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A SEARCH FOR A STABLE LONG RUN MONEY DEMAND FUNCTION FOR THE US

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ABSTRACT

The study was conducted at the School of Economics, University of Nottingham in a project as a requirement of the assessment of Economics data analysis module in November 2008. In this paper an attempt has been made to examine the US narrow money demand that is monetary aggregate 'M1' and it's determinants for the period 1960 Q1 to 2001 Q2 using the quarterly Data . A stable demand function for money has long been perceived as a prerequisite for the use of monetary aggregates in the conduct of policy. The stochastic trend of the data has been removed prior to estimation by applying first differences which are Integrated of order one I(1) variables, rendering them stationary which is integrated of order zero I(0). Although this removes the problem of trends it also throws away valuable information about the long run behaviour of the variables and leaving only the short run behaviour. In this study an approach has been reviewed to estimation which allows us to describe both short run and long run behaviours yet avoid the problem of spurious regression which is quite common with Integrated of order one data.

Keywords: Money demand, Time series properties, Co-integration and Error correction model.

INTRODUCTION

The money demand function has long been a fundamental building block in macroeconomic modeling and an important framework for monetary policy. This is specially relevant for countries where monetary authorities continue to emphasize the role of the money demand function on their monetary policy operations (Bae *et al.,* 2005). This has been argued in literature that money demand function does not work only through the interest rate channel; it can provide useful information about portfolio allocations. While investigating the money demand function a critical point to consider is the identification problem. By this notion it means the non-observability of the money demand. We can only measure the quantity of money supplied and we have to make an important supposition that the quantity of money supplied and demanded equal each –other, thus assuming the equilibrium in the money market. We are interested in M1 monetary aggregate which is the 'narrow money' consists of currency and demand deposits (non interest bearing checking accounts). To convert it to 'real money demand', its have deflated the M1 series by 'GDP implicit deflator series' for the sample period, where the base year is 2000 and the base year = 100. The explanatory variables that affect real money demand in our model are 'Real Gross Domestic Product' with base year 2000, since .The another explanatory variable is the 'interest rate', which represents the opportunity cost of holding money balances. The money demand increases with increase in income and decreases with rise in the interest rate, because of increasing opportunity cost of holding cash balances. The expected sign for this variable is negative. It had selected 'the rate of interest rate on treasury bills whose maturity is one year' as the interest rate variable in our model. The M1 and the real GDP both are measured in billions of US dollars and the interest rate in proportion. To fully specify our model is express the real money demand and the real GDP in logarithmic form, because the coefficients of the explanatory variables turn out to be as 'elasticity's', thus the coefficient of 'log of real GDP is the income elasticity of real money balances & coefficient of the interest rate is the 'interest semi-elasticity of real money balances'. The real money demand model becomes the following:

$$\text{Log } M_t = \alpha + \beta \text{Log } Y_t + \gamma I_t + e_t$$

log M_t is the logarithm of real money balances at time t and Log Y_t is the logarithm of real GDP at time t, and I_t is interest rate at time t, e_t is the random error term at time t. 'α' is the constant term, 'β' represents the income elasticity of real money balances and 'γ' is the interest semi – elasticity of real

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money balances. In this model the expected sign of β is positive, and the expected sign of γ is negative.

So, $\beta = \dfrac{d\log M_t}{d\log Y_t}$ and $\gamma = \dfrac{d\log M_t}{dI_t} = \dfrac{dM_t}{dI_t} \cdot \dfrac{1}{M_t}$.

METHODOLOGY

The data has been collected from The Business and Economic Statistics section of the American Statistical Association contains an extremely detailed list of data sources and provides links to them. The address is http://www.econ-datalinks.org (Wooldridge, 2006).

FINDINGS AND DISCUSSION

Time series properties of the variables of the money demand model

Descriptive statistics are in the table.

Sample period 1960Q1 – 2001Q2.

Variables	Log M_t	Log Y_t	I_t
Maximum	7.14	9.2	.14
Minimum	6.49	7.8	.03
Mean	6.75	8.5	.06
Standard Deviation	0.19	.38	.02

Standard deviation is the lowest for the 'interest rate', the logarithm of real GDP has the largest value of standard deviation.

The next table depicts the estimated correlation matrix of the variables

	Log M_t	Log Y_t	I_t
Log M_t	1.00	.88	-.16
Log Y_t	.88	1.00	.20
I_t	-.16	.20	1.00

There is positive high correlation (.88) between the real money balances and the real GDP and weak negative correlation (-.16) between real money demand and the interest rate.

Time-series properties*:* It is known to the variables have 'deterministic trend' by observing the coefficient of the linear time trend. Each variable is regressed on 'constant' and a linear time trend 'T'.

