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A Demand for Money Function with Output Uncertainty, Monetary Volatility, and Financial Innovations: Evidence from Japan

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Abstract

The impact of monetary policy is essentially determined by the stability of the money demand function. Inclusion of financial innovation as a variable led to a more explanatory model which was unable to predict the future. When the inadequacy of partial adjustment modeling framework is adjusted, the model faces empirical difficulties. Considering instability of money demand is an omitted variable problem, this paper employs Vector Error Correction Method to solve that problem. Output volatility, monetary volatility and financial service are included in the model besides real output and nominal interest rate. Based on augmented Dicky-Fuller tests and cointegration tests, long run stability of money demand function is established. The Vector Error Correction Model yields conventionally expected and statistically significant results for all variables. Variance decomposition and impulse response show an increasing effect of monetary volatility, output uncertainty and financial services. On the other hand, interest rate and real GDP show declining effect. Innovations in financial service, output volatility and monetary volatility are vital in explaining money demand.

Keywords: Money demand, monetary volatility, uncertainty, cointegration, vector error correction, real balance.

Introduction

The effectiveness of monetary policy heavily depends upon the stability of demand for money function. Hence a huge stream of research, both theoretical and empirical has been carried out on this issue. Models using the post World War II US data reveal some instability. Some other OECD countries also show the similar trend.

Two sets of explanations were provided. First, financial innovation, which is considered an important variable by many, was omitted in the money demand function. Second, the inadequacy of partial adjustment modeling framework was used as an empirical tool to analyze demand for money. First group propose a variety of scale variables and modeled the financial innovations in various ways. While this approach increases the explanatory power of the model, it does not predict the future well. Second group proposes buffer-stock models; however this type of models faces empirical difficulties. Vector Error Correction method is proposed in order to solve the problem.

In line with Choi and Oh[1], this paper seeks to examine whether a stable long run money demand relationship exists in Japan. The argument is that the 'instability' of demand function is an omitted variable problem [1]. Hence, in addition to real output and nominal interest rate, three other variables such as financial service, output volatility (uncertainty) and monetary volatility (uncertainty) are also considered.

Literature Review

Theory suggests that demand for money is the demand for real balances and is a function of scale variable (as a measure of economic activity) and a set of opportunity cost variables (to indicate the foregone earnings by holding assets which are alternatives to money).

The empirical literature on the demand for money is vast. As the theories share common important variables, they determine a relationship between the quantity of money demanded and a set of variables. In general, the empirical works start with a relationship that shows the association between real money balance (m) and a measure of transactions (y) and the opportunity cost of holding money (r).

Money Stock Definition: Two definitions are considered: Narrow money (M1) consists of those assets readily available and transferable in everyday transactions which provide the means-of-exchange function. Broad money (M2) comprises of a wide range of assets rendering portfolio opportunity to asset holders. The narrow money includes currency plus demand deposits at the commercial banks while the broad money contains less liquid assets, comprises of several other assets such as deposits at the commercial banks, savings and loan associations etc. plus M1. The bulk of the analytical work on M1 was conducted on the assumption that M1 was more amenable to control by the monetary authorities. On the other hand, some studies cite the empirical difficulties in using narrow definition of money[2]. Many studies used M2 or broader aggregates to estimate the demand for money. Some studies even use both narrow and broad money aggregates to evaluate demand for money.

Scale Variable: The scale variable is used as a measure of transaction relation. The level of income has been widely used to represent scale variable. GNP, GDP, NNP etc are used in this context. Though these variables have some limitations, it turns out that other proposed variables such as bank debit, bank loans or consumption component of GNP do not perform better[2].

Opportunity cost of money: The opportunity cost of holding money involves two ingredients: the own-rate of money and the rate of return on assets alternative to money. Some authors are in favor of including both the rates[3]. Some researchers treated the own rate as zero when narrow definition of money is used because checkable deposits then consisted solely of demands with an explicit yield of zero. As the return on assets alternative to money, one or more short-term rates like the yields on government securities, commercial paper, or saving deposits are used with a notion that these instruments are close substitute for money. Others use return of equities, yields on long-term government or corporate bonds or on CDS[4]. Several authors suggest that suggest a possibility of holding more money in the face of uncertainties, such as political instability[5-9]. However, the effect does not go in the long run. However, some research has shown that the demand for money is not sensitive to the precise measure of the variable chosen[7].

