the augmented aggregate supply and the goods market determine expected inflation and output, which are outside of the analysis. Furthermore, the number of different co-integrating vectors can be derived by examining the significance of the characteristic roots. It is known that the rank of a matrix is equal to the number of relevant characteristic roots. The tests for the total number of characteristic roots that are significantly different from one can be performed by employing the maximum $(\lambda_{\max})$ and trace (λ_{trace}) statistics, which are reported in Table [1] and Table [2] overleaf:

Table [1]: Co-integration with restricted intercepts and no trends in the VAR
Co-integration LR Test Based on Maximal Eigen-value of the Stochastic Matrix
****

192 observations from 1960Q1 to 2007Q4. Order of VAR=4

List of variables included in the co-integrating vector:

$m-p \quad i_o \quad i_s \quad i_l \quad h-p \quad wl-p \quad y \quad \hat{p}$ Intercept

List of Exogenous Variables:

$i_o \quad i_s \quad i_l \quad y \quad \hat{p}$

List of eigen-values in descending order:

0.23265 0.20146 0.13149

****

Null	Alternative	Statistic	95% Critical Value	90% Critical Value
$r=0$	$r=1$	50.8442	37.1900	34.5600
$r\langle=1$	$r=2$	43.1938	30.5000	27.8700
$r\langle=2$	$r=3$	27.0681	23.0200	20.5700

****

Table [2]: Co-integration with restricted intercepts and no trends in the VAR
Co-integration LR Test Based on Trace of the Stochastic Matrix
****

192 observations from 1960Q1 to 2007Q4. Order of VAR=4

List of variables included in the co-integrating vector:

$m-p \quad i_o \quad i_s \quad i_l \quad h-p \quad wl-p \quad y \quad \hat{p}$ Intercept

List of Exogenous Variables:

$i_o \quad i_s \quad i_l \quad y \quad \hat{p}$

List of eigen-values in descending order:

0.23265 0.2146 0.13149

****

Null	Alternative	Statistic	95% Critical Value	90% Critical Value
$r=0$	$r\rangle=1$	121.1061	69.7200	65.6900
$r\langle=1$	$r\rangle=2$	70.2619	44.5600	41.3300
$r\langle=2$	$r=3$	27.0681	23.0200	20.5700

****

The results of the maximum $(\lambda_{\max})$ and trace (λ_{trace}) statistics give the same result, although the $(\lambda_{\max})$ test has the sharper alternative hypothesis, and therefore, gives the preferred statistic when trying to 'unearth' the number of co-integrating vectors (Enders, 2010). The calculation of model selecting criteria, that is the Akaike Information and the Hannan–Quinn statistics, confirm the result of $r=3$. A number of combinations between one and three, however, were experimented with, although the latter led to more accommodating (or parsimonious) restrictions than the former, as outlined in Table [3] overleaf. The limits imposed were tested using the t-statistics and the Log-Likelihood ratio statistic, which is distributed chi-square, at each stage, to discover the exact restrictions on the number of co-integrating vectors, and hence, the prevailing content in terms of the make-up of the various variables of interest.

The empirical results from the estimation of the co-integrating vectors in Table [3] below identify the theoretical parameters of the long run equilibrium equations revealed in [1], [2] and [3]. The first two co-integrating vectors are deliberately estimated as real money demand and supply functions to facilitate the application of theoretical considerations to the imposition of identification restrictions. The third is a demand function for real Federal government debt. The parameters of interest that make up the partial equilibrium model seem to have the correct signs on theoretical grounds. The sole proviso is that the constant that corresponds to the drift term in equation [3] went to zero on statistical grounds and seems to be playing no significant function in the co-integrating vector of e3.

Table [3]: ML estimates subject to over identifying Restrictions
Estimates of Restricted Co-integrating Relations (Standard errors in brackets)

192 observations from 1960Q4 to 2007Q4. Order of VAR=4, chosen $r = 3$

List of variables included in the co-integrating vectors: $m-p$ i_s i_l i_o $h-p$ $wl-p$ y $\hat{p}$

