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The Demand for Narrow Money in Japan: An Examination by Cointegration and Error Correction Modeling

Kazuhiko Nakahira*

Abstract

This paper examines the stability of demand for narrow money in Japan utilizing the cointegration tests and conducts the estimation of the money demand function with the error correction model during 1980:1 – 2004:4. The former examination suggests the cointegration with respect to the money demand and the latter one shows the tendency of going back to the long-run equilibrium.

Key words: Demand for money, Unit root, Cointegration, Error correction model

JEL classification: E41; E52; E58

1. Introduction

The stability of money demand is one of the most significant issues of monetary policy. Thus, there have been many empirical studies in money demand function in major leading industrialized countries including Japan. For instance, Bahmani-Oskooee(2001) employed the autoregressive distributed-lag approach to study the M2 demand. Conclusion derived by this study is that M2 monetary aggregate in Japan during 1964:1–1996:3 was cointegrated with income and interest rate. Amano and Wirjanto(2000) examined whether a structurally stable long-run M2 demand function could be found in Japan during 1967–1993 by various tests for cointegration. They found the strong evidence in favor of cointegration between money, income, and interest rate by DF-GLS test. For narrow money, Hafer and Jansen(1991) and Miller(1991) investigated the stability of money demand function in the United States relying on the cointegration technique. These two studies found M1 demand was not cointegrated with income and interest rate, but M2 demand was. Hoffman, Rosche, and Tieslau(1995) implemented the cointegration analyses with respect to M1 demand in the United States, Japan, Canada, Britain, and Germany concluding the money demands in the above five countries were stable. Miyao(1998) showed that the cointegrating relation with regard to M1 demand in Japan did not exist in the period 1955:2 – 1996:4 by the Johansen's test. Ghosh(2000) investigated the long-run equilibrium relationship in M1 demand and the chance of structural change in five major countries – U.S., U.K., Canada, Germany, and Japan – applying the Johansen's

*Assistant professor at the University of Shimane, Department of Policy Studies and part-time lecturer at Saitama University, Department of Liberal Arts; Economics.

test and the Gregory and Hansen's(1996) test. In the case of Japan, Ghosh(2000) found that M1 demand had a long-run equilibrium relationship with income and long-term interest rate but not with income and short-term interest rate, and found no evidence of structural change.

Theoretically, the policy which targets the interest rate is comparatively appropriate rather than the one which targets the money supply when money demand is unstable. Japanese economy experienced the rise and the crush of the bubble, the financial distress, and the untraditional monetary policies to deal with the recession from 1980s to 2000s. These factors are the examples which might lead the money demand in Japan to be unstable. In this respect, the examination of the stability of money demand function in Japan is worth while implementing for the purpose of discussing the direction of future monetary policy. Thus, the purpose of this paper is to carry out empirical examination of the stability of demand for narrow money, M1, utilizing cointegration tests and to estimate the money demand function with the error correction model for recent Japan.

The reminder of this paper is organized as follows. In section 2, the results of the unit root tests and the cointegration tests are presented. Section 3 is for the estimation of the error correction model. Conclusions are described in section 4.

2. Unit Root Tests and Cointegration Tests

We examine the existence of a long run equilibrium relationship, in other words, cointegration, between the variables which compose a money demand function.[1] For our estimation, M1(as the narrow money in Japan),[2] GDP(Gross Domestic Product: as the scale variable), CALL(collateralized overnight call rate: as the short-term money market rate),[3] and QDEF(implicit price deflator for GDP: as the variable for price index) are considered.

The first task for our analysis is to determine the order of integration of each variable, in short, to conduct unit root test. Sample period is 1980:1 – 2004:4(quarterly). The results of ADF tests (augmented Dickey-Fuller tests) are reported in Table 1. In these tests, M1 and GDP are expressed in natural logarithm after deflated by the implicit price deflator to convert them into real values. CALL and QDEF are expressed in natural logarithmic form. Test procedure is based on Dolado, Jenkinson, and Sosvilla-Rivero(1990) and the maximum lag length is set as eight basically following the procedure proposed by Campbell and Perron(1991). According to the results of ADF tests displayed in Table 1, the test statistics for the levels are not smaller than the 5 percent critical value, while the ones for the first difference are not. Thus, all the

Table 1: ADF Test

	Levels		First difference	
Variables	Test statistic	Opt. lag	Test statistic	Opt. lag
M1	-1.263740	4	-4.244069	4
GDP	-0.7316911	7	-4.119497	6
CALL	-1.575766	3	-7.560813	4
QDEF	-0.1653890	7	-3.923263	6

Notes: This test includes drift and time trend. Critical values are in Fuller(1976).

