FINANCIAL INNOVATION AND THE STABILITY OF MONEY DEMAND IN KOREA

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ABSTRACT

The existence of a stable demand function for M2 in Korea is important for the conduct of monetary policy and financial analysis. However, despite much research into the subject, results thus far yield no conclusion as to whether M2 demand is in fact stable. Previous studies, however, have failed to adequately control for financial innovation. When adding a proxy for such innovation to the cointegrating vector, we find that M2 demand is in fact stable, thus reconciling previous conflicting findings.

INTRODUCTION

The demand for money in Korea has received attention from a number of authors in recent years. These studies have yielded important insights into the long-run stability of demand for aggregates such as M1 and M2 (see Bahmanin-Oskooee and Rhee, (1994), Lee and Chung, (1995), Lee and Hwang, (1998), Chun (1998)). The aggregate M1 is a fairly narrow definition of money that includes currency and checking account balances. On the other hand, M2 is a broader measure that includes M1 plus savings and time deposits. The purpose of this study is to examine the stability of demand for M2. This category of money was long the intermediate target of the Bank of Korea in setting policy. While it no longer serves such a formal role, there is always controversy over whether central banks should adopt such formal targets (Fatas, Mihov and Rose (2004) find a formal target of any type reduces inflation). Moreover, M2 is still a very significant indicator of liquidity for policymakers and agents in the economy. Ascertaining whether a *stable* long run demand for M2 exists is therefore important, and has properly attracted the attention of a number of authors. The mixed results thus far on cointegration and the plausibility of parameter estimates imply that further investigation is warranted. In addition, another puzzling aspect of M2 has been the secular downward trend in velocity (see Kim (1992) and Chun (1994)). Velocity is the average number of times a given unit of currency turns over, usually within a year. This presents a bit of a mystery, given that velocity is usually expected to rise over time as the payments system evolves.

This paper will also examine the impact of financial liberalization and innovation for obtaining a stable demand function. Financial innovation allows agents to economize, over time, on cash holdings. Tobin (1965) emphasized the importance of innovation to money demand. Other authors such as Baba, Hendry and Starr (1992), Bordo and Jonung (1987) and Lieberman, (1977) have used various

techniques to model the process. Failure to do so may cause false inference in estimation. Accordingly, we will here employ a linear time trend within the cointegratng vector. This specification yields results that are stable and plausible.

The other puzzle, falling velocity, has been attributed to the "monetization" of the Korean economy. Several authors (Yoo (1994), Chun (1998)) have found that the coefficient on the scale variable in the money demand function exceeds one, implying that real money balances have an income elasticity of greater than unity. Agents are thus willing to hold greater money balances for a given set of income and opportunity cost variables. This effect is contrary to that from financial liberalization, which allows agents to economize on cash holdings. However, that the two effects exist will be demonstrated. To do so requires the modeling of innovation so that innovation and monetization are not conflated, which may cause omitted variable bias as well as a failure to find cointegration.

This paper proceeds as follows. The previous results on Korean money demand are surveyed. Then the importance of innovation to money demand is explored. Finally, a long run demand function for M2 is estimated, and results indicate stability and plausible estimates once a linear trend captures the process of liberalization. The coefficient on output is greater than one, implying monetization and explaining falling velocity, while the negative trend implies that there has been a movement in the other direction, towards economizing cash balances, due to financial liberalization.

PREVIOUS RESULTS

For any nation, stability (or lack thereof) in monetary aggregates has significant policy implications. The decision on what instruments to use as intermediate and operating targets depends crucially on the nature of money demand. Previous studies have yielded important insights into this subject for Korea. These studies examine whether cointegration exists for real money balances and interest rates and income. This analysis begins with a set of variables which are *nonstationary.* That is, they have no well-defined finite mean or variance. As such, standard regression analysis on such variables would lead to spurious results. However, there could be a linear combination of nonstationary variables that is stationary. For instance, spot currency and forward currency prices are individually nonstationary, but a linear combination is stationary since the two never prices never move far from each other for long. Thus to find stable money demand a researcher must find cointegration between real money balances and other determinants such as interest rates and output.

