

Government Debt and Demand for Money: A Cointegration Approach

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Conventionally, the relationship between government debt and money demand is estimated using ordinary least squares (OLS) adjusted for serial correlation. However, if government debt and money demand time series are nonstationary, the results obtained may be spurious in that they may indicate a relationship between two variables where one does not exist. To overcome the potential spurious regression problem of the extant tests, this paper applies cointegration technique to determine whether an equilibrium debt – money relationship exists in U.S. data from 1966Q1 to 2011Q1 period. Consistent with the standard Keynesian and Neoclassical models, the cointegration analysis reveals a positive long-run correlation between government debt and money demand, suggesting that government debt can be viewed as net wealth.

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1. Introduction

Macroeconomic theorists have long been aware that a government debt – money demand relationship has important implication for the efficacy of fiscal policy (Tanner and Devereux 1993). However, the empirical work concerning the subject has primarily focused on small economies¹, and the research on recent US data is very limited. The most updated empirical investigation on US debt and money demand was conducted using data from 1950 to 1990 period by Tanner and Devereux (1993). Even though the public awareness on the importance of government debt on US economy has increased in response to the large government debt in recent years, the empirical evidence is missing for the last 20 years. The paper attempts to fill this gap and revisits the relationship between government debt and money demand by extending the sample period to 2011.

This paper employs cointegration technique to analyze whether a long run equilibrium relationship between government debt and demand for money exists in US economy over the 1966-2011 period. Cointegration analysis in the government debt-money demand relationship was first used by Tanner and Devereux (1993), and they find no evidence of cointegration relationship. Current paper improves upon their research in two ways. First, sample period extends to 1990-2011 period, which has never been explored before. Second, we use Johansen test rather than the Engle and Granger procedure to determine the existence of cointegration among variables (Johansen 1988, 1996; Engle and Granger 1987). Engle and Granger test, is suitable for identifying cointegration between two variables, Johansen test allows for more than one cointegration relationship, therefore can be used when more than two variables involved in the process, as reflected in the money demand function used in the study. The empirical results reported in this paper reveal a positive long-run relationship between government debt and demand for money, implying that government debt can be viewed as net wealth.

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The paper is organized as follows. Section 2 provides literature review. Section 3 discusses theoretical model and methodology along with description of variables and data. Section 4 presents empirical results. Section 5 concludes.

2. Literature Review

Standard Keynesian and Neoclassical models provide theoretical justification for a positive relationship between government debt and money demand. These two standard analyses argue that if money demand is a function of wealth, the increased holdings of government bonds raises money demand as well. These increases in money demand would occur as long as the private sector did not fully discount future tax liabilities resulting from the new debt. An alternative view of the effects of budget deficits on economy is Ricardian model, in which the value of new debt would be seen simply as the present value of future tax liabilities. Thus when the debt was issued, the private sector would hold the debt and private saving would increase by an equal amount because the government debt is not viewed as net wealth, money demand would not increase (Gulley 1994).

Both standard theories and Ricardian model have been supported by the empirical studies. The Positive debt-money relationship has been advanced and supported by empirical studies of Butkiewicz (1979), Barth, Iden and Russek (1984-85), and Deravi, Hegji and Moberly (1990). On the other hand, Ricardian model is embraced by empirical studies of Evans (1985n) and Gulley (1994), Wheeler (1999). The international evidence is also mixed. For instance, Vamvoukas (1998) find a positive relation between deficit and money demand in Greek economy. Saad and Kalakech (2009) find no significant deficit and money demand correlation in Lebanon. Therefore the empirical literature to date has been inconclusive and the issue is unsettled.

The majority of existing empirical studies in US economy employ partial adjustment model (PAM) to examine the long-run debt – money relationship. PAM is generally estimated with the ordinary least squares (OLS) using the Cochrane-Orcutt technique to adjust for serial autocorrelation. By introducing the lagged money demand variable in the equation, PAM brings out the short-term dynamics to the long-run demand for money. The model fared well when the post-war data were used, but failed to explain the instability in money demand function since early-1970s, which partially contributes to the mixed empirical results on debt – money studies covering different sample periods. For instance, Deravi, Hegji and Moberly(1990) find that the increases in government have a positive impact on money demand during the 1954.1-1972.4 period, but the correlation disappeared during the 1973.1-1980.4 period.

