Interest Rates Elasticity of Money Demand in Different States of the Economy

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This paper investigates the long-term and short-term interest elasticity of money demand. Our cointegration analysis of US data from 1966Q1 to 2011Q1 confirms the existence of a stable long-run negative correction between interest rates and money demand. However, the short-term interest elasticity analysis reveals that the negative correlation between interest rate shocks and demand for money exists only when GDP grows, and the significant link reduces as GDP declines. This provides a partial explanation for the ineffectiveness of monetary policy during a financial crisis.

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1. Introduction

During the recent financial crisis, central banks around the world implemented monetary policy that targeted a very low short-term interest to stimulate aggregate demand. The Fed increased the monetary base by more than 200% between 2007 and 2009 by targeting the Federal Fund Rate in the 0-1/4 percent range; however, the M1 money demand only rose by less than 25%. The occurrence of this liquidity trap, where money demand does not respond to the reduced interest rate, naturally raises two questions: 1) Does the negative correlation between money demand and interest rates still hold? And, if yes, 2) Is there any short-term disruption in the long-term stable relationship that causes the money demand to be insensitive to changes in interest rates during the financial crisis?

To answer these two questions, the research described in this paper employed US data from 1966Q1 to 2011Q1 to analyze 1) The long-term equilibrium between money demand and interest rates, and 2) the short-term response of money demand to interest rate shocks.

By including new millennium US data in the analysis of the interest elasticity of money demand, the paper contributes to the existing literature by providing new evidence of the existence of the long-run negative relationship between money demand and interest rates in the US. Furthermore, the paper also argues that the short-term dynamic response of money demand to interest rate shocks varies according to the state of the economy and, consistent with our hypothesis, we find that the significant inverse relationship between interest rate shocks and demand for money exists only when GDP grows, not when GDP declines. As such, this result provides a partial explanation for the ineffectiveness of monetary policy during a financial crisis.

The paper is organized as follows. Section 2 contains the literature review. Section 3 presents an overview of the theoretical model and methodology and provides a description of the variables and data. Section 4 presents the empirical results. Section 5 concludes the paper.

2. Literature Review

A central question in monetary theory is whether, or to what extent, the quantity of money demanded is affected by changes in interest rates. In his famous 1936 book *The General Theory of Employment, Interest and Money,* Keynes developed the liquidity preference theory, which emphasized the importance of interest rates in determining money demand. He assumed that money earns no interest and, hence, the nominal interest rate is the opportunity cost relative to holding other assets. As the interest rate rises, the opportunity cost of money rises, and the quantity of money demanded falls; hence, there is a stable long-term inverse relationship between interest rates and money demand.

Ever since the founding work of Keynes (1936), empirical studies on the long-term interest elasticity of money demand has typically focused on three factors: 1) What methodology? 2) M1 or M2 money measurement? 3) What sample period? For instance, earlier studies used conventional modeling (Tobin 1956; Laidler 1966; Brunner & Meltzer 1963), whereas more recent research has employed cointegration technology to overcome the endogeneity and nonstationarity problems. Furthermore, some studies have found a stable function between M1 and interest rates (McNown & Wallace 1992), whereas others have concluded that there is a long-term equilibrium between M2 and interest rates (Hafer & Jansen 1991; Miller 1991). Regardless of the methodology that is employed, money measurement or sample period, the existing empirical evidence has largely supported the theory that there is a stable negative relationship between interest rates and money demand. However, this once overheated topic has attracted significantly less attention in recent decades. In fact, the most recent empirical study on the stability of money demand was conducted on US data from the 1953 to 1991 period (Mehra, 1993). As such, more contemporary empirical evidence on this relationship that is based on data acquired within the last 20 years is lacking. The paper fills the gap by employing cointegration analysis on US data from 1966Q1 through to 2011Q1 and provides the newest empirical evidence of a long-run negative correlation between short-term interest rates and M1.

The long-term stable relationship can be constantly interrupted by short-term disequilibrium (Granger 1983,1986), suggesting that the short-run interest elasticity of money demand may not be negative at all times. In fact, studies have shown that the negative response of money demand to interest rate shocks may diminish, even disappear, in certain circumstances. For instance, Karni (1973) found that short-run interest elasticity is sensitive to the nature of money transaction cost and the sources of income. Mulligan and Sala-i-Martin (2000) and Li (2009) argued that the short-term interest elasticity of money demand becomes insignificant when the

interest rate is small. Motivated by an interest in the ineffectiveness of expansionary monetary policy during the financial crisis, this paper attempts to investigate whether the states of the economy play a role in the instability of money function. Specifically, we propose that the short-term interest elasticity of money demand tends to diminish during periods of economic contraction according to the reasoning outlined below.

