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Tests of Changes in the Elasticity of the Demand for M2 and Policy Implications: The Case of Four Asian Countries

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This paper examines the demand for real M2 for India, Korea, Pakistan, and Singapore. The constant elasticity hypothesis can be rejected for India and Korea. Income elasticities at the means varied widely from 1.067 for Pakistan to 1.162 for Korea, 1.361 for Singapore, and 3.407 for India. Average interest elasticities also ranged from -0.178 for India to -0.239 for Pakistan and -0.241 for Korea. For Korea, during 1967-1995 income elasticities declined from 1.517 to 1.036 and interest elasticities changed from -0.660 to -0.092, suggesting more efficient cash management and more sensitivity to higher interest rates.

I. Introduction

Since the classic work of Mckinnon (1973) investigating money demand for 17 industrialized and developing countries and Fair (1987) studying the demand for M1 for 27 nations, there has been increasing interest in examining the dynamic relationship between the demand for money and its determinants across countries. The study of money demand is important because of potential policy implications. For example, the coefficients of income and the interest rate in the money demand function are expected to affect the steepness and flatness of the LM curve. When the coefficient for the interest rate is larger (smaller), the LM curve is flatter (steeper). When the coefficient for income is larger (smaller), the LM curve becomes steeper (flatter). The shape of the LM and IS curves may affect the effectiveness of monetary and fiscal policies. During the sample period, it is also possible that the sensitivity of money demand to income and interest rates may increase or decrease, thus affecting the shape of the LM curve and the outcome of any changes in policy variables of a macroeconomic model. In Fair's (1987) study, the interest rate was found to be insignificant for all of the LDCs in the two different models. The policy implication of this finding is of great importance, because it suggests that the LM curve is vertical. That being the case, fiscal policy of shifting the IS curve outward would not change equilibrium real output. Thus, it is worth reexamining the demand for money to see if empirical findings would be different from what Fair (1987) reported.

This paper examines the demand for real $M2$ for four Asian countries to see if the income and interest elasticities of the demand for real $M2$ are constants or may change because of different economic systems and development stages. Specifically, the author would like

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to test the following two hypotheses: (1) the income elasticity declines as income rises because of economies of scale or more efficient cash management; and (2) the interest elasticity in absolute value increases as the interest rate rises, as microeconomic theory suggests that the price elasticity of demand for a good or service increases as the price rises. These two hypotheses have been empirically proved by Chang and Hsing (1994) in examining the money demand function for the U.S. The paper is organized as follows. The theoretical model and the methodology of estimating the regressions are described in the second section. Empirical results and hypothesis tests are presented and interpreted in the third section. A summary and conclusions are given in the last section.

II. The Model

Based on the work of Chow (1966), Goldfeld (1973, 1976), Fair (1987), Chang and Hsing (1994) and others, desired demand for real $M2$ can be expressed as

$$(M2_t^*/P_t) = f_1(Y_t, R_t), \tag{1}$$

where $M2^*$, P, Y, R, and t denote desired demand for $M2$, price, real GDP, the interest rate, and time. Suppose that actual demand for real $M2$ adjusts to the desired level in real or nominal terms

$$M2_t/P_t - M2_{t-1}/P_{t-1} = Y(M2_t^*/P_t - M2_{t-1}/P_{t-1}), \tag{2}$$

$$M2_t - M2_{t-1} = \theta(M2_t^* - M2_{t-1}). \tag{3}$$

Equation (2) represents the real adjustment model (RAM) in that the partial adjustment process is specified in real terms (Chow (1965)). Equation (3) stands for the nominal adjustment model (NAM) (Goldfeld (1973, 1976)) that expresses the partial adjustment process in nominal terms. Substituting Equation (2) or (3) into (1), we have

$$(M2_t/P_t) = f_2(Y_t, R_t, M2_{t-1}/P_{t-1}), \tag{4}$$

$$(M2_t/P_t) = f_3(Y_t, R_t, M2_{t-1}/P_t). \tag{5}$$

The difference between the RAM and the NAM can be seen from the last terms. In Equation (4), the last term is equal to lagged $M2$ divided by lagged P, whereas in Equation (5), the last term is equal to lagged $M2$ divided by current P.