Focusing only on M1, Arrau, et al. (1995), found mixed results when testing for cointegration using the Engle-Granger method. Bahmani-Oskooee and Rhee (1994, referred to as B-R hereafter) found results indicating that M1, and not M2, were cointegrated. Since the Bank of Korea was formally targeting M2 at the time, this suggested that the authorities switch targets as a policy implication. Later studies, such as Yoo (1994), Lee and Chung (1995), and Chun (1998) found cointegration for M2 and in the case of the latter two, none for M1. Lee and Whang (1998) found cointegration for M3, but no meaningful long-term relationships for M2 or M1.

These studies have used a variety of techniques and regressors. In B-R, as in Arrau, et al., the Engle-Granger method of detecting a cointegrating vector is used. The others rely on the Johansen test. All rely on some form of income and

opportunity cost variable. B-R and Chung and Lee add the real exchange rate as a determinant of money demand (and do not find stability without it for either aggregate). Chun, in addition to scale and interest rate measures on the right hand side, used the real wage as an indicator of permanent income.

These papers indicate that a cointegrating vector likely does exist for M2, given that most studies using the Johansen procedure have found one. Another finding of some of these papers is that real money demand responds more than proportionally to a change in output. While Lee and Chung (1995) find an income elasticity of only 0.602 for M2, Yoo (1994) finds a corresponding figure of 1.13. Moreover, Chun (1998) finds that the effect of transactions on money demand is on the order of 1.3. These estimates are quite plausible when compared to other results worldwide. Goldfeld (1987, p. 137) points out that some studies of money demand in the United States found income elasticities of nearly two. This "excess sensitivity" of M2 holdings to a change in output is presented as evidence that the Korean economy is becoming "monetized", or that money is playing a larger role in transactions generally. This effect can explain the secular decline in M2 velocity noted by a number of authors (see Kim (1992), Chun (1998), and Lee and Hwang (1998)).   In most nations, velocity is expected to increase over time as payments systems evolve and cash management improves. However, the increased willingness to hold M2 as income increases would tend to move velocity in the opposite direction, despite increasing financial sophistication in Korea.

MOTIVATION AND METHOD

In modeling long run money demand, accounting must be made for the effects of financial liberalization and innovation.   Over time, as restrictions on holding interest-bearing assets are loosened and agents learn to economize on holding cash, less money should be demanded for a given set of scale and opportunity cost variables.   This phenomenon has been determined as important in a number of empirical studies for many nations. In the U.S., for example, Baba, Hendry and Starr (1992) use a weighted learning curve to proxy adaptation to new financial instruments as a determinant of M1 demand. Arrau, et al (1995) use a random walk term in the cointegrating regression to capture the effects of innovation. Bordo and Jonung (1987) employ the currency-money ratio to measure the effect of financial deepening on money demand. Finally, other observers, such as Lieberman, et al. (1977) include a linear time trend in the demand function to account for the increasing ability to manage cash balances over time.

Financial liberalization has been ongoing in Korea since the 1970s. Failure to account for its effect on M2 holdings can impart an omitted variable bias on the estimates of a money demand equation. There have been many cases in the literature on money demand for both developed and developing nations where traditional equations "break down" in that they forecast more cash than is actually held. Moreover, it is often the case, for instance, that in many studies cointegration fails to obtain, or that parameter estimates are of the wrong sign or insignificant.   It follows that inclusion of a proper measure of financial innovation can lead to sensible estimates of stable, long run money demand functions. This is an important issue for Korea as there is as yet no consensus on a stable M2 demand function for the country. The idea can be summarized in the following equation:

$$(M/P)_t = \beta_1 y_t + \beta_2 i_t + \beta_3 fi_t + \varepsilon_t \tag{1}$$

Here, M is nominal M2, P is the producer price index, y is real output, i is the nominal interest rate, and fi is financial innovation. The key question at hand is finding a proper proxy for such financial innovation in Korea.