There is a vast literature on the demand for money, especially involving cointegration and Error-Correction Model. By using quarterly and monthly Australian data over 1977-1990, cointegration relation for both monthly and quarterly data has been found[10]. ECM shows some evidence for the significance of the 90-day bill rate in influencing the short-run monetary aggregate. For Canadian data over 1953:1 – 1990:4, the results vary depending on the cointegration tests selected and the combination of money and interest rates[11]. However, stable long run relationship is found among M1, Real GDP and the 91 day T-bill rate. With German quarterly data over 1970:1-1994:4, the existence of cointegrating relation among money, interest rate and real GDP has been observed[12]. The EC term is negative and significant. Swiss quarterly data over 1973:2-1991:4 leads to the conclusion that without exchange rate there is no cointegrating relationship[13]. ECMs indicate that the speed of adjustment of the EC term is faster for M1 than for M2 and M3.

Observing US data leads to the conclusion that there exists cointegration relation among M2, real GNP, IPD and The CPR[14]. ECM for M2 suggests valid and significant error-correction term. Baba, Hendry and Starr[15] using US quarterly data find stable cointegrating demand function for M1.

Quarterly Indonesian data over 1969:1-1987:4 find that the evidence of cointegrating relation is rather weak for currency[16]. Annual Indonesian data leads to no cointegrating relationship[17]. Data from Iran over 1959-90 find that the most suitable model is the one that applies the black market XR with real GDP and inflation to explain demand for real M2[18]. Quarterly annual data over 1951-91 from Pakistan is used to show that different cointegration test techniques give conflicting results[19]. Studies based on Japan suggest relatively stable income elasticities can facilitate the Central Bank's policies in regulation M2[20].

Data and Variables

Quarterly data of the money stock M1, the price level, real income and interest rate have been use. The price level and real income are measured by the implicit GDP deflator and real GDP, respectively. The opportunity cost of money is measured by nominal short term lending rate. Short term rate has been used because much of the literature, based on a transactions view, uses a short-term rate. To construct measures of output and monetary uncertainty (volatility), Rolling Regressions have been run where each variable is regressed on its lag and a constant, with a sample size of 20 for each replication over 1967:1 -2006:3. After, every replication, one period is moved ahead and at the same time one period is dropped from the beginning. Lag length is restricted at 1 in all cases for simplicity, which is also common in literature. Real GDP and log of Real GDP are used as two measures of output uncertainty (volatility), and M1 and log of M1 for two measures of monetary uncertainty. Because, VEC in log variables and VAR in level (first difference) variables have been employed, a proxy for the financial service flow from the financial capital stock is measured as $F_t = R_t+(1-\delta)R_{t-1,}$ where R is the long-term interest rate per quarter, and δ, the depreciation rate on the capital stock, is set to $\delta = 0.0212$, a value widely used in the business cycle literature. For long term rate, Government Bond (long term) Yield is used. So for the proxy of financial service, finance service, fin = (F_t/π_{t+1}) is constructed, where π_{t+1} is future inflation which is used as a proxy for expected inflation (perfect foresight), for simplicity. Real balance is calculated as $(M1/P_{+1})$. In this context, it should be mentioned that, a forward looking agent is assumed.

Model, Estimation Method and the Result

We would like to examine whether there exists an equilibrium relationship among the variables such as real balance, real income, rate of interest, financial service, output volatility and monetary volatility.

Stationarity: First, stationarity of all the series is checked by using Augmented Dicky-Fuller test. All variables except output uncertainty are found to follow a unit root process at 1%, 5% and 10% levels. Output volatility is found to be stationary at 10% level. However, the null hypothesis of unit root cannot be rejected at 1% and 5% levels. Hence, it seems that for output uncertainty, the notion of stationarity is rather weak.

