The Causality between the Domestic Credits and the Foreign Exchange Reserves

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1. Introduction

According to the exchange market pressure model which is one version of the monetary approach analyzing the managed floating exchange rate system, expansion (contraction) in the domestic credits tends to lead to a fall (rise) in the foreign exchange reserves. That is, change in the domestic credits is implicitly assumed to cause change in the foreign exchange reserves.[1] Under the recent managed floating exchange rate system. however, central banks in many countries have

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1) See, for example, Mah(1991) for further details.

often attempted to isolate the domestic money supply from change in the foreign exchange reserves through change in the domestic credtis.[2] In this case, change in the foreign exchange reserves causes change in the domestic credtis. Consequently, revealing the causality in which direction is an important problem to be solved in the international finance literature and may cast doubt on many established models.

In investigating the causal relationship between the concerned variables, recent researches focused on the optimal choice of the lengths of the distributed lags. Since Hsiao's(1981) application of Akaike's(1969) final prediction error(FPE) criterion, several other authors have applied the FPE oriterion to choose the optimal lag lengths; for example, Thornton and Batten(1985) on the causality between money and income, and Kholdy and Sorabian(1990) on the causality between the exchange rates and the prices.

Gasos and Maennig(1987) applied the Granger causality test on the relationship between the domestic credits and the foreign exchange reserves using the FPE criterion. However, their research dealt only with the developed EMS countries. Though Kamas(1986) pursued the causality between the concerned variables regarding a few Latin American countries, her finding was not based on the appropriate statistical analysis, In addition, all the works ignored checking the stationarity assumption on the concerned series. The purpose of this paper is to test for the Granger causality between the domestic credits and the foreign exchange reserves in case of Korea after performing a few unit root tests, on which as well as on most other LDCs little empirical work has been done yet. Since ad hoc approaches such as one considering a few arbitrary lag numbers can produce misleading results, in this paper attention is also focused on the optimal choice of lengths of the distributed lags by using Akaike's FPE criterion.

This paper is organized as follows. Section 2 briefly discusses the Granger causality test and Akaike's FPE criterion that can be used to search over the lag space of a dynamic model. Section 3 reports the evidence of the unit root tests, the Granger causality tests, a few diagnostic checking results and explains the implications of the causality between the domestic credits and the foreign

2) Several empirical works have been performed regarding this issue; Feige and Johannes(1981), Obstfeld (1982, 1983), Cumby and Obstfeld(1983), Kamas(1986), Gasos and Maennig(1987) and so on.

exchange reserves. Finally, section 4 offers a summary and conclusion.

2. Methodological Overview and Data

In this section we examine the causal relationship between changes in the domestic credits (D) and changes in the foreign exchange reserves (R) for Korea. That is, D and R are of the first differenced forms. Quarterly data are collected from the International Monetary Fund's International Financial Statistics. The sample was chosen to span the most recent managed floating exchange rate system. The procedure for testing the statistical causality between D and R adopted here is the Granger causality test.[3)]

To test the causality between D and R in the Granger sense, the following bivariate autoregressive models for D and R can be specified as:

$$R(t) = \sum_{i=1}^{m} b_i R(t-i) + \sum_{j=1}^{n} c_j D(t-j) + u(t) \quad (1)$$

$$D(t) = \sum_{i=1}^{p} f_i D(t-i) + \sum_{j=1}^{h} g_j R(t-j) + v(t) \quad (2)$$

, where m, n, p, and h are the lag lengths for each variable in each equation; and u and v are serially uncorrelated white noise residuals. By assuming that the error terms u and v are mutually uncorrelated, i. e. $E(u(t), v(s)) = 0$ for all t and s, the two equations can be estimated using the ordinary least squares method. Further discussion of the Granger test is omitted here to save the space as this test is well known.

Since results from the causality tests are sensitive to the selection of lag lengths, Akaike's FPE criterion is used to determine the optimal number of lags in each equation (i. e. values of m, n, p, and h). As is shown in McMillin and Fackler(1984), in the absence of a priori reasons for selecting particular lag lengths, FPE criterion can be implemented according to a two-stage procedure. In using the FPE criterion, the procedure for selecting the optimal lag numbers can be

3) Guilkey and Salemi (1982) suggested that in small samples Granger's method is superior to other procedures. In addition, Granger's method results in the fewest degrees of freedom lost from formation of lags (and leads).