Table 2: Johansen's Test

Test statistics			
λ_{trace}		λ_{max}	
H_0:r=1	53.057660	H_0:r=0	56.200467
H_0:r≤1	5.731510	H_0:r=1	6.460252
H_0:r≤2	0.291310	H_0:r=2	0.345926
Opt. lags	4		
Eigval.1	0.44655		
Eigval.2	0.065742		
Eigval.3	0.0036347		
AIC	-467.28882		

Estimated cointegrating vectors			
	1	2	3
M1	1.00000	1.00000	1.00000
GDP	-2.35086	1.62471	-0.14614
CALL	0.17765	0.051063	0.015030

Notes: This test includes const., time trend, and seasonal dummies. Lag length is determined by the minimum AIC setting the maximum lag length is 8. Critical values for this test are in Osterwald-Lenum M.(1992). The estimated cointegrating vectors are normalized with respect to M1.

variables are found to be non-stationary I(1) variables.

Since all the variables are found to be I(1), our next task is to conduct the cointegration test. In this case, the cointegration test itself investigates the equilibrium of supply and demand for money. Table 2 indicates the results of the Johansen's Trace Tests(λ_{trace}) and the Maximal Eigenvalue Tests(λ_{max}) for M1, GDP, and CALL. We would find a single cointegrating vector by examining the λ_{trace} and λ_{max} statistics at 5 percent level of significance. However, it is often pointed out that we have to consider the problems of size distortion when we interpret the test statistic derived by the Johansen's procedure with small sample.[4] One of the possible treatments for this problem is to adjust the test statistic following the procedure proposed by Cheung and

Table 3: Adjusted test statistic for Johansen's Test

Adjusted test statistics by the method of Cheung and Lai(1993)

λ_{trace}		λ_{max}	
H_0:r=0	46.355640	H_0:r=0	49.101461
H_0:r≤1	5.007530	H_0:r=1	5.644220
H_0:r≤2	0.254513	H_0:r=2	0.302230

Table 4: AEG Test

Test statistic	Opt. lags
-3.033367	8

Estimated cointegrating vectors

GDP	0.747427	(12.0218**)
CALL	-0.114713	(-29.4577**)
Const.	4.29391	(9.87129**)

Notes: T-statistics are in parentheses. The symbol ** denotes significance at 1%.

Lai(1993) – we multiply original statistic by (T–nk) / T, where T: number of the sample, n: number of dimension of the system, k: number of the lags. Table 3 shows the adjusted λ_{trace} and λ_{max} statistics by this procedure, and we could find a single cointegrating vector again at 5 percent level. Moreover, Table 4 indicates the result of the AEG Test(augmented Engle-Granger test) which is one of the other cointegration tests. The test statistic displayed in Table 4 rejects cointegration at 5 percent level of significance. On the whole, the results of Johansen's procedure and AEG test are not consistent. But the favorable result given by the Johansen's test is adopted to constitute our analysis. Therefore, the variables – money, income, and short-term interest rate – are regarded as the ones which have a common stochastic trend, in short, they are cointegrated. In other words, M1 demand is stable as long as we assume the model constituted by M1, GDP, and CALL during the period 1980:1 – 2004:4 from the aspect of cointegration.

3. Estimation of Money Demand Function

There have been many discussions with respect to the technique for estimation of money demand function. One of the examples is that conventional Goldfeld-type specification, which is based on the theory of adaptive expectation or of partial adjustment, is now regarded as the one that has lost adaptability for money demand in major industrialized countries. Hence, many researchers have tried to develop the quality of estimation. One way to deal with this kind of problem is to adopt the ECM, the error correction model, which many of the recent studies have shed light on. The basic idea of the ECM is that the theoretical equilibrium for the variables is held only under the long-run steady state while the observed data set is the reflection of people's

Table 5: Estimated money demand function with the ECM

Variable	coefficient	t-statistic
C	-0.111821	-2.58508*
ECT(-1)	-0.016015	-3.10126**
DG	0.199349	1.67359#
DC	-0.00916247	-2.46457*
DP	-0.900682	-2.85198**
Q1	0.037877	1.75479#
Q2	0.033437	3.61573**
Q3	-0.010749	-0.529549
Adj.-R^2	0.726710	
SER	0.018846	
D-W	1.51787	

Notes: Q1, Q2, and Q3 denote dummy variables for the first quarter, the second quarter, and the third quarter, respectively. T-statistics are in parentheses. The symbols **, *, and # denote significance at 1%, 5%, and 10% levels, respectively. SER is standard error of regression. D-W denotes Durbin-Watson statistic.

behavior for partially correcting some errors in the past. Bolstered by this favorable characteristic, the ECM is applied to the estimation of money demand function in this paper.

The estimated cointegrating vectors for our analysis are listed in Table 2. Based on the cointegrating vectors, the error correction term(ECT) is constituted as follows.

$$ECT = M - 2.35086 \cdot G + 0.17765 \cdot C$$

where M = ln(M2+CD / QDEF), G = ln(GDP / QDEF), C = ln(CALL),

QDEF: implicit price deflator for GDP.