The next step is then to check whether the variables are cointegrated to employ Vector Error Correction method.

Cointegration: In line with literature, the logarithm of real balance, real income and financial service, and interest rate are used while other variables are in level.

With output uncertainty being unit root at 10% level, and other variables being clearly unit root process, a cointegration test could be performed directly. However, to be more certain, I perform a Panel Unit Root test with all mentioned variables, in order to check whether the variables together are a unit root process.

Table-1
Group unit root test: Summary

Sample: 1972Q1 2001Q2				
Series: FINANCE, INT_RATE, LNREAL_BALANCE, LNRGDP,				
MONEY_UNCERTAINTY, OUTPUT_UNCERTAINTY				
Method	Statistic	Prob.**		
Null: Unit root (assumes common unit root process)				
Levin, Lin & Chu t	0.30586	0.6201		
Breitung t-stat	-1.18591	0.1178		

The most widely used Panel Unit Root test, Levin, Lin and Chu test shows that the Null hypothesis of group (panel) unit root cannot be rejected at 1%, 5% or 10% levels. Breitung test also confirms the result.

Hence, by using cointegration method, the long run money demand relationship is tested. For comparison purpose, it is convenient to start with the conventional relationship,

$$(m- p_{+1}) - \alpha_y y - \alpha_r r = u \quad (1)$$

where m, p+1 and r denote logarithms of m1, the one period-ahead GDP deflator, real GDP and short term interest rate.

Johansen's (1988, 1991) trace test, JT(1) and maximum Eigen value test and Jmax(1) for cointegration among the variables are employed. Both Trace Test and Maximum Eigen value Test indicate two cointegrating vectors for model (1), which does not give a clear indication as to what should be the appropriate cointegration relationship.

Then the financial service variable is included. The model is then,

$$(m- p_{+1}) - \alpha_y y - \alpha_r r - \alpha_f f = u \quad (2)$$

Both Trace Test and Maximum Eigen value Test indicate two cointegrating vectors for model (2). Hence, the next model with uncertainty variables is tested.

As the stationarity of output volatility cannot be rejected at 1% or 5%, two methods are employed. First, monetary volatility is included in the model but output uncertainty is dropped. The model is then,

$$(m- p_{+1}) - \alpha_y y - \alpha_r r - \alpha_f f - \alpha_\lambda \sigma_\lambda^2 = u \quad (3)$$

Cointegration of the system is tested. In line with Choi and Oh (2003)[1], monetary volatility variable is treated as exogenous while testing for cointegration. Here, weak exogeneity of monetary volatility and output volatility is tested, and found that they cannot be treated as exogenous. Both trace test and maximum Eigen value test show two cointegrating vectors which makes it difficult to decide as to which vector is appropriate.

The next model includes both monetary volatility and output volatility,

$$(m- p_{+1}) - \alpha_y y - \alpha_r r - \alpha_f f - \alpha_\lambda \sigma_\lambda^2 - \alpha_\mu \sigma_\mu^2 = u \quad (4)$$

Where, σ_λ^2 and σ_μ^2 are the output volatility and monetary volatility respectively.

Johansen's (1988, 1991) trace test, JT(1) and maximum Eigen value test and Jmax(1) for cointegration among the variables are employed. Although trace test shows two cointegrating vectors, Maximum Eigen value shows only one cointegrating vector.

The results of the cointegration tests seem to show a long run stable money demand relationship.
Model (4) is then estimated by Vector Error Correction method.

Vector Error Correction Model: Using vector error correction on model (4), the estimated equation is given below:

d(real balance) = 0.014035 + 0.042405 dfin(-1) -0.237377dreal balance (-1)
[2.74510] [2.63828] [-0.94021]
-0.022133dinterest rate(-1) +0.000776dreal gdp(-1) + 78.18467doutput volatility(-1)
[-1.02759] [2.3403] [2.14877]
+ 47.28974 dmonetary volatility(-1) - 0.054860 EC
[2.71772] [-1.56624]

The coefficients have expected signs. Interest rate has negative and real output has positive sign as expected. A relationship between long run unit output elasticity of money demand cannot be established. Finance variable has positive, both monetary volatility and output volatility have positive signs. All of them are statistically significant. The EC term is negative but not significant. We then look into Impulse Response and Variance Decomposition.