Real money balances

$M_t = 594.5 + 3.25\,T$ ………(1)

t = 49.3 t = 30.5, Adjusted $R^2 = .82$

$\log M_t = 6.44 + .004T$ ……….(2)

t = 524 t = 32.4 Adjusted $R^2 = .84$

From regression (1) on average the real money demand increases over the sample period in the US by 3.25 billions of dollars because of change in one quarter from regression (2), it can be inferred that the estimated average quarterly growth rate of real money balances (M1) in the US over the sample period is .4%.

Real Gross Domestic Product

$Y_t = 1617.2 + 46.16\,T$ ……… (3)

t = 24.8 t = 80.2, Adjusted $R^2 = .97$

$\log Y_t = 7.84 + .007T$ ……….(4)

t = 1575.7 t = 179.8 Adjusted $R^2 = .99$

The real GDP on average increase by 46.16 billions of dollars over the sample period because of change in one quarter and the estimated average quarterly growth of real GDP is .7%.

Interest rate

$I_t = .053 + .8800E\ -4T$ ……… (5)

t =13.98, t = 2.28, Adjusted R^2 = .02.

For interest rate it was observed an extremely small positive coefficient of the linear time trend. In vertical axis are measured the log of narrow money.

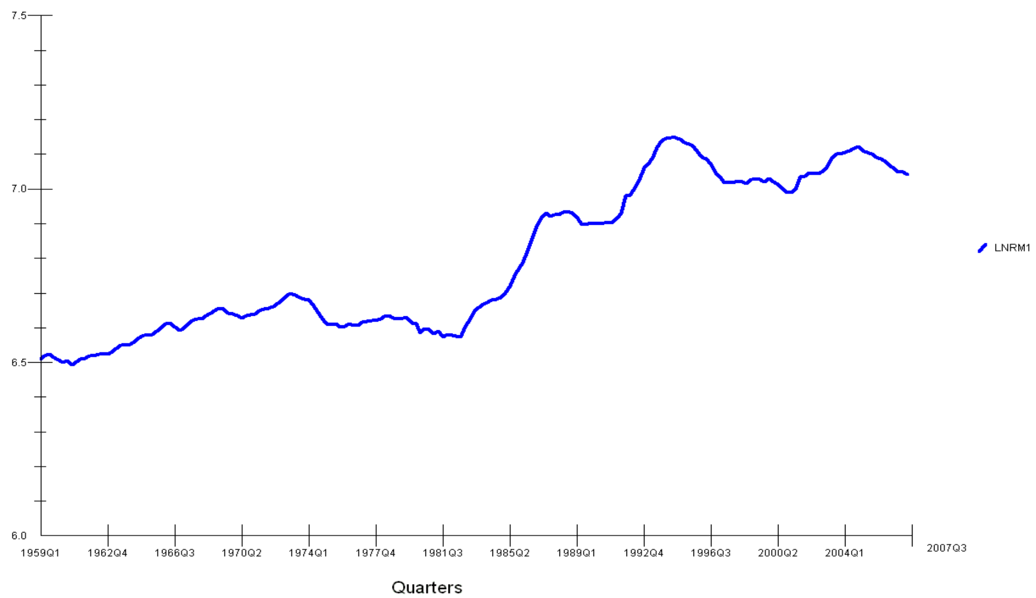

Fig. 1. The trend of growth rate of narrow money.

Over the sample period the $\log M_t$ has upward trend, on average the quarterly growth rate has increased, from the period of early 70's to early 80's there was a decline in the quarterly growth of M1, and from that period onwards there was steady increase of $\log M_t$ up to mid 90's. Early 80's and early 90's are the periods of

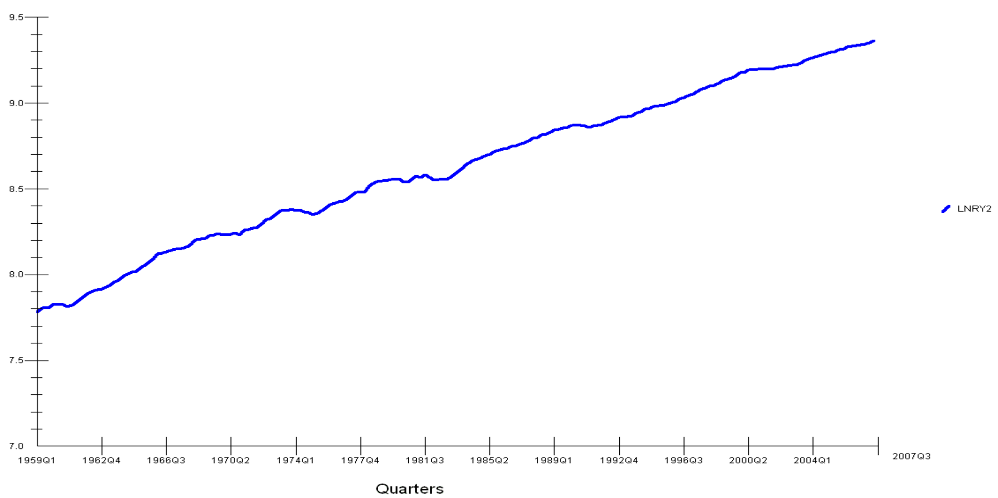

Fig. 2. The trend of growth rate of real GDP.