The liquidity preference theory assumes that households are willing to trade less liquidity for a higher return. However, this willingness varies with the state of the economy or the quantity of wealth. During periods of economic growth, the total wealth of households increases and consumer confidence also increases. In such circumstances, people are more willing to take risk and more likely to trade excess liquidity for a higher return on assets. Hence, the contractionary monetary policy can effectively reduce the liquidity or money demand by increasing interest rates during the expansion phase. Conversely, during periods of economic contraction, the total wealth of households declines. Out of fear of adverse events, people tend to hold on to whatever amount of money is supplied to them. Regardless of how low the interest rate is, or how high the money supply, they hoard cash without borrowing or lending, resulting in a reduced money velocity. As such, M1 balance does not grow as much as desired through an expansionary monetary policy. To summarize the above reasoning, people are more willing to trade liquidity for higher interest when the level of wealth grows, and less willing when the level of wealth declines. As such, we developed the hypothesis that the short-term interest elasticity of money demand is greater during economic expansion and weaker during economic contraction.

3. Methodology and Model

3.1 Variables and Data

According to the liquidity preference theory proposed by Keynes in 1936, the real money balance is positively related to income and negatively related to interest rates and inflation (Mishkin 1997); as such, a money demand specification can be written as per Eq. 1:

$$\ln M_t = \beta_1 + \beta_2 \ln Y_t + \beta_3 \ln R_t + \varepsilon_t \quad (1)$$

M_t= US M1 real money demand,
Y_t = Real GDP,
R_t = Short-term interest rates (prime interest rate),

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

3.2 Tests for Unit Roots

The Augmented Dickey-Fuller (ADF) and the Phillips-Perron (PP) test were used in this study to investigate the stationarity of the time series. The testing procedure for ADF was applied to the model as follows:

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

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

3.3 Johansen Cointegration Testing for Long-Run Interest Elasticity

Granger (1983, 1986) demonstrated that the concept of a stable long-run equilibrium is the statistical equivalence of cointegration. That is, if two or more individually nonstationary series can form a stationary linear combination, the original series are said to be cointegrated, and this signifies that there is an equilibrium relationship between the series. We employed the Johansen procedure (1996, 1988) to test for cointegration of the nonstationary series in Equation [1]. The 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 was used in the current research to generate information on the effects of both the short- and long-run adjustments to changes in y_t by estimating Γ_i and Π respectively. The rank of Π is indicative of the cointegration rank r, that is rank (Π) = 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, if r=1, one cointegration process exists.

3.4 First-Difference Testing for Short-Run Interest Elasticity

The short-term money demand response to interest rate shocks was estimated through the following first difference regression:

$$\mathrm{Dln}\, M_t = \beta_1 + \beta_2 \,\mathrm{Dln}\, Y_t + \beta_3 D \ln R_t + \varepsilon_t \qquad (2)$$

where D is the first difference operator. $\mathrm{D}\ln M_t$ was approximately interpreted as the growth rate of M1 money demand, $\mathrm{D}\ln Y_t$ as the growth rate of real GDP, and $D\ln R_t$ as the growth rate of short term interest rate.

4. The Findings

The findings of the long-run and short-run interest elasticity of money demand are presented as follows:

4.1 Long-Run Stability of Money Demand Function

Table 1 presents the results of the ADF and the Phillips-Perron (PP) stationarity test procedures. All the variables are nonstationary in levels.

Table 1: ADF and PP unit root test results

	Levels		First Differences	
Variables	**ADF (4)**	**PP(4)**	**ADF(4)**	**PP(4)**
lnM	1.08	1.38	-3.86 **	-9.96 **
lnY	3.28	5.80	-3.47**	-8.33 **
lnR	-0.69	-0.62	-4.20 **	-10.52 **

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

4.1.1 Cointegration Analysis of Real Money Demand

As the above results supported the hypothesis of nonstationarity, we subsequently tested for cointegration. We applied Johansen's cointegration methodology to investigate whether or not there was a long-run relationship among the variables specified in money demand Equation [1]. The test results are presented in Table 2. The trace test revealed that the null hypothesis of nocointegration (r = 0) against the alternative of the presence of one or more cointegrating vector(s) was rejected at the 5% level of significance, implying that a cointegration relationship exists among real money demand, real GDP, and interest rate.