		Vector 1 (e1)		Vector 2 (e2)		Vector 3 (e3)
$m-p$	a1	1.0000 (None)	b1	1.0000 (None)	c1	0.0000 (None)
i_s	a2	−7.7479 (2.7618)	b2	−7.6334 (2.5303)	c2	25.6335 (6.5552)
i_l	a3	12.2246 (4.3062)	b3	12.2103 (4.1635)	c3	−18.8602 (9.1321)
i_o	a4	3.8087 (1.1070)	b4	0.0000 (None)	c4	−23.1045 (4.3611)
$h-p$	a5	0.0000 (None)	b5	−0.80163 (0.023845)	c5	0.0000 (None)
$wl-p$	a6	0.0000 (None)	b6	0.0000 (None)	c6	1.0000 (None)
y	a7	−0.62925 (0.016488)	b7	0.0000 (None)	c7	−1.1679 (0.022328)
$\hat{P}$	a8	−15.6058 (6.3125)	b8	−18.4179 (6.0704)	c8	50.8047 (13.5591)
Intercept	a9	2.2250 (0.12940)	b9	−2.4233 (0.085154)	c9	0.0000 (None)

Total number of restrictions (11) – number of just-identifying restrictions (9)

The next part of the procedure is to move from the money demand and supply functions to derive possible solutions for real M2, real high-powered money, and real Federal government debt in a simultaneous equation system by taking linear combinations with algebra of the three estimated vectors in Table [3]. This is done by vector space column operations, either multiplying a vector by a factor κ or by adding (or subtracting) another one. This practice is analogous to changing co-ordinates in geometry, leaving the basic structure unchanged. The solution for the above subset of 'focus' variables: $m-p$, $h-p$ and wl - p chosen on theoretical grounds as relatively endogenous, is shown in Table [4] overleaf.

These variables previously are set equal to zero in the three vectors except in the case of the normalization, chosen to be minus one so that the other coefficients have the theoretically familiar sign. For instance, in the first case, the real M2, $m-p$ in Vector one is the normalised variable with the other 'focus' variables set equal to zero; the second case, real high powered money, $h-p$ in Vector two is normalised, with $m-p$ and $wl-p$ put to zero. The procedure continues until the end-variable of real government debt, $wl-p$ with $m-p$ and $h-p$ equalling zero. The calculated coefficients in Table [4] overleaf can then be directly compared with theory because the normalizations are in terms of minus one.

Table [4]: Possible Solutions to the Simultaneous System

	Vector e1	Vector e2	Vector e3
$m-p$	-1.0000	0.0000	0.0000
i_s	7.7479	0.1428	-25.6335
i_l	-12.2246	-0.01783	18.8602
i_o	-3.8087	-4.75193	23.1045
$h-p$	0.0000	-1.0000	0.0000
$wl-p$	0.0000	0.0000	-1.0000
y	0.62925	0.7850	1.1679
$\hat{P}$	15.6058	-3.50798	-50.8047
Intercept	-2.2250	-5.79856	0.0000

The interesting feature to emerge from the analysis is that a number of coefficients approach the value of one on output, which are highlighted in Table [4]. This suggests that real income (or output) is the leading variable, determined by exogenous agents within the goods market of the economy, which confirms the assumption made in the calculation of Table [3].

Even though there are three co-integrating vectors with two normalizations on the same data set that represent the real demand and supply of money at the long term equilibrium position, subsequent modelling focuses on real money, monetary base and debt in order to capture the long run solutions along with the short run dynamics. Thus, only one equation is required to embody both sets of variables that represent real money demand and supply. In fact, at this stage, the empirical analysis adopts a general form that includes a fourth-lag structure of changes on the variables of interest with the error correction mechanisms including various dummy variables to meet the critical values of the diagnostic tests for a 'sound' statistical model. The next step is the process of 'Hendryfication' of the general models, which is a process of imposing restrictions to remove insignificant variables *via* the t-statistics over the period of 1960 Q1 to 2007 Q4. Furthermore, this 'Hendryfication' of the estimated co-integration vectors with the short run dynamics exposes the dynamic stability and replaces the need to calculate impulse functions. This process led to one of the following restricted models that represent the short run dynamics with the long-term solutions for the real demand and supply of money overleaf:

$$\Delta(m-p)_t = \underset{(0.10461)}{-0.41216}\ \Delta i_{l,t-1} \underset{(0.51613)}{-1.8957}\ \Delta\hat{p}_{t-1} \underset{(0.25198)}{+0.76544}\ \Delta i_{o,t-2} \underset{(0.11778)}{-0.31468}\ \Delta i_{s,t-2} \underset{(0.054540)}{+0.11998}\ \Delta(wl-p)_{t-2}$$

$$\underset{(0.054746)}{+0.17292}\ \Delta(wl-p)_{t-3} \underset{(0.0071631)}{-0.090539}\ e2_{t-1} \underset{(0.0028540)}{-0.046531}\ e3_{t-1} \underset{(0.0074582)}{+0.032335}\ D831 + \varepsilon_t, \qquad [5]$$

$R^2 = 0.66256$, $\bar{R}^2 = 0.64781$, $\hat{S} = 0.0067350$, DW=1.8419, Log L=692.2561, T=192, where $D831$ is a dummy variable for the observations 1983 Q1, set to plus one, otherwise all zeros. The standard errors of the coefficients are in brackets. The diagnostic statistics are shown in the table [5] below.