unusual behaviour, where there was a sharp decline and rise of growth of money balances respectively. In vertical axis are measured the log of real GDP. Over the sample period the $\log Y_t$ has obvious upward trend, (with less fluctuation) on average the quarterly growth rate of real GDP has increased steadily.

In vertical axis are measured the interest rate.

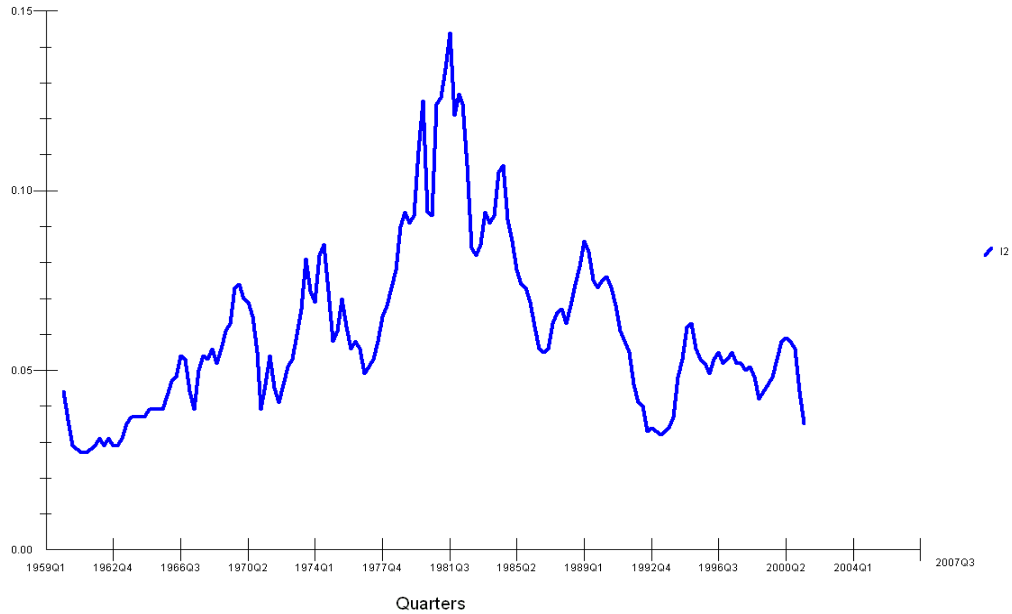

Fig. 3. The trend of interest rate.

There is no clear trend observed for interest rate. There was a sharp increase in the interest rate in the early 80's (1981).

The Graphical representation of the trends of the first differences of the variables

It was created the first difference of each of the variables and label them as 'D' where $D\log M_t = \log M_t - \log M_{t-1}$, $D\log Y_t = \log Y_t - \log Y_{t-1}$, $DI_t = I_t - I_{t-1}$

$D\log M_t$

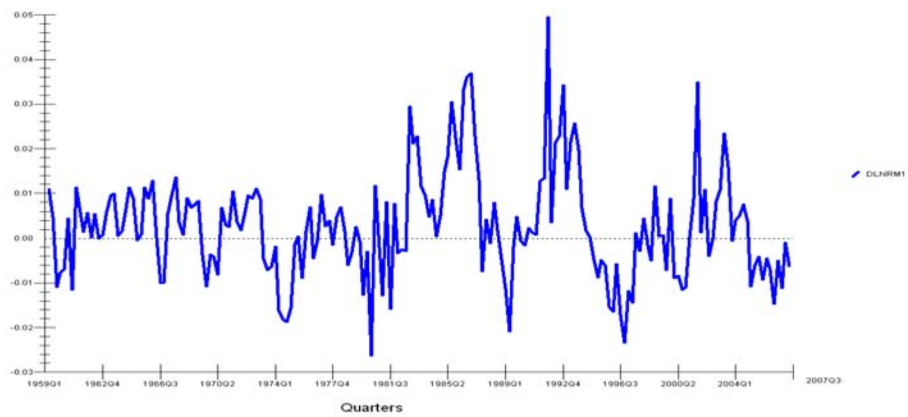

Fig. 4. The trend of first difference of the growth of Narrow Money.