Most of the pervious studies chose a priori the log-linear form to estimate the above equations, assuming that the income and interest elasticities are constants. However, the hypothesis of the constant income and interest elasticities may be too restrictive for some countries that have experienced different development stages. It is possible that cash management may become

more efficient. That being the case, the income elasticity of the demand for real $M2$ may decline over time when income rises. The interest elasticity may be sensitive to the level of the interest rate. Goldfeld (1976) attempted to use a quadratic form for the interest rate to test whether the interest elasticity varied for the U.S. sample.

The Box-Cox transformation of variables can be applied to test if the hypothesis of the constant income and interest elasticities are appropriate. For any variable (W_t), it is transformed as ($W_t^{\lambda} - 1$)/ λ, where λ is the transformation parameter. The log-linear form is a special case of the Box-cox general functional form when $\lambda = 0$. In empirical work, we first select a value for λ, transform each variable in Equation (4) or (5), and estimate the regression. Different values of λ yield different values of the log-likelihood function. We choose that value of λ and the estimated regression that has the maximized value of the log-likelihood function. The likelihood ratio test can be used to determine which specific functional form is more appropriate.

III. Empirical Results

Data came from the 1997 *International Financial Statistics Yearbook* published by the International Monetary Fund. The Choice of $M2$ as the dependent variable is because in the U.S. M1 had structural breaks or shifts, whereas $M2$ is relatively stable (Hetzel (1992)). Money market rate, the deposit rate, or the bond rate is used to represent the interest rate. Following Fair (1987), $M2$ and GDP are divided by total population and the GDP deflator and are expressed in real terms. The selection of India, Korea, Pakistan, and Singapore is based on the availability of data and reflects different development stages. For example, per capita real GDP in U.S. dollar in 1995 was $208 for India, $242 for Pakistan, $7,411 for Korea, and $24, 191 for Singapore. Average annual growth rates of real GDP per capita also varied from 3.32% for Korea to 9.54% for Singapore. The sample period ranges from 1966 to 1995 for Korea, from 1967 to 1995 for India, and from 1972 to 1995 for Singapore and Pakistan. Different beginning years were chosen due to data availability or consistency. Note that after taking a lag for real GDP and price, the first observation is lost.

Table 1 reports the estimated values of λ and the log-likelihood function for both the general and log-linear forms. Table 2 presents estimated regressions for the general functional form for both the RAM and the NAM. To save space, the log-linear regressions are not reported. Autocorrelation is tested and corrected if found.

For India, the log-linear form can be rejected at the 1% level in the RAM and cannot be rejected at the 5% level in the NAM. The RAM performs better than the NAM in view of the results that in the NAM the coefficient of Y_t is insignificant and the coefficient of R_t has a wrong sign. The value of the coefficient of $M2_{t-1}/P_t$ in the NAM is unexpected, because it should be less or equal to one. Based on the RAM and estimated parameters, long-run E_Y's declined from 3.832 to 1.686, and long-run E_R's ranged from -0.070 to -0.453 during the sample period. These findings indicate that cash management has become more efficient and that interest elasticities do not exhibit a clear trend. However, one finds

Table 1 Estimated Values of the Log-Likelihood Function for the Real and Nominal Adjustment Specifications

	RAM	NAM
India		
General	-84.614	-80.277
λ	0.980	0.290
Log-linear ($\lambda = 0$)	-89.268	-80.881
Korea		
General	-75.338	-70.614
λ	0.520	0.740
Log-linear ($\lambda = 0$)	-79.805	-76.630
Pakistan		
General	-91.843	-88.814
λ	0.640	0.600
Log-linear ($\lambda = 0$)	-93.630	-90.288
Singapore		
General	-18.259	-15.088
λ	0.200	-0.100
Log-linear ($\lambda = 0$)	-18.490	-15.140

RAM: the real adjustment model.
NAM: the nominal adjustment model.