Table [5]: The Diagnostic Statistics for Expression [5]

Test Statistics	LM Version
A: Auto-correlation	$\chi^2(4) = 2.8316$ [0.586]
B: Functional Form	$\chi^2(1) = 0.32777$ [0.567]
C: Normality	$\chi^2(2) = 0.85227$ [0.653]
D: Heteroskedasticity	$\chi^2(1) = 1.0376$ [0.308]

A: Lagrange multiplier test of residual Auto-correlation,
B: Ramsey's RESET test using the square of the fitted observations,
C: Based on a test of Skewness and Kurtosis of residuals,
D: Based on the regression of squared residuals on squared fitted values.

The empirical model embodied in [5] encapsulates the short run dynamics of the real demand and supply of money with the rates of interest in the first instance. There is a positive value on the 'own rate', but negative ones on the short and long term rates of interest. The expectations find their way through with a negative contribution. Furthermore, two long run solutions, that is, the error correction terms, figure significantly in the empirical model, namely $e2$ and $e3$. The next component part of the 'puzzle' is the variable that represents the growth in real wealth (or debt)[3].

[3] The difficulty is that the short-run dynamics are not explained by economic theory, and therefore, there is no guidance on their interpretation. Thus, the structural parameters of the long-run equations are used as a proxy of the direction.

The restricted representation overleaf shows the determinants that 'drive' the growth in real wealth, emanating from a general form that evolves out of the system that exemplify the short term dynamics as well as the long run solutions, that is

$$\begin{aligned}\Delta(w-p)_t = & -\underset{(0.15044)}{0.34014}\Delta i_{o,t-1} - \underset{(0.78542)}{3.5790}\Delta \hat{p}_{t-1} - \underset{(0.056815)}{0.19406}\Delta(h-p)_{t-2} + \underset{(0.0666044)}{0.30207}\Delta(w-p)_{t-2} + \underset{(0.84441)}{2.6830}\Delta \hat{p}_{t-2} \\ & - \underset{(0.060506)}{0.17575}\Delta(m-p)_{t-3} + \underset{(0.060333)}{0.16892}\Delta(w-p)_{t-2} - \underset{(0.069029)}{0.28058}\Delta i_{s,t-6} - \underset{(0.072487)}{0.23460}\Delta y_{t-3} \\ & - \underset{(0.0019677)}{0.017004}\, e3_{t-1} + \varepsilon_{t,}\end{aligned} \qquad [6]$$

$R^2 = 0.68375$, $\overline{R}^2 = 0.66811$, $S = 0.0080929$, DW=2.0703, Log L=657.5181, T=192. The diagnostic statistics are in table [6] below.

Table [6]: The Diagnostic Statistics for Expression [6]

Test Statistics	LM Version
A: Auto-correlation	$\chi^2(4) = 4.9129$ [0.296]
B: Functional Form	$\chi^2(1) = 0.79760$ [0.372]
C: Normality	$\chi^2(2) = 0.38701$ [0.824]
D: Heteroskedasticity	$\chi^2(1) = 2.0552$ [0.152]

Expression [6] indicates a 'mix' of monetary variables that are manipulated by the monetary authorities to keep real income along the positive, long run path, embodied in the error corrections to offset the crowding-out effect from fiscal policy financing. Once again, distinguishing features are the significant contributions made by the various rates of interest. In the case of the 'own rate', its contribution is a negative effect as also is the three-month rate. The value on high-powered money is also negative, which reflects the case of debt sold to the Federal Reserve, leading to an increase in the real monetary base, but effectively reducing the burden of the debt, that is the monetizing of the debt to offset the depressing effects of crowding-out *via* the term structure of interest rates. The expectations have a diverse contribution coming through the short run dynamics, with negative and positive effects. Finally, the error-correction term, $e3$, is performing significant rôle in explaining the rate of growth in real wealth with variables of itself.