$DlogM_t$ has no trend over the sample period that is by creating the 'first difference' trend has been removed. M_t has trend when expressed in 'log level', and the trend is removed in it's first difference that is in 'Growth rates'.

First Difference of $logY_{t:}$

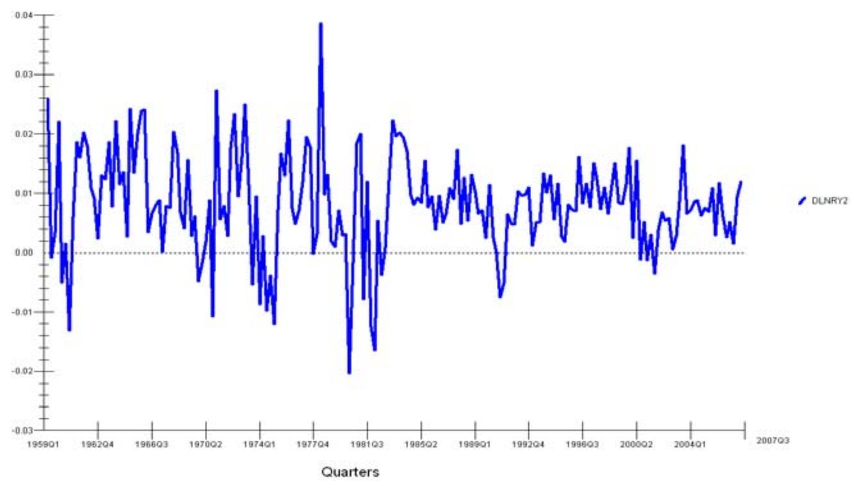

Fig. 5. The trend of first difference of the growth of real GDP.

$DlogY_t$ has no trend over the sample period that is by creating the 'first difference' trend has been removed. Y_t has trend when expressed in 'log level' and the trend is removed (detruded) in it's first difference that is in 'Growth rates'.

DI_t:

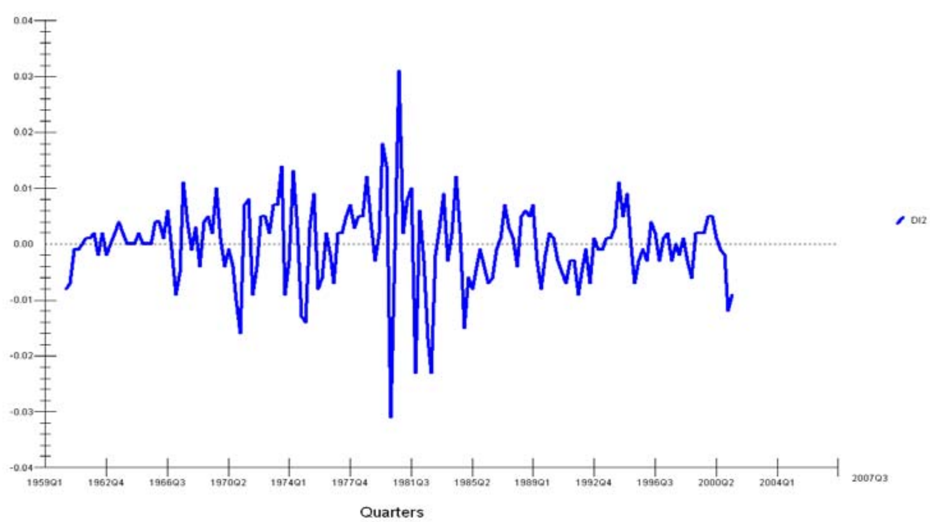

Fig. 6. The trend of first difference of the interest rate.

'DI_t' has no trend over the sample period that is by creating the 'first difference' trend has been removed.

Variance analysis: The variance of the non- stationary series falls when it is differenced, as this is observed in the following table:

Sample period: 1960Q1 to 2001Q2

Variable(s)	Log M_t	$\log Y_t$	I_t	$DlogM_t$	$DlogY_t$	DI_t
Maximum	7.1482	9.2009	.14400	.049512	.038657	.03100
Minimum	6.4922	7.8145	.027000	-.026305	-.020393	-.03100
Mean	6.7589	8.5523	.061497	.0029912	.0083024	-.5455E-
Std. Deviation	19912	.38364	.024103	.012002	.0088352	.007297

Non stationary time series and testing for unit roots: Augmented Dickey- Fuller Test.

So far by the term 'trend' referred to deterministic trend that is our models assumed linear time trend. Another type of trend which is most common in time series analysis is the 'Stochastic trend'. Non-stationary processes have 'Unit root', and are called 'Integrated of order One', and when they become stationary they do not have the 'unit root' and become 'Integrated of order zero'. Augmented dickey fuller (ADF) test is designed to distinguish between the stationary and non – stationary process. If it is assumed the following first order auto regressive process of the variable $\log M_t$ is

$\log M_t = c_1 + c_2T + c_3\log M_{t-1} + \varepsilon_t$, subtracting $\log M_{t-1}$ from both sides we have

$\Delta \log M_t = c_1 + c_2t + c_3\log M_{t-1} + \varepsilon_t$, where $\Delta \log M_t = \log M_t - \log M_{t-1}$.