Table 2 Estimated Regressions of the Demand for Real M2 for Four Asian Countries

	India		Korea		Pakistan		Singapore	
	Real	Nominal	Real	Nominal	Real	Nominal	Real	Nominal
Y_t	0.281	-0.127	0.384	0.211	0.392	0.302	0.317	0.421
	(4.708)	(-1.506)	(3.466)	(2.971)	(3.728)	(2.963)	(1.509)	(1.650)
R_t	-1.045	0.006	-0.300	-0.202	-0.945	-0.867	0.004	0.026
	(-3.165)	(0.152)	(-2.555)	(-1.429)	(-1.482)	(-1.766)	(0.110)	(-1.962)
M_{t-1}/P_{t-1}	0.668		0.416		0.371		0.767	
	(8.008)		(2.613)		(2.109)		(4.561)	
M_{t-1}/P_t		1.129		0.649		0.569		0.693
		(21.290)		(4.764)		(3.312)		(3.772)
Int.	-56.902	1.405	0.241	1.140	-2.104	2.104	-0.364	-0.330
	(-3.170)	(1.573)	(0.162)	(0.491)	(0.663)	(0.663)	(-1.265)	(-1.342)
$\overline{R}^2$	0.997	0.997	0.996	0.997	0.982	0.986	0.993	0.995
$D-W$	1.755	1.934	1.840	1.677	1.691	1.659	1.543	1.700

Table 2 (Continued)

	India		Korea		Pakistan		Singapore	
	Real	Nominal	Real	Nominal	Real	Nominal	Real	Nominal
ρ	0.830 (7.874)	-0.136	0.660 (4.731)	0.610 (4.146)	0.400 (2.093)	0.510 (2.843)	0.190	0.132
λ	0.980	0.290	0.520	0.740	0.640	0.600	0.200	-0.100
$L(\lambda)$	-83.614	-80.277	-75.338	-70.614	-91.843	-88.814	-18.259	-15.088

Real: the real adjustment model.
Nominal: the nominal adjustment model.
Int.: the intercept term.
λ: the transformation parameter.
$L(\lambda)$: the log-likelihood function.
Figures in parentheses are t-ratios.

that the magnitude of the interest elasticity is positively associated with the level of the interest rate. For instance, when the interest rate was at its peak of 19.35% in 1991, the interest elasticity in absolute value was at a higher level of -0.219, whereas the interest elasticity was estimated to be -0.160 when the interest rate was 3.9% in 1968.

For Korea, following the suggestion by a referee, the bond rate was considered first because it is determined by market forces. But the results were poor probably due to the relative small sample size. Therefore, the deposit rate was chosen as the interest rate. The log-linear form can be rejected at the 1% level in both the RAM and the NAM, because the values of the test statistic are greater than the critical value of 6.635 with one degree of freedom. In comparison, the interest rate is significant at the 1% level in the RAM but is insignificant at the 5% level in the NAM. Another difference is that the adjustment speed of 0.584 is faster in the RAM than that of 0.351 in the NAM. Based on the estimated parameters obtained from the RAM, estimated long-run E_Y's and E_R's are calculated. Upon examination of the estimated elasticities, one finds that long-run E_Y's exhibited a declining trend from 1.517 in 1967 to 1.036 in 1995. Long-run E_R's varied widely from -0.660 to -0.092 during the sample period. These findings suggest that cash management has become more efficient over time, because to support a certain percent growth in GDP, the percent growth in real $M2$ is smaller. Consistent with economic theory as described by Chang and Hsing (1994), the demand for real $M2$ is found to be more (less) sensitive to higher (lower) interest rates. An analysis of the data indicates that nominal interest rates were lower in recent years caused by financial liberalization and other factors. Thus, interest elasticities in absolute value were smaller in recent years. In comparison, cash management is more efficient and demand for real $M2$ is more sensitive to interest rates in Korea than in India.