Impulse response: Impulse response functions are depicted in the above diagram. The diagram shows that innovation in financial service has negative impact on real balance and the effect increases as time passes by. Interest rate has negative effect and the effect persists over time. Effect of real income is positive and declines slowly. Monetary uncertainty has negative impact and the effect increases gradually. The impact of output uncertainty is positive and the effect declines slightly.

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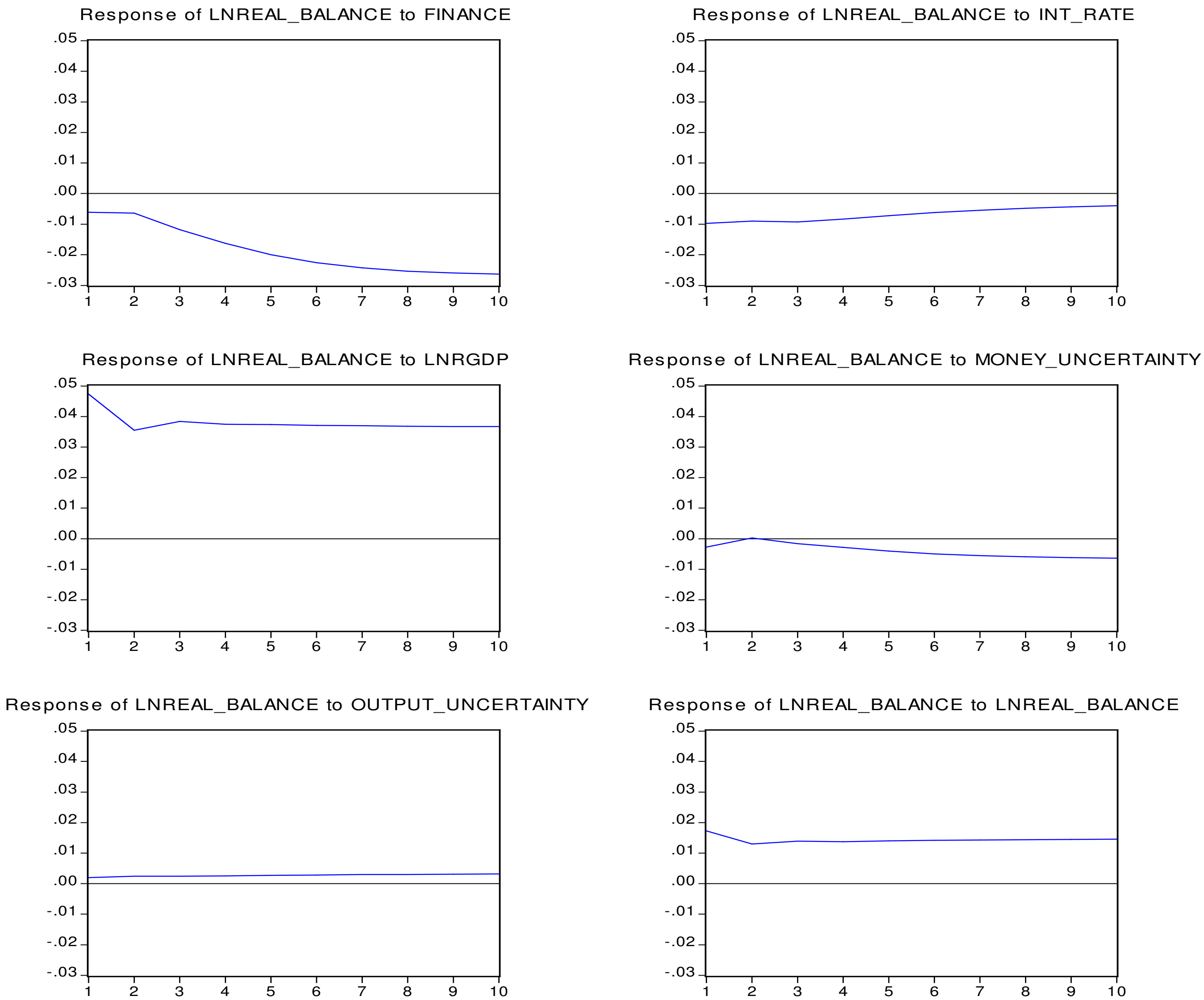