One of the major reasons for the failure of the PAM framework is that it restricts the lag structure by relying solely on economic theory without examining the actual data generating process. Since Nonstationarity is very common in macroeconomic time-series data, using linear regressions on those nonstationary data could produce spurious correlation in that they may indicate a relationship between variables where one does not exist (Granger 1981). However, if two or more individually nonstationary series can form a stationary linear combination, the original series are said to be cointegrated, which signify an equilibrium relationship between the series. To overcome the potential nonstationary problem of the PAM, growing literature has

applied cointegration technique to investigate the long-term relationship between time series variables in money demand function in the past twenty years. Tanner and Devereus (1993) use Engle-Granger (1987) procedure to test the existence of cointegration between US government debt and money demand over the 1950-1990 period, and no cointegration relation is found. The current research employs Johansen test to identify potential cointegration between US government debt and money demand over the 1966-2011 period.

3. The Methodology and Model

3.1 Variables and Data

According to the liquidity preference theory proposed by Keynes in 1936, there are three motives behind the demand for money: the transaction motive, the precautionary motive and the speculative motive. He postulated that demand for both transactional and precautionary money is proportional to income, whereas the demand for speculative money is negatively related to the level of interest rates, because a rise in interest rates encourages people to hold their wealth as bonds rather than real money for a given level of income. Keynes also pointed out that money is valued in terms of what it can buy, therefore, people want to hold a certain amount of real money balance (the quantity of money in real terms) – an amount that his three motive indicate would be positively related to income and negatively related to interest rates and inflation (Mishkin 1997).

Applying Keynes' liquidity preference theory, a money demand specification that includes government debt as an independent variable can be written as:

$$\ln M_t = \beta_1 + \beta_2 \ln Y_t + \beta_3 \ln R_t + \beta_4 \ln B_t + \beta_5 P_t + \varepsilon_t \quad [1]$$

M_t = US M1 real money demand,

Y_t = Real GDP,

R_t = Short term interest rates (prime interest rate),

B_t = Real federal debt outstanding,

P_t = Prices, consumer price index,

All quarterly data covering period from 1966Q1 through 2011Q1 are from the FRED (Federal Reserve Economic Data) database. M1 money demand and government debt are deflated using GDP deflator to reflect the real terms of money demand and government debt. All data series except consumer price index (P_t) are in logarithmic form.

3.2 Tests for Unit Roots

The methods used in this study to investigate the stationarity of the time series are the Augmented Dickey-Fuller (ADF) and the Phillips-Perron (PP) tests. The testing procedure for ADF is applied to the model:

$$\Delta y_t = \alpha + \beta t + \gamma y_{t-1} + \sum_{t=2}^p \delta_t \Delta y_{t-1} + \varepsilon_t$$

Where Δ is the first differencing operator, p is the lag order of the autoregressive process. The null hypothesis that y_t is nonstationary is rejected if γ is significantly negative. τ statistic for coefficient γ is computed and compared to the critical value for ADF test. If τ statistic is less than the critical value, null hypothesis is rejected and no unit root is present.

3.3 Johansen Cointegration Test

Johansen procedure is appropriate for testing cointegration of several time series, because it permits more than one cointegration relationship. Johansen approach starts with the unrestricted vector error correction model (VECM):

$$\Delta y_{t-1} = \mu + \Pi y_{t-1} + \sum_{i=2}^{p-1} \Gamma_i \Delta y_{t-i} + \varepsilon_t$$

Where y_t is a $(n \times 1)$ vector of $I(1)$. This model contains information on both the short and long run adjustments to changes in y_t via the estimates of Γ_i and Π respectively. The rank of Π indicates the cointegration rank r , that is $\text{rank}(\Pi) = r$. If $r=0$, no cointegration is evident. If $r=n$, all variables in the model are stationary and there is no spurious regression. If $1 < r < n$, r cointegration vectors are present. For example, $r=1$ indicates the existence of one cointegration process.

4. The Findings

The purpose of this study is to investigate whether US government debt along with other variables have long run effects on the demand for money through the use of Johansen multivariate cointegration procedure. The procedure starts with checking level of integration of each time series in Equation [1].

4.1 Stationarity of the Variables

Table 1 presents the results of ADF and the Phillips-Perron (PP) stationarity test procedures. All the variables are nonstationary in levels from both ADF and PP tests. Thus, they all need to be differenced once in order to become stationary. Additional ADF and PP tests on first difference are performed in all series. The results show that all the variables appear to be stationary in first difference. Therefore, we treat all time series as integrated of order one, denoted as $I(1)$.