Table 2: Cointegration Rank Test for Interest Rate and Money Demand

H0: Rank=r	**H1: Rank>r**	**Eigenvalue**	**Trace**	**5% Critical Value**
0*	**0**	0.0957	26.6662	24.08
1	**1**	0.0400	8.7685	12.21
2	**2**	0.0084	1.5000	4.14

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

4.1.2 OLS Regression on Interest Rate and Money Demand

The above cointegration test confirmed the existence of a stable long-run relationship between the variables in the money demand function. Therefore, we

proceeded by developing an OLS estimation of Equation [1]. The coefficient estimation of Equation [1] is presented in Table 3. Consistent with the standard Keynesian theories, the negative correlation between interest rate and money demand was significant with a long-run interest elasticity of 0.14.

Table 3: Long-run Interest Rate and Real M1 Demand Equation

Variables	Parameter Estimate	t Value	Pr > |t|
Intercept	4.04865 ***	23.99	<0.0001
lnY	0.31855***	17.09	<0.0001
lnR	-0.14471***	-9.59	<0.0001

Note: Adjusted R^2 =0.7575 *** indicates significance at 1% level.

4.2 Short-Run Interest Elasticity of Money Demand

Our entire sample included 180 quarterly observations of US real money balance, real GDP, and short-term interest rates from 1966Q1 through 2011Q1. Table 4 presents the most significant statistics of the sample. Among the 180 real GDP observations, 144 observations increased from the prior period, and 36 observations declined from the prior period. We defined economic expansion periods as periods with GDP growth, and economic contraction periods as periods with GDP decline.

Table 4: Statistic Analysis of Expansion and Contraction Sample

	N		Mean		Std Dev	
Variables	**Up**	**Down**	**Up**	**Down**	**Up**	**Down**
DLnM	144	36	0.0044	-0.00408	0.01746	0.01958
DLnY	144	36	0.0091	-0.00834	0.00641	0.00611
DLnR	144	36	0.0027	-0.02576	0.09440	0.12879

Table 5 presents the estimation results of Equation [2] for the entire sample during economic expansion, and during economic contraction respectively. Comparing the estimated coefficients of DLnR across these three samples, we found that the significant inverse relationship between money demand and interest rate shocks existed in the entire sample and the GDP growth periods; however, the significance diminished during periods of GDP decline. Specifically, the significant coefficient for DLnR for the expansion periods was -0.08, indicating that a 1% increase in short-term interest rate will cause money demand to fall by 0.08% during the expansion of the economy.

Table 5: Short-run Interest Rate and Real M1 Demand

Variables	Entire Sample	Economic Expansion	Economic Contraction
Intercept	-0.00080	0.00070	0.00507
DlnY	0.59484***	0.42897**	1.21911**
DlnR	-0.06662***	-0.08196***	-0.03919

Note: *** indicates significance at 1% level, **indicates significance at 5% level.

5. Conclusion

By employing a cointegration technique within long-term interest elasticity analysis, the research presented in this paper confirmed the existence of a stable inverse relationship between interest rate and aggregated money demand in the US economy for the periods 1966-2011. However, the short-term negative correlation between interest rate shocks and money demand was found to exist only when GDP was in a period of growth, not when it was in decline, suggesting that short-term interest elasticity becomes insignificant or zero during an economic downturn.

The findings of the asymmetric response of money demand to interest rate shocks has significant implications for establishing appropriate monetary and fiscal policy. As pointed out by Bernanke (1993), monetary policy has proven to be highly effective in containing inflation during economic expansion by increasing short-term interest rates; however, it has been ineffective at stimulating aggregated demand by reducing short-term interest rates during times of financial crisis. The ineffectiveness of expansionary monetary policy can be partially explained by a lack of interest elasticity during the recession period. To mitigate the depression and deflation associated with the "liquidity trap," where aggregated spending is not responding to the increases in money supply, government spending might be necessary to complement monetary policy by promoting inflation and stimulating output.

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