Figure-1
Response to Cholesky One S.D. Innovations

Table-2
Impulse Response of Real Balance

Period	Finance	Int_Rate	Lnrgdp	Money_Uncertainty	Output_Uncertainty	Lnreal_Balance
1	-0.00617	-0.00972	0.04738	-0.00278	0.002008	0.017243
2	-0.00642	-0.00903	0.035543	0.000179	0.00246	0.012921
3	-0.01177	-0.00932	0.038441	-0.00163	0.002464	0.013895
4	-0.01628	-0.00828	0.037448	-0.00287	0.002568	0.013764
5	-0.02001	-0.00723	0.03739	-0.00411	0.002703	0.014013
6	-0.02261	-0.00623	0.037124	-0.00498	0.002838	0.014172
7	-0.02432	-0.00543	0.036966	-0.00558	0.002953	0.014316
8	-0.02537	-0.00482	0.036836	-0.00596	0.003044	0.014418
9	-0.02598	-0.00436	0.036746	-0.0062	0.003112	0.01449
10	-0.02633	-0.00403	0.036682	-0.00635	0.003162	0.014539

Table-3
Variance Decomposition of Real Balance

Period	S.e.	Finance	Int_Rate	Lnrgdp	Money_ Uncertainty	Output_ Uncertainty	Lnreal_ Balance
1	0.05183	1.414984	3.51539	83.56356	0.288406	0.150149	11.06751
2	0.065158	1.866709	4.144656	82.63242	0.183248	0.237525	10.93544
3	0.078424	3.539406	4.273333	81.06701	0.169621	0.262682	10.68795
4	0.089947	5.965996	4.095836	78.95939	0.230996	0.281226	10.46655
5	0.100805	8.689824	3.775114	76.62366	0.349786	0.295785	10.26583
6	0.111011	11.31335	3.428027	74.36533	0.489329	0.309259	10.09471
7	0.120646	13.64113	3.104985	72.3493	0.628047	0.321756	9.954784
8	0.129738	15.61953	2.822854	70.62636	0.754387	0.333289	9.843581
9	0.138327	17.26831	2.582534	69.18432	0.864652	0.343799	9.756384
10	0.146462	18.63492	2.379274	67.98539	0.959014	0.353284	9.688122

Variance Decomposition: Variance decomposition (table-3) shows that in the first period, 1.42%, 3.51%, 83.56%, 0.29%, 0.15% and 11.07% of the variance of real balance are explained by financial service, interest rate, real GDP, money uncertainty, output uncertainty and itself respectively. The effect of financial service increases rapidly overtime. The effect of interest rate declines very slowly. The effect of real GDP declines. The effect of monetary uncertainty increases and the effect of output uncertainty increases and own effect decreases overtime.

Conclusion

Cointegration method shows that there exists a long run stable money demand relationship for Japanese economy. However, the result does not seem to be as robust as US economy. The cointegration tests reveal that there is some ambiguity in the number of the cointegration vectors. The vector error correction model though shows the correct signs of the elasticities. However, the coefficients are very low and mostly, not statistically significant. Impulse response functions suggest that innovation in financial service has negative impact on real balance and the effect increases as time passes by. Innovations in interest rate have negative effect and the effect persists over time. Effect of real income is positive and declines slowly. Innovations in monetary uncertainty have negative impact and the effect increases gradually. The impact of the innovations in output uncertainty is positive and the effect declines slightly. Variance decomposition shows that most of the variation in real balances is explained real GDP though the role of other variables such as financial service and output and money volatility increases as time passes by. Generally, impulse response and variance decomposition show that innovations in financial service, output volatility and monetary volatility play an important role in explaining money demand.