Table 1: ADF and PP unit root test results

Variables	Levels		First Differences	
	ADF (4)	PP(4)	ADF(4)	PP(4)
lnM	1.06	1.38	-3.86 **	-9.94 **
lnY	3.32	5.77	-3.50 **	-8.31 **
lnR	-0.66	-0.63	-4.19 **	-10.53 **
lnB	2.50	5.08	-2.71 **	-5.05 **
P	3.85	9.67	-1.63 *	-6.87 **

Note: lag 4 is used in all tests. ** and * represents the levels of significance at 1% and 5% respectively.

4.2 Cointegrating Analysis of Real Money Demand

As the above results support the hypothesis of nonstationarity, a natural extension is to test for cointegration. We apply Johansen's cointegration methodology to investigate whether or not there is a long-run relationship among the variables specified in money demand Equation [1]. The test results are presented in Table 2. The trace test reveals that the null hypothesis of no cointegration ($r = 0$) against the alternative of the presence of one or more cointegrating vector is rejected at the 5% level of significance, implying that there is one cointegration relationship among real money demand, real government debt, real GDP, interest rate and consumer price index ².

Table 2: Cointegration Rank Test Using Trace

H0: Rank=r	H1: Rank>r	Eigenvalue	Trace	5% Critical Value
0*	0	0.2496	86.4882	59.24
1	1	0.1041	35.6677	39.71
2	2	0.0655	16.2045	24.08
3	3	0.0209	4.2075	12.21
4	4	0.0027	0.4774	4.14

Note: Trace test indicates 1 cointegration equation at the 0.05 level. * denotes rejection of null hypothesis at the 0.05 level.

4.3 OLS Regression on Money Demand

Since there is one cointegration vector, the long-run money demand function can be economically interpreted and reported as shown in Equation [1]. We therefore proceed with OLS estimation of Equation [1]. The coefficient estimation of Equation [1] is presented in Table 3.

Table 3: Long-run Real M1 Demand Equation

Variables	Parameter Estimate	t Value	Pr > t
Intercept	1.65480 ***	3.59	0.0004
lnB	0.59347 ***	23.71	<.0001
lnY	0.09785 *	1.71	0.0891
lnR	-0.02561***	-2.85	0.0050
P	-0.00440***	-12.05	<.0001

Note: Adjusted R² =0.9415. *** indicates significance at 1% level, * indicates significance at 10% level.

Consistent with the standard theories, the government debt has a significant impact on the demand of money. The positive coefficient of 0.59 indicates that the long-run government debt elasticity for real M1 is 0.59. Signs of all the other independent variables are in line with the transactions and precautionary theories of money

holding: the real money balance is positively correlated with the real GDP, and negatively correlated with the short-term interest rates and consumer price index.

5. Summary and Conclusions

The paper estimates the effects of government debt in US, along with other macroeconomic variables, on money demand function using quarterly data over 1966-2011 period. Through the use of Johansen cointegration technique, we are able to confirm the existence of a long-run relationship among money demand, government debt and other variables. Specifically, the tests reveal a significant positive long-run equilibrium between government debt and money demand, implying that government debt could be a missing variable in the stable money demand equation. The finding is consistent with the body of literature that supports the Standard Keynesian and Neoclassical models, suggesting that the government debt can be viewed as net wealth.

Once the equilibrium relationship between government debt and money demand is confirmed, the positive correlation between the two should be taken into consideration when policy makers establish appropriate fiscal and monetary policies. For example, the results in this research could provide further insight into the current debt ceiling debate. When government debt is viewed as net wealth, a forecastable decline in government debt results in a forecastable decline in wealth. This should lead to a decline in consumption and therefore slow down the economic recovery.

One of the limitations with Johansen cointegration procedure is that this method assumes that the cointegrating vector is constant during the period of study. In reality, it is possible that the long-run relationships between the underlying variables change because of changes in economic conditions, especially, when long sample period is used. Future research could use time-varying cointegration vector techniques to remedy for the limitation.

Endnotes

1. Saad and Kalakech (2009) study the impact of deficit on money demand in Lebanon. Vamvoukas (1998) investigates Greek data, and Pavle (1995) studies Yugoslavia's data.
2. To be consistent with Tanner and Devereux (1993), we also performed the Engle-Granger procedure in testing the cointegration relationship. The Engle-Granger test supports the existence of cointegration relationship.

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Li

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