The final equation considered is the growth rate of the real monetary base, outlined below.

$$\Delta(h-p)_t = -0.28346\,\Delta i_{o,t-1} + 0.14350\Delta(h-p)_{t-1} - 0.11160\,\Delta y_{t-1} + 0.14227\Delta(h-p)_{t-2} - 0.22602\,\Delta i_{o,t-3}$$
$$\qquad (0.12913) \quad (0.046517) \quad (0.055536) \quad (0.042776) \quad (0.10522)$$

$$- 0.14570\, e1_{t-1} + 0.095323\, e2_{t-1} - 0.028464\, e3_{t-1} + 0.067111\, D9920 + 0.033766\, D0134 + \varepsilon_t, \qquad [7]$$
$$\qquad (0.026014) \quad (0.019904) \quad (0.0039792) \quad (0.0046474) \quad (0.0045238)$$

$R^2 = 0.75906$, $\bar{R}^2 = 0.74715$, $\hat{S} = 0.0061116$, DW=2.0662, Log L=711.4317, T=192, where $D9920$ and $D0134$ are dummy variables for the observations 1999 Q4 and 2000 Q1, 2001 Q3 and 2001 Q4, set to +1 and -1 respectively, otherwise all zeros. The diagnostic statistics are shown in the table [6] below.

Table [7]: the Diagnostic Statistics for Expression [7]

Test Statistics	LM Version
A: Auto-correlation	$\chi^2(4) = 4.5004$ [0.342]
B: Functional Form	$\chi^2(1) = 0.0062413$ [0.937]
C: Normality	$\chi^2(2) = 3.6413$ [0.162]
D: Heteroskedasticity	$\chi^2(1) = 0.11880$ [0.738]

Both the 'own rates' of interest in [7] exhibit negative contributions. The lagged values of the real base of itself are positive, although the change in real income is negative, meaning that if output grows, then the growth in the real monetary base is a contraction. Furthermore, all three error correction terms are present with negative and positive values, although $e1$ is the largest number.

Moreover, the estimated co-integration vectors and the 'Hendryfication' results show evidence of dynamic stability in all three cases. In fact, it is the sign of the normalised (or real monetary base) variable within the co-integrating vector, in conjunction with the opposite sign that appears on the corresponding error correction in the relevant Hendry equation, that means stability. For instance, in the case of the real monetary base equation of [6], high-powered money is present within e2 with a negative value, but with an overall positive sign in the 'Hendryfication' expression, and therefore, the two opposites mean convergence back to equilibrium. The presence of e1 and e3, however, does not matter concerning stability because the real monetary base is absent from those vectors. The argument for real money is that the plus in e2 is opposite in sign to the negative coefficient on e2 within the 'Hendryfication'. With real debt, the positive normalisation in e3 is opposite in sign to the negative coefficient on it in the Hendry equation.

Conclusions

This empirical study analyses not only the long run responses, but also shows the short run dynamics usually ignored by economic theory, uncovered by the application of 'Hendryfication' in a co-integrated system of equations, explaining real money, Federal debt and the monetary base from output, expected inflation and various interest rates. In the long run, a positive effect on real income and not the expected crowding-out phenomena arises from the use of fiscal policy. This is removed by the 'active' monetary policy that partly monetizes the Federal debt, and therefore leads to this auspicious outcome.

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Endnotes

[i] For an overview of the VARs analysis, see Juselius (2006).

[ii] See Maddala and In-Moo Kim (2003) for an outline of the criticisms.

[iii] Given the large theoretical discussion as well as the empirical evidence reported by Grauwe and Polan (2005), Morana and Bagliano (2007) on inflation, it was decided to include inflationary expectations into the 'picture' for stability. For an overview, see Chapter eight in Bårdsen et al. (2005).

[iv] The number of bonds sold to the public by open market operations can be denoted as $P_B.\Delta B_P$. This implies the that nominal budget deficit is financed either by borrowing from the Central bank or from the private sector, that is $P.G - tY = \Delta H^d + P_B \Delta B_p$. If Central Bank monetizes the deficit, then the positive ΔH is matched by a negative value on $P_B \Delta B_P$.

[v] Portfolio selection was first expressed by Hicks (1935).

[vi] Assuming the term structure of interest, the study adopts data on the three-month, the ten-year, and the twenty-year as well as the thirty-year yields on Treasury Bills, although initially there were several gaps that needed to be estimated. The study filled the gap between 1987 Q1 to 1993 Q3 by using the three-month, the ten and the thirty-year as interest rate differences to explain the changes in the twenty-year rate. Then the analysis employed differences in the three-month, the ten and twenty-year rates (including the estimates) to derive the thirty-year over the period, 1959 Q1 to 1976 Q4 in the first instance, and then subsequently between 2002 Q1 and 2005 Q4 to complete the series.

[vii] It was found that it was possible to substitute the real debt sold to the Federal Reserve System $(P_B \Delta B_f)$ instead of the real monetary base, although the real high-powered money variable produced superior results. It was, however, not possible to include both because of the 'one-to-one' similarity between the two that led to multicollinearity.