References

1. Choi W.G. and Oh S., A Money Demand Function with Output Uncertainty, Monetary Uncertainty, and Financial innovations", *Journal of Money, Credit and Banking*, **35(5)**, 685-709 **(2003)**

2. Goldfeld S.M., and Daniel E.S., The Demand for Money, *Handbook of Monetary Economics, edited by Friedman, B.M. and Hahn, F.H.*, 299-356, **(1990)**

3. Tobin J., Liquidity Preference as Behavior Toward Risk, *The Review of Economic Studies*, **25(2)**, 65-86, **(1958)**

4. Hamburger M.J., Behavior of the Money Stock: Is There a Puzzle?, *Journal of Monetary Economics*, **3(3)**, 265-288, **(1997)**

5. Narayan P.K. and Narayan S., Estimating the Demand for Money in an Unstable Open Economy: The Case of the Fiji Islands, *Economic Issues,* **13(1)**, 71-91, **(2008)**

6. Jackman M., Money demand and economic uncertainty in Barbados, *Munich Personal RepEc Archive* , MPRA Paper No. 29360, **(2011)**

7. Mierzejewski F., Liquidity Preference as Rational Behaviour under Uncertainty, *Munich Personal RepEc Archive,* MRPA Paper No. 2771, **(2007)**

8. Laidler and David E.W., *The Demand for Money: Theories, Evidence and Problems*, Fourth Edition, Harper Collins College Publishers, (**1993)**

9. Oskooee M.B. and Bahmani S., Monetary Uncertainty and Demand for money in Korea, *Asian Economic and Financial Review*, **4(3)**, 317-324, **(2014)**

10. Lim G.C., The Demand for the Components of Broad Money: Error-Correction and Generalised Asset Adjustment Systems, *Applied Economics*, **25(8)**, 995-1004, **(1993)**

11. Haug, A.A. and Robert F.L., Long-Term Money Demand in Canada: In Search of Stability, *The Review of Economics and Statistics*, **78(5)**, 1209-16 **(1996)**

12. Deutche Bundesbank, Demand for Money and Currency Substitution in Europe, Monthly Report (January), **(1995)**

13. Chowdhury A.R., The Demand for Money in a Small Open Economy: The Case of Switzerland, *Open Economies Review*, **6(2),** 131-44, **(1995)**

14. Stephen M.M., Monetary Dynamics: An Application of Cointegration and Error-Correction Modeling, *Journal of Money, Credit and Banking,* **23**(**2**), 139-154, (**1991**)

15. Baba Y., David F.H. and Ross M.S., The Demand for M1 in the USA, 1960-1988, *Review of Economic Studies*, **59**(**1**), 25-61, **(1992)**

16. Price, Simon and Insukindro, The Demand for Indonesian Narrow Money: Long-Run Equilibrium, Error Correction and Forward-Looking Behaviour, *Journal of International Trade and Economic Development*, **3**(**7**), 147-63, **(1994)**

17. Dekle Robert and Pradhan M., Financial Liberalization and Money Demand in ASEAN Countries: Implications for Monetary Policy, IMF Working Paper 97/36, International Monetary Fund, Washington, **(1997)**

18. Bahmani-Oskooee M., The Black Market Exchange Rate and Demand for Money in Iran, *Journal of Macroeconomics*, **18(4)**, 171-76, **(1996)**

19. Hossain A., The Search for a Stable Money Demand Function for Pakistan: An Application of the Method of Cointegration, Pakistan Development Review, **33(4)**, 969-81, **(1994)**

20. Fujiki H., Mulligan C.B., A Structural Analysis of Money Demand: Cross-sectional Evidence from Japan**,** Institute for Monetary and Economic Studies, Bank of Japan, **(1996)**