Since Korea liberalized in a fairly gradual fashion over a long period (see Kim, (1992), and Park (1996) for an accounting of the liberalization process in the late 1970s and 1980s) a time trend in the long run demand function should serve as the appropriate approximation of innovation. Arrau, et al. (1995) employed a random walk term to find monetary stability in Korea for M1, but this technique did not produce stability in this case (although it did for other nations whose payments systems were doubtless far less advanced than Korea's). It is likely appropriate in nations where there has been greater financial repression and little in the way of liberalization. A weighted learning curve for various financial instruments, as was employed in Baba, Hendry and Starr (1992) would be difficult to model here. The aggregate in question for that paper was M1, and there was only one really relevant change that the learning curve was employed to detect (adjustment to the NOW and Super NOW accounts recently legalized). There were a large number of laws changed with regard to interest rates in Korea, on the other hand, as well as many other changes in the financial sector, and modeling all relevant changes would lead to high collinearity among the regressors.

Thus, we will employ a linear trend to capture the effects of gradual innovation. This trend will be part of the cointegrating vector itself, rather than outside of the long-run money demand function, in the VAR, as has been done in previous studies (see Lee and Chung, (1995) as well as Lee and Hwang, (1998)). This is important as the effect of liberalization should enter as a variable directly into the long run money demand function. The hypothesized sign of the trend coefficient is negative. On the other hand, if the Korean economy has become monetized, there is an increasing tendency to hold cash balances, which is contrary to the effect of innovation. This is an unobserved process, and there is no way to explicitly model it based on first principles. A proper measure must, however, capture the main effects of growing sophistication in managing cash holdings.

The effect of greater monetization and decreasing velocity should show up, as it has in previous studies, on the income parameter. The impact here is to lower velocity. Again, it is initially puzzling, in the face of financial innovation, to observe falling velocity. An increasing ability to mange money holdings would be expected to raise velocity, as generally occurs. However, the very liberalization which allows agents to minimize cash balances also permits greater interest paid on many categories of money. Thus it is not entirely surprising that velocity has fallen in Korea over the past two decades. A similar phenomenon was observed in the United States, during 1982-1983, when velocity experienced a sharp drop after years of steadily rising. Making this turn of events all the stranger was the fact that those years experienced relatively high nominal interest rates. The factor that seemed to lower velocity was the ability of checking and other deposits to earn interest, which they could not do in earlier years, thus encouraging a longer holding period for cash. This same situation is likely at work in Korea, with liberalization having these contrary influences on money demand. The following model will capture these effects.

DATA AND ESTIMATION

The data on M2 was compiled from the International Financial Statistics database and covers the period 1976:4 through 1998:3 (all data is quarterly).   The monetary aggregate is deflated by the producer price index. The scale variable is real GDP. Other scale variables have proven useful for some countries, but Park (1998) has indicated that real GDP is the main source of transactions demand in Korea. For the opportunity cost determinant, care must be taken since some studies have included deposit rates that are more properly own-yields and should be expected to have positive signs (see Lee and Chung's (1995) comment on B-R, p.104). Thus, the rate on government housing bonds is used.

Lee and Chung (p. 104) discuss the importance of seasonal effects in the Korean money market. Accordingly, all of the variables are first seasonally adjusted before any analysis to avoid any biases that seasonality might impart (M2 is first divided by the price index, as seasonally adjusting only nominal quantities and then deflating can impart biases on the estimates. See Lee and Chung, p. 106, note 7).

Next, the Augmented Dickey-Fuller test is applied to all of the variables and the results are displayed in Table 1This test is designed to detect the presence of unit roots. Each series, denoted here as z_t, is modeled as follows:

$$\Delta \ z_t = \alpha + \gamma \ z_{t-1} + \varepsilon_t \tag{2}$$

If we cannot reject the null hypothesis that $\gamma = 0$, we conclude that the given series has a unit root and is nonstationary. As noted, the null hypothesis of a unit root cannot be rejected at any standard significance level in any case.