According to the likelihood ratio test in Table 1, the log-linear form of the demand for real $M2$ for Pakistan can not be rejected at any reasonable level of significance. Hence, long-run E_Y's and E_R's should be regarded as constants. Based on the log-linear regression and the RAM, the long-run E_Y and E_R are estimated to be 1.067 and -0.239, respectively. The long-run E_Y and E_R based on the NAM are very close to the figures obtained from

the RAM. There is almost one-to-one link between real GDP and the demand for real $M2$. In other words, when real GDP rises by 1%, the demand for $M2$ will increase by 1.067%. In comparison, the interest elasticity for Pakistan in absolute value is greater than that for India and close to that for Korea.

The log-linear form for Singapore cannot be rejected at the 5% level. The RAM and the NAM show similar empirical results in that the coefficient of Y_t is only significant at the 10% level and that the coefficient of R_t has a wrong sign and is insignificant. Based on the RAM, the short-run E_Y is estimated to be 0.317 and the long-run E_Y is calculated to be 1.361.

It may be interesting to compare the estimates for these four countries with those obtained for the U.S. Estimated long-run income elasticities of the demand for real $M2$ for the U.S. are close to unity (Hetzel and Mehra (1989), Hafer and Jansen (1991), Mehra (1991)). Hence, average income elasticities for Korea and Pakistan are comparable to those found for the U.S. Estimated long-run interest elasticities for the U.S. varied from a low of -0.03 (Hafer and Jansen (1991)) to a high of -0.60 (Friedman and Schwartz (1982)). Thus, the mean values of the interest elasticities for India, Korea, and Pakistan fall into the range of the U.S. estimates. Comparisons between this study and Mckinnon (1973) and Kenny (1991) cannot be made due to the use of different dependent variables and samples.

IV. Summary and Conclusions

This paper has examined whether the income and interest elasticities of the demand for real $M2$ have changed for four Asian countries, namely, India, Korea, Pakistan, and Singapore. The Box-Cox transformation of variables is applied to test the appropriateness of the log-linear form which implies a constant elasticity of the demand for real $M2$. Empirical results are summarized as follows. It appears that either the real or the nominal adjustment process may be relevant, depending upon individual countries. For instance, in this study we find that the real adjustment specification fits better for Korea, whereas the nominal adjustment mechanism is more suitable for India. The log-linear form of the demand for real $M2$ can be rejected for India, Korea, and Singapore, suggesting that income and interest elasticities are expected to vary with income, interest rates, the demand for real $M2$, and the estimated parameters. This is likely to affect the shape of the LM curve and the effectiveness of monetary and fiscal policies.

Empirical findings in this study may have several policy implications. First, the impact of monetary policy is expected to vary among countries. For example, when the interest rate drops by 10%, on average the demand for real $M2$ would increase by 2.41% for Korea and 1.78% for India. Variations in the interest elasticity during the sample period are also large. For instance, interest elasticities for Korea changed from -0.660 in 1967 to -0.092 in 1995, suggesting that the demand for real $M2$ is more sensitive to higher interest rates. Hence, monetary authority needs to be aware of the dynamic nature of money demand in order to have more precise predictions.

Second, the income elasticity of 1.162 for Korea compared to 3.031 for India suggests

that Korea has more efficient cash management system than India. When the income elasticity is higher, it needs more percent increase in money to sustain a given percent increase in real GDP. Countries with greater value of E_y's may develop mechanisms to improve efficiency of cash management such as the NOW account, automatic transfer services (ATS), money market deposit accounts (MMDA), money market mutual funds (MMMF), etc. that have been implemented in the U.S. since late 1970s and early 1980s.

Future research may be directed at the following areas. We may increase the number of the transformation parameter from one to two or three in order to increase the flexibility of the general functional form. It is possible that real GDP and the interest rate may need different transformation parameters to model their nonlinear relationship with the demand for real $M2$. Data for other variables such as assets, returns on stocks, and other interest rates may be collected so that the model can be improved. Some empirical findings such as the directions of changes in the income and interest elasticities of the demand for real $M2$ may need more theoretical investigation.

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