A built-in error correction term for money demand function as a lagged variable could express a tendency of going back to the long-run equilibrium. From another aspect, if the sign of the estimated lagged error correction term is negative, it would indicate the inclination of recovering the equilibrium.[5]

The model for our estimation is formed by the variables—M1, GDP, CALL, and QDEF — with the one-period lagged error correction term, ECT(−1). Thus, the structure of our model is as follows.

$$DM = \beta_0 + \beta_1\, ECT(-1) + \beta_2\, DG + \beta_3\, DC + \beta_4\, DP + \varepsilon$$

where DM = Δln(M2+CD / QDEF), ECT(−1) = ECT_{-1}, DG = Δln(GDP / QDEF),

DC = Δln(CALL), DP = Δln(QDEF).

All the variable are employed as first order difference forms since they follow unit root processes as shown by the results of ADF tests in Table 1.

Table 5 displays the result of the estimation. The error correction term, the loading vector or the speed of adjustment coefficient, has the particular implication in that it is related to the dynamics of the money demand function as described above. ECT(−1), one period lagged error correction term, is significant at 1 percent and its sign is negative. Thus, a tendency to recover the long-run equilibrium would be found. One of the other important factors, DG, as the scale variable yielded 10 percent level of significance. DP, the price level term, is highly significant but its sign contradicts the standard assumption. It might be related to the deflation in Japan from the 1990s to the early 2000s, or could be understood to mean that money and price level had a negative relationship in deflation if we take the monetary policies by the central bank in this period into account. The estimated coefficient of interest rate is significant at 5 percent, and it implies the negative relationship between the interest rate and the demand for money.

4. Conclusion

This paper empirically investigated the stability of demand for narrow money, M1, in Japan from the 1980s to the early 2000s. Johansen's cointegration tests conveyed favorable results, and they implied the stability of money demand in the period we focused on. In addition, the result of the estimation of the money demand function based on the error correction model had no crucial problem except the unfavorable sign of the price term. However, we have to consider the latent problems of Japanese economy which might affect the money demand. Looking back on the past, the 1980s was the era of financial deregulation and the bubble economy, while the 1990s was that of bubble crush, financial distress, and prolonged deflation. Furthermore, the Bank of Japan conducted the "zero interest rate policy"(from February, 1999 to August, 2000) by guiding the uncollateralized overnight call rate to very close to zero percent and the "quantitative easing policy"(from March, 2001 to March, 2006) by temporarily changing its operating variable from the uncollateralized overnight call rate to the amount of reserve accounts of monetary institutions. Therefore, it is not strange to doubt the underlying stability of Japanese money demand in the past two decades.

Unstable demand for money derives the particular implication for the direction of monetary policy. Money supply cannot always be controlled by the central bank as the exogenous variable in reality. The level of money supply is usually determined as the accommodatingly supplied quantity by the central bank toward the level of money demand. Hence, unstable money demand derives the difficulty for the central bank in adjusting money supply.

Taking the problems above into consideration, further investigations with respect to the money demand in Japan are required from various aspects.

Endnotes:

1. The data description is as follows.
   *M1: billion yen, (Data Source: Toyo Keizai Shinposha(ed.)(2005), *Keizaitoukeinenkan 2005*(in Japanese), Toyo Keizai Shinposha.)
   *GDP: Quarterly Estimates of Nominal GDP on SNA93, base year = 2000, billion yen. (Data Source: Toyo Keizai Shinposha(ed.)(2005), *Keizaitoukeinenkan 2005*(in Japanese), Toyo Keizai Shinposha.)
   *CALL: Collateralized Over Night Call Rate, Average Rate, %. (Data Source: Toyo Keizai Shinposha(ed.)(2005), *Keizaitoukeinenkan 2005*(in Japanese), Toyo Keizai Shinposha.)
   *QDEF: Quarterly Estimates of GDP deflator on SNA93, base year = 2000. (Data Source: Toyo Keizai Shinposha(ed.)(2005), *Keizaitoukeinenkan 2005*(in Japanese), Toyo Keizai Shinposha.)
2. M1 = currency + demand deposits. With respect to M1, long run sequential time series data is not available due to the renewal of the statistics by the Bank of Japan. Therefore, the data on M1 excluding foreign banks in Japan, etc. was used for 1980:1 − 1999:1 and the one including foreign banks in Japan, etc. was used for 1999:2 − 2004:4.
3. The Bank of Japan traditionally regards uncollateralized overnight call rate as the operating variable of its monetary policy. However, data on the uncollateralized overnight call rate is available only from 1985. Therefore, the collateralized overnight call rate is adopted as the proxy variable in this paper.
4. This is a kind of delicate problem which is related to the size and power properties of the cointegration test with a finite-sample size. In other words, due to size distortions, a test might inappropriately reject the null hypothesis, or a test might wrongly accept the null owing to its low power.
5. In the cointegration literature, “equilibrium” means a certain observed relationship which has been maintained on average in the long run by a set of variables.

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