TABLE 1.
ADF TESTS

	Test Statistic	5 Percent Critical Value
Log of Real M2	-2.66757	-3.462
Log of Bond Yield	-0.947539	-3.462
Log of Real GDP	-2.158987	-3.462

Having established that all variables are I(1), the Johansen method of testing for cointegration is employed.   Other studies have employed the Engle-Granger method, but as Lee and Chung point out, this technique is ad hoc and results depend on the choice of the left hand side variable. That is, while asymptotically the Engle-Granger procedure will determine cointegration without respect to which variable is dependent, in the finite samples available in research, which variable is placed on the left hand side will affect the results.

Moreover, the Engle-Granger technique relies on a two-step procedure, in which the cointegrating regression is estimated, and then the residual from this regression is tested for a unit root. Rejection of the null hypothesis of a unit root in the estimated residual is tantamount to rejecting the null hypothesis of no

cointegration. However, the process of least squares regression in the first step means fitting a model by choosing parameters to minimize the residual variance. Thus the Engle-Granger procedure can be biased in favor of finding cointegration when the variables may not in fact be cointegrated. Accordingly, the Johansen procedure, which is a rank test and doesn't rely on which variable is considered dependent, is now the preferred choice in studies of cointegration.

The method entails collecting all the variables-real money balances, real GDP and the government bond rate-into a vector, y_t. Then, we form a vector autoregression (VAR) with p lags:

$$y_t = \mu + A_1 y_{t-1} + A_2 y_{t-2} + \dots + A_p y_{t-p} + u_t \tag{3}$$

The number of lags can be chosen by likelihood ratio tests. This VAR can be rewritten as:

$$\Delta y_t = \mu + \sum_{i=1}^{p-1} \Gamma_i \Delta y_{t-i} + \Pi y_{t-1} + u_t \tag{4}$$

where $\Gamma_i = -\sum_{j=i+1}^{p} A_j$, and $\Pi = \sum_{i=1}^{p} A_i - I$. There are three possibilities for the rank of Π. If all of the variables have unit roots and there is no linear combination that is stationary, then the rank is zero and we have a traditional VAR in first differences. If the rank is equal to the number of variables, then all of the variables are stationary, and there is no cointegration. Finally if the rank of Π is less than the number of variables, but greater than zero, (say rank(Π) =r, where 0< r <n), then there are r cointegrating vectors. Since only nonstationary variables can be cointegrated, it was necessary to perform Dickey-Fuller tests.

There are two tests employed to determine whether there is cointegration among the variables. The trace test, computed as:

$$\lambda_{trace}(r) = -T \sum_{i=r+1}^{n} \ln(1 - \lambda_i)$$

where T is the number of usable observations , and the λ_is are the estimated eigenvalues from the matrix Π, tests the null hypothesis of at most r cointegrating vectors against a general alternative of more than r such relations in the VAR. The max test, calculated as:

$$\lambda_{max}(r, r+1) = -T\ln(1 - \lambda_{r+1})$$

tests the null hypothesis of at most r cointegrating vectors against the more specific alternative of r +1 common trends.

In order to apply this method, a standard money demand function, with real GDP and the housing bond interest rate, is estimated. As demonstrated in table two,] despite experimenting with several different lag lengths, it was impossible to obtain sensible parameter estimates. This situation is similar to that in Lee and Hwang, in which the coefficients in the M2 equation are insignificant, and Chun, who finds the results for M1 inconsistent with theory in that GDP has a negative sign. This result is somewhat different than that found in B-R and Lee and Chung. These authors also found coefficient estimates that were clearly nonsensical with respect to standard

theory, but unlike our estimation, they failed to find cointegration. In all of the first three columns of table two, the trace test indicates we can reject the null hypothesis of no cointegrating vectors at the five percent level (and indeed at the one percent level for five lags).   Again, the parameter estimates do not conform to theory, but we do find cointegration by the trace (but not the max) test.

      Since these results are likely driven by the omission of financial innovation, a linear time trend was added to the model. To determine appropriate lag length, the likelihood ratio test is used. As noted in table 2, the null hypothesis of three lags can be rejected in favor of four. However, the null hypothesis of four lags cannot be rejected in favor of five. Four is then the optimal lag length. The results clearly indicate the presence of a cointegrating vector. The null of no cointegrating vector against the alternative of at least one can be rejected at the one percent level by the trace test. In addition, the null of no cointegrating vector against an alternative of exactly one can also be rejected at the one percent level be the more powerful maximum eigenvalue test.