illustrated with equation (1). In the first stage the determination of the optimal own lag lengths (m) is found by estimating a univariate autoregressive equation with only lagged values of R and determining the minimum value of FPE(m) by the formula;

$$FPE(m) = ((N+m)/(N-m)) / (N/RSS(m)) \quad (3)$$

, where N = the number of observations and RSS(m) = the residual sum of squares estimated with m lags of R. In comparing the FPE values, the maximum number of lags in each variable was determined as twelve. The equation giving the smallest FPE is selected as the appropriate lag length for R. In the second stage, the lagged values of D are added to the lagged values of R where the lag length of R is that determined in the first stage. The bivariate autoregressive equation is again run 12 times by adding one more lag of D each time. The optimal value of n is that minimizing FPE(m, n) whose formula is;

$$FPE(m, n) = ((N+m+n) / (N-m-n)) / (N/RSS(m, n)) \quad (4)$$

The data period covers the period of the recent managed floating exchange rate system. Up to the end of the 1970s, Korea was on an adjustable pegged exchange rate system. This was followed by the managed floating exchange rate system from February 1980 until the present. For the purpose of empirical testing, quarterly data from 1980:1 to 1990:1 are used. By using first differences and with a maximum lag length of 12 quarters, data from 1980:1 − 1983:1 were used as the presample data. Estimation is then carried out over 1983:2 − 1990:1.

3. Empirical Evidence

Since Granger's definition of causality assumes stochastic stationarity of the concerned variables, Dickey−Fuller (1979) unit root test results regarding R and D are presented before those of the Granger causality tests. First, R(t) is regressed on R(t−1) or on 1 and R(t−1);

$$R(t) = .286\, R(t-1) \quad (5)$$

$$(.150)$$

$$R(t) = 1.478 + .217\ R(t-1) \qquad (6)$$
$$\qquad (1.049) \qquad (.157)$$

Numbers in parentheses below the coefficients are standard errors. Dickey−Fuller statistic $\tau = (.286-1)/.150 = -4.76$ in eq. (5) is compared with a 1% critical value −3.62. The series is stationary. This conclusion does not change even if the constant term is included, as is shown in eq. (6).

Second, D(t) is regressed on D(t−1) or on 1 and D(t−1);

$$D(t) = -.355\ D(t-1) \qquad (7)$$
$$\qquad (.149)$$
$$D(t) = -.087 - .355\ D(t-1) \qquad (8)$$
$$\qquad (1.677)\ (.151)$$

Dickey−Fuller statistic $\tau = (-.355 - 1)/.149 = -9.094$ in eq. (7) shows that the series is also stationary. The result with the constant term is presented in eq. (8); however, it does not change the conclusion. Next, Phillips' (1987) $Z(\alpha)$ test is performed, which allows for weakly dependent and heterogeneously distributed innovations. As for the R series, the calculated $z(\alpha)$ statistic is −20.387, which is even less than 1 % critical value, −18.5. Regarding the D series, the calculated $z(\alpha)$ statistic is −81.919, which is also less than 1 % critical value. That is, Phillips' (1987) $Z(\alpha)$ test also suggests that both of the concerned series are stationary.

Since the stationarity assumptions needed in the Granger causality tests are fulfilled checked through Dickey—Fuller or Phillips unit root tests, the Granger causality tests are performed. The results are presented in Tables 1 and 2. As can be seen from Table 1, the first column represents m, the optimum order of lags of R(t−1), where R(t) is regressed on its own past values only. The optimum lag number is 2. The second column is n, the optimum order of lags of D(t−j), when R(t) is regressed on its own past values and past values of D. The corresponding minimum FPE(m, n) is shown in the third column. The fourth column reports the adjusted R^2 and the fifth column shows the value of F−statistic used to test the null hypothesis that all the coefficients of D(t−j) are zero. According to the results in Table 1, we cannot decide whether the domestic credits cause the foreign exchange reserves in Korea or not since, though the calculated F−statistic is significantly different from zero at the 5% level of sifgnificance, it is not significantly different from zero at the 1% level of significance. It implies that the implicit assumption of causality running from the domestic credits to the foreign exchange reserves may not be valid in the application of the monetary approach to the managed floating exchange rate system (say, the exchange market pressure model (Mah (1991)) and, consequently, we should be very cautious in applying the monetary approach.

Table 2 is similarly interpreted. The F−statistic is used to test the null hypothesis that all the coefficients of R(t−j) are zero. Since the F−statistic is significantly different from zero at the 1% level of significanve, we can