If the $c_3 = 0$, this implies that the process has the unit root since $c_3 = \rho - 1$, unit root means $\rho = 1$.To allows for more general autoregressive processes (of order p), the equation is the following:

$$\Delta \log M_t = c_1 + c_2t + c_3\log M_{t-1} + \Sigma\, \delta\Delta\log M_{t-i} + \varepsilon_t \text{ , where } i = 1 \text{ to } p.$$

The number of lag length is dependent on the frequency of the data, since we have quarterly data the frequency is '4' and according to the rule of thumb the lag length in our ADF model is thus frequency +1 , that is '5'. So runs the automated command for ADF where the lag length is 5 for each series to identify whether the series is non-stationary or not. The ADF regression models for other two variables are same as the '$\log M_t$'(as shown above), only difference is we have '$\log Y_t$' and 'I_t' instead of '$\log M_t$'. The preferred number of lag length in the model should be selected on the basis of the 'AIC' criteria. The lag length with the highest number for AIC criteria is the preferred number of lag length. (This is the lag length at which the residuals are white noise).

To detect whether the process has unit root the null hypothesis is H_O: $c_3 = 0$, if the estimated ADF test statistic is lower (in absolute value) than the critical ADF test statistic accepted the null hypothesis and therefore, the process is non- stationary, otherwise stationary.

The ADF regression results: [The preferred lag length of ADF is shown in bold letters.]

$\text{Log}M_t$:

Unit root tests for variable $LOGM_T$

The ADF regressions include constant but not a trend
166 observations used in the estimation of all ADF regressions.

Sample period from 1960Q1 to 2001Q2

ADF Lag length in parenthesis	Test statistic	AIC
DF	-.84690	567.9743
ADF(1)	-1.0793	605.6001
ADF(2)	-1.3120	611.6035
ADF(3)	-1.2805	610.6398
ADF(4)	-1.3529	610.1415
ADF(5)	-1.4137	609.4801

95% critical value for the ADF statistic = -2.8768 and AIC = Akaike Information Criterion

Unit root tests for variable $LOGM_T$

The ADF regressions include constant and a linear trend

ADF Lag length in parenthesis	Test Statistic	AIC
DF	-.65605	567.0354
ADF(1)	-1.6272	605.4648
ADF(2)	-2.2241	612.3503
ADF(3)	-2.1869	611.3503
ADF(4)	-2.3765	611.2056
ADF(5)	-2.5475	610.8989

95% critical value for the ADF statistic = -3.4345 and AIC = Akaike Information Criterion

$LOGY_t$:

Unit root tests for variable $LOGY_T$
The ADF regressions include constant but not a trend
166 observations used in the estimation of all ADF regressions.

Sample period from 1960Q1 to 2001Q2

ADF Lag length in parenthesis	Test Statistic	AIC
DF	-1.7920	636.1199
ADF(1)	-1.4611	642.8763
ADF(2)	-1.2864	644.0981
ADF(3)	-1.3373	643.5666
ADF(4)	-1.3102	642.6981
ADF(5)	-1.4038	642.7421

95% critical value for the ADF statistic = -2.8768 and AIC = Akaike Information Criterion.

Unit root tests for variable $LOGY_t$
The ADF regressions include constant and a linear trend

ADF Langth in parenthesis	Test Statistic	AIC
DF	-2.4630	637.8409
ADF(1)	-2.9918	646.0383
ADF(2)	-3.3463	648.3892
ADF(3)	-3.2176	647.4750
ADF(4)	-3.3641	647.1043
ADF(5)	-3.1765	646.5677

95% critical value for the ADF statistic = -3.4345 and AIC = Akaike Information Criterion

I_t: Unit root tests for variable I_t
The Dickey-Fuller regressions include constant but not a trend
166 observations used in the estimation of all ADF regressions.