TABLE 2.
COINTEGRATION TEST RESULTS

Variable	Column 1	Column 2	Column 3	Column 4	Column 5	Column 6
Lngdp	-1.599 (0.0411)	-1.614 (0.0417)	-1.637 (0.0477)	0.977 (0.667)	1.771 (0.795)	1.058 (0.669)
Bond Yield	-0.066 (0.0522)	-0.0496 (0.0486)	-0.0425 (0.051)	-0.852 (0.172)	-1.1127 (0.2169)	-0.81 (0.162)
Trend				-0.0585 (0.0144)	-0.0761 (0.0174)	-0.059 (0.014)
Lags	3	4	5	3	4	5
Likelihood	489.156	489.645	502.315	500.294	506.926	508.923
Trace Tests	26.208*	26.169*	33.216**	46.572*	56.64**	38.55
Max Tests	20.177	20.677	22.47	28.978*	42.164**	19.705

Note: For the coefficients in the cointegrating regressions, standard errors are in parentheses. For the trace and maximum eigenvalue tests, * denotes rejection of the null of no cointegrating vector at the five percent level of significance, while ** denotes rejection at the one percent level. The critical values are from Osterwald-Lenum (1992), table 2, p. 469. For the regressions with the time trend included, the likelihood ratio test was employed to determine optimal lag length. It was possible to reject three lags in favor of four with a Chi-square test statistic of 13.2644, which exceeds the one percent critical value of 11.34. It is not possible to reject four lags in favor of five, however, as the test statistic is 5.99, which does not exceed the ten percent critical value of 6.25.

      The coefficients are all significant and appropriately signed. The elasticity with respect to real GDP is 1.77, indicating that the Korean economy is indeed becoming monetized. That is, demand for M2 rises by 1.77 percent for every one percent rise in real output.   The fact that money demand responds more than proportionally to income helps explain the declining velocity experienced over the last several decades. Also important is the coefficient on the linear time trend. Both negative and significant, it indicates that, for a given level of scale and opportunity

cost determinants, cash balances are declining. Thus this equation contains both the effect of financial innovation and monetization. Finally, the negative coefficient of -1.12 suggests that M2 responds negatively and significantly to higher interest rates.

It is important to note that in most typical studies of money demand, finding cointegration is usually evidence that a stable money demand function exists. There could be structural change in the cointegrating vector, but the existence of a structural break will lower the power of the Johansen procedure and often lead to a failure to find cointegration. Thus the finding of cointegration is strong evidence of stability. However, there could still be some structural change in the cointegration relationship. We tested residuals from the Engle-Granger equation, and found there was a structural change in the midpoint of the data set. This method of testing for structural change is similar to the technique of Gregory and Hansen (1996). However, the finding of a cointegrating relationship (at less than the one percent level of significance) does indicate a stable long run M2 demand function, regardless of any potentially small changes in parameters over time. Estimating the exact nature of any structural change in the money demand function is a topic for future research.

It is important to recall that other studies have found plausible M2 demand functions, although the results are somewhat conflicting. B-R found no cointegration for M2, but did for M1 by adding the real exchange rate to the right hand side of the equation. In a similar spirit, Chung and Lee found cointegration for M2, but not M1, by adding the real exchange rate. Chun used the real wage to get cointegration for M2. However, variables such as the real exchange rate or the real wage are only capturing a small part of the liberalization process in Korea. Deregulation was very broad in Korea, and took place over many years. The process included decontrol of interest rates, allowing banks to expand overseas operations, and then later allowing for commercial paper and bank privatization. Thus particular variables such as the real exchange rate or real wages will at best capture only a portion of the deregulation and innovation process. Thus a linear time trend, as employed in Lieberman, et al. (1977) is more appropriate.