Sample period from 1960Q1 to 2001Q2

ADF Lag length in parenthesis	Test Statistic	AIC
DF	-2.0820	559.4462
ADF(1)	-2.4661	561.9670
ADF(2)	-1.9580	566.5583
ADF(3)	-2.4202	571.6537
ADF(4)	-2.3096	570.7426
ADF(5)	-2.5054	570.6588

95% critical value for the ADF statistic = -2.8795 and AIC = Akaike Information Criterion

Unit root tests for variable I_t

The Dickey-Fuller regressions include constant and a linear trend

ADF Lag lehgth in parenthesis	Test Statistic	AIC
DF	-1.9379	558.8647
ADF(1)	-2.3358	561.1906
ADF(2)	-1.7834	566.0082
ADF(3)	-2.2703	570.8775
ADF(4)	-2.1490	569.9852
ADF(5)	-2.3462	569.8494

95% critical value for the ADF statistic = -3.4385 and AIC = Akaike Information Criterion

Analysis: It is found that the entire series exhibit the 'Non- Stationary' process, each series has 'Unit–root', since its are unable to reject the null hypothesis of unit-root. For each series, the computed ADF test statistic with the preferred lag length (with the highest number of AIC criteria) are lower (in absolute value) than the critical ADF Test statistic (95% critical value of ADF Test statistic)in both cases where the ADF regression includes time trend and no time trend.

To be confirm that the variables are integrated of order One, I(1), it is performed the ADF test of each variable in it's first difference. The results are the following:

$DlogM_t$:

Unit root tests for variable $DLOGM_t$

The ADF regressions include an intercept but not a trend

165 observations used in the estimation of all ADF regressions.

Sample period from 1960Q1 to 2001Q2

ADF Lag length in parenthesis	Test statistic	AIC
DF	-7.0111	602.5771
ADF(1)	-4.7345	608.3982
ADF(2)	-4.5647	607.4542
ADF(3)	-4.0594	606.7930
ADF(4)	-3.6826	605.9954
ADF(5)	-3.7174	605.2241

95% critical value for the ADF statistic = -2.8769 and AIC = Akaike Information Criterion

Unit root tests for variable $DLOGM_T$

The ADF regressions include an intercept and a linear trend

ADF Lag length in parenthesis	Test Statistic	AIC
DF	-7.0044	601.6490
ADF(1)	-4.7338	607.4647
ADF( )	-4.5627	606.5188
ADF(3)	-4.0572	605.8649
ADF(4)	-3.6790	605.0735
ADF(5)	-3.7118	604.2980

95% critical value for the ADF statistic = -3.4346 and AIC = Akaike Information Criterion

DlogYt:

Unit root tests for variable $DLOGY_T$

The ADF regressions include constant but not a trend

165 observations used in the estimation of all ADF regressions.

Sample period from 1960Q1 to 2001Q2

ADF Lag length in parenthesis	Test statistic	AIC
DF	-10.1827	638.9507
ADF(1)	-6.9357	640.5929
ADF(2)	-6.5937	640.0217
ADF(3)	-5.7096	639.1447
ADF(4)	-5.7462	638.9031
ADF(5)	-5.4997	638.0724

95% critical value for the ADF statistic = -2.8769 and AIC = Akaike Information Criterion

Unit root tests for variable $DLOGY_t$
The ADF regressions include constant and a linear trend

ADF Lag length in parenthesis	Test statistic	AIC
DF	-10.2835	638.8024
ADF(1)	-7.0326	640.2519
ADF(2)	-6.7110	639.7720
ADF(3)	-5.8334	638.8558
ADF(4)	-5.8851	638.7017
ADF(5)	-5.6579	637.9437

95% critical value for the ADF statistic = -3.4346 and AIC = Akaike Information Criterion.

DI_t:
Unit root tests for variable DI_T
The ADF regressions include constant but not a trend
165 observations used in the estimation of all ADF regressions.

Sample period from 1960Q1 to 2001Q2

ADF Lag length in parenthesis	Test statistic	AIC
DF	-10.3807	555.9251
ADF(1)	-10.6054	561.5680
ADF(2)	-6.1632	565.6108
ADF(3)	-5.8348	564.9342
ADF(4)	-4.8632	564.3618
ADF(5)	-5.0562	564.3953

95% critical value for the ADF statistic = -2.8797 and AIC = Akaike Information Criterion

Unit root tests for variable DI_T
The ADF regressions include constant and a linear trend

ADF Lag length in parenthesis	Test statistic	AIC
DF	-10.4267	555.4270
ADF(1)	-10.6898	561.3293
ADF(2)	-6.2427	565.1565
ADF(3)	-5.9243	564.5207
ADF(4)	-4.9561	563.9115
ADF(5)	-5.1565	564.0016

95% critical value for the ADF statistic = -3.4387and AIC = Akaike Information Criterion

Analysis: First differencing removes the ‘Stochastic trend’ from all the variables, all series now exhibit a ‘stationary process’, all the differenced series are integrated of order ‘0’or I(0). First differencing removes the deterministic trend and the more common stochastic trend, the computed ADF test statistic is greater (in absolute value) than the critical ADF test statistic at all lag lengths for each series which allow us to reject the null hypothesis of ‘unit- root’ in both types of ADF Regressions: time trend included and excluded.

Seasonality: Since the quarterly data, the issue of 'Seasonality' should be addressed. The US authority, regularly de-seasonalise the Macroeconomic time series (that are frequently used) before they are presented for public use. The data have used are all 'seasonally adjusted.'

Co-integration analysis

Since all the variables are integrated of order one, so they can legitimately enter in co-integrating Regression (Johnston *et al.*, 1993). For co-integration analysis the estimated the static model is:

$$\text{Log } M_t = \alpha + \beta \text{Log } Y_t + \gamma I_t + e_t$$

The result is the following:

Ordinary Least Squares Estimation

Dependent variable is $LOGM_t$

166 observations used for estimation from 1960Q1 to 2001Q2

Regressor	Coefficient	Standard Error	T-Ratio [Prob]
CONSTANT	2.7156	.10551	25.7387[.000]
$LOGY_t$	.49431	.012542	39.4123[.000]
I_t	-2.9908	.20143	-14.8478[.000]
R-Squared	.90767	R-Bar-Squared	.90654
SE of Regression	060983	F-stat. F (2, 163)	801.2200[.000]
Mean of Dependent Variable	6.7573	S.D. of Dependent Variable	.19948
Residual Sum of Squares	.60618	Equation Log-likelihood	230.2988
Akaike Info. Criterion	227.2988	Schwarz Bayesian Criterion	222.6309
DW-statistic	.13695	-	-

Without looking at the diagnostic test the proceed to test for co-integration, before that plot residuals , they need not be white noise, merely stationary, integrated of order 'zero', from the visual inspection of the residuals it is difficult to detect whether the residuals represent a 'stationary process.'

Plot of residuals and two standard Error bands (Its call them RES).

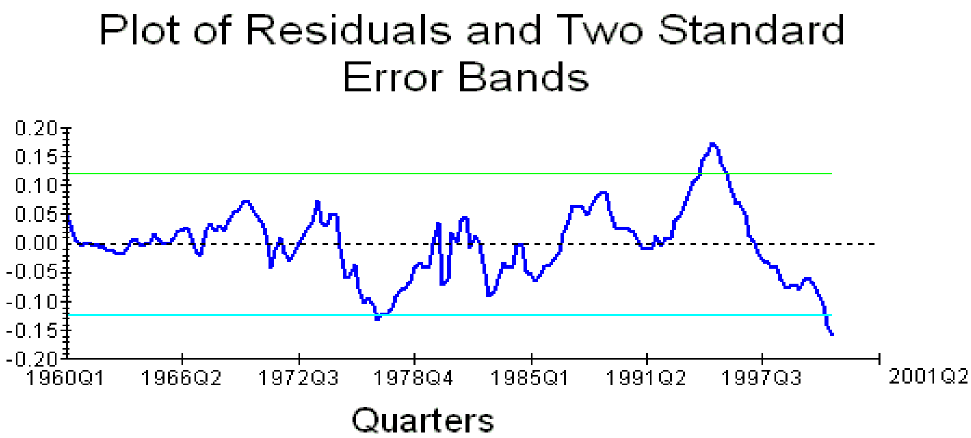

Fig.7. The Graph of residuals.

If the process is non- stationary then there will be 'upswing' and 'downswing' of residuals for arbitrarily long period of time. It was observed that from the period 1960 to 1995, there is an upward trend, with outlier in mid 70's and in mid 90's and from the 1995(approximately) onwards there is downswing. Since the data on the interest rate is not available after 2001, unable to conclude how long the downswing continued .Given the sample size most probably the residuals are not I(0) process.(a lot of fluctuations are there) Now we can formally test whether our variables co-integrate or not by applying the 'unit root test for the residuals' and it had the following results:

Unit root tests for residuals
Based on OLS regression of $LOGM_t$ on:
CONS $LOGM_t$ I_t
166 observations used for estimation from 1960Q1 to 2001Q2

ADF Lag length in parenthesis	Test statistic	AIC
DF	-1.6517	379.6079
ADF(1)	-2.1634	381.2467
ADF(2)	-1.5992	382.6583
ADF(3)	-2.4004	388.6043
ADF(4)	-2.3826	387.6365
ADF(5)	-2.8416	388.9300

95% critical value for the Dickey-Fuller statistic = -3.7956 and AIC = Akaike Information Criterion

The formal test implies that our variables do not co-integrate, that is the residuals are I(1), therefore, non-stationary, though our variables all are integrated of order one individually, but they do not have the 'homogeneous stochastic trend'. Although our variables are not co-integrating, it still proceed for the 'Error correction model'.

Ordinary Least Squares Estimation Res (-1) is the lagged residual
Dependent variable is $DLOGM_t$
165 observations used for estimation from 1960Q2 to 2001Q2

Regressor	Coefficient	Standard Error	T-Ratio[Prob]
CONS	.2840E-3	.0012527	.22669[.821]
$DLOGY_t$	.32958	.10708	3.0779[.002]
DI_t	-.29505	.12766	-2.3113[.022]
RES(-1)	-.046826	.015035	-3.1145[.002]
R-Squared	.13411	R-Bar-Squared	.11797
SE of Regression	.011272	F-stat. F(3, 161)	8.3118[.000]
Mean of Dependent Variable	.0029912	SD of Dependent Variable	.012002
Residual Sum of Squares	.020456	Equation Log-likelihood	507.9983
Akaike Info. Criterion	503.9983	Schwarz Bayesian Criterion	497.7864
DW-statistic	.89900	-	-

Diagnostic Tests

Test Statistics	LM Version	Version
A:Serial Correlation*CHSQ(4) =	76.0956[.000]* F(4, 157) =	33.5951[.000]
B:Functional Form *CHSQ(1) =	1.3680[.242]* F(1, 160) =	1.3376[.249]
C:Normality *CHSQ(2) =	37.7192[.000]* =	Not applicable
D:Heteroscedasticity*CHSQ(1) =	37201[.542]* F(1, 163) =	36833[.545]

According to Diagnostic test, the model still involves the problem of 'Serial Correlation', as it was rejecting the null hypothesis of 'no serial correlation 'because of high F ratio, but the model has no problem of heteroscedastic variance in the error term and also there is no error in the functional form, it is very 'low F ratio to accept the null hypothesis.' Thus all the terms are not stationary. But the coefficient of the lagged residual term is -.04 which is statistically significant, (because of high t ratio), this implies that if our variables co-integrated any disequilibrium would have been corrected by 4% per quarter (4% is the rate of adjustment). Our unit root test on residuals confirms that our variables do not co-integrate, it need to increase our sample size or search for other variables.

If its ignore the potential long-run relationship (co- integration) between the variables, the short-run model is the following: $\Delta \text{Log } M_t = \alpha + \beta \Delta \text{Log } Y_t + \gamma \Delta I_t + e_t$
Δ = first difference.
The estimated model is the following:
The Ordinary Least Squares Estimation

Dependent variable is $DLOGM_t$
165 observations used for estimation from 1960Q2 to 2001Q2

Regressor	Coefficient	Standard Error	T-Ratio[Prob]
CONS	-.2519E-3	.0012737	-.19780[.843]
$DLOGY_t$	.38861	.10818	3.5921[.000]
DI_t	.30791	.13097	-2.3510[.020]
R-Squared	.081940	R-Bar-Squared	.070605
S.E. of Regression	.011571	F-stat. F(2, 162)	7.2295[.001]
Mean of Dependent Variable	.0029912	S.D. of Dependent Variable	.012002
Residual Sum of Squares	.021688	Equation Log-likelihood	503.1718
Akaike Info. Criterion	500.1718	Schwarz Bayesian Criterion	495.5129
DW-statistic	.96718	-	-

Diagnostic Tests

Test Statistics * *	LM Version *	* F Version
A: Serial Correlation*CHSQ(4) =	56.6900[.000]*F(4, 158) =	20.6745[.000]
B: Functional Form *CHSQ(1) =	1.1962[.274]*F(1, 161) =	1.1757[.280]
C: Normality *CHSQ (2) =	32.0377[.000]*	Not applicable
D:Heteroscedasticity*CHSQ (1) =	.10741[.743]*F(1, 163) =	.10618[.745]

The income elasticity of real money balances do not vary that much between short-run and long-run model, which is inelastic, that is 1% point increase in the real GDP induces .5% increase in the real cash balances for long run model, for short- run model it is 0.4%. In case of bond rate, the sign is negative in both cases as theory predicts, but the size of the 'semielasticity' differs, in long run semielasticity is greater than short-run semielasticity, the short run model has lost it's explanatory power substantially because of first differencing. Because of the presence of the serial correlation, need to re specify our model by including other variables, but the model is free from problem of heteroscedastic variance and error in the functional form.

CONCLUSION

The no co-integration finding signals that additional integrated of order one I(1) variables are required to explain the long run bahaviour of the dependent variable of our error correction model. This involves collecting new data and repeating the tests it's have gone through. The estimated the short run model which ignores any potential long run relationship between the variables. The short run elasticities are not too dissimilar from those obtained in the error correction model. However, omitting information about the long run has diluted the model's explanatory power. Thus in the absence of co-integration this would be the best that it can be done as implemented the techniques of modern time series analysis.

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Appendix

In the regression output: LNRM1 = $LogM_t$:, LNRY2 = $LogY_t$, I2 = I_t , DLNRM1 = $DlogM_t$, DLNRY2 = $DlogY_t$ and DI2 = DI_t