CONCLUSION

The results make clear that a stable long run demand function for M2 exists. Some previous conflicting estimates likely are attributable to the absence of a term accounting for financial innovation. The liberalization of financial markets in Korea, and the corresponding adjustment of money-holding agents have led to smaller cash balances, given a set of scale and interest rate variables. The demand function estimated is cointegrated, with the corresponding test statistics able to reject the null of no stability at the one percent level.

This finding has important implications for the conduct of monetary policy. While there is no longer a policy in place of formally targeting M2 as an aggregate, the measure is still a major indicator of monetary conditions and doubtless central bank officials continue to keep it under close observation. While M2 was formally targeted, the central bank usually missed its target level of the variable (a situation similar to those in other countries who chose to target monetary aggregates). In order to hit the target with relative accuracy, money demand must be stable. It is not surprising then, that relying on forecasts for money demand which fail to take account of financial innovation, a policymaker will be systematically disappointed in efforts to control M2.

REFERENCES

Arrau, Patricio, Jose DeGregorio, Carmen M. Reinhart and Peter Wickham, "The Demand for Money in Developing Countries: Assessing the Role of Financial Innovation", *Journal of Development Economics*, April 1995, 317-340.

Baba, Yoshihisa, David F. Hendry and Ross M. Starr, "The Demand for M1 in the U.S.A., 1960-1988", *Review of Economic Studies*, 1992, 25-61.

Bahmani-Oskooee, Mohsen and Rhee, Hyun-jae, "Long-Run Elasticities of the Demand for Money in Korea: Evidence from Cointegration Analysis", *International Economic Journal*, Summer 1994, 83-93.

Bordo, Michael and Lars Jonung, *The Long-Run Behavior of the Velocity of Circulation: The International Evidence*, Cambridge, University Press, 1987.

Chun, Sang June "Cointegration-Error Correction Model Estimation in Korean Money Demand Function", *Studies in Monetary Economics*, 1998, 1-32 (in Korean).

Fatas, Antonio, Ilian Mihov and Andrew Rose, "Quantitative Goals for Monetary Policy", working paper, university of California Berkeley, 2004.

Gregory, A.W. and Hansen, B.W. "Residual-based Tests for Cointegration in Models with Regime Shifts", *Journal of Econometrics*, 1996, 99-126.

Johansen, Soren, "Statistical Analysis of Cointegration Vectors", *Journal of Economic Dynamics and Control*, February 1988, 231-254.

_____ and Katarina Juselius "Maximum Likelihood Estimation and Inference on Cointegration-With Application to the Demand for Money", *Oxford Bulletin of Economics and Statistics*, May 1990, 169-210.

Kim, Dae Sik, "Financial Liberalization and Monetary Control in Korea: An Analytical Framework", *Journal of Economic Development*, June 1991, 99-130.

Lee, Tong Hun and Keun Jon Chung, "Further Results on the Long-Run Demand for Money in Korea: Cointegration Analysis", *International Economic Journal*, Autumn 1995, 103-113.

Lee, Tong Hun and Hoyoung Hwang, "Money, Interest Rate and Foreign Exchange Rates Intermediate Targets of Monetary Policy", *Paper presented at the 1997 annual meeting of the Korean Economic Association,* February 1998.

Lieberman, Charles. "The Transactions Demand for Money and Technology Change", *Review of Economics and Statistics*, August 1977, 307-317.

Osterwald-Lenum, Michael. "A Note with Quantiles of the Asymptotic Distribution of the Maximum Likelihood Cointegration Rank Test Statistics", *Oxford Bulletin of Economics and Statistics*, August 1992, 461-471.

Park, Won-am. "Financial Liberalization: The Korean Experience", in Takatoshi Ito and Anne O. Krueger, eds., *Financial Deregulation and Integration in East Asia*, University of Chicago Press, 1996.

Tobin, James. "The Monetary Interpretation of History", *American Economic Review*, 1965, 464-485.

Yoo, Yoon Ha, "An Examination of the Long Run Stability of Money Demand Function: Application of the Johansen Procedure", *Korea Development Institute Research Papers,* Autumn, 1994, 45-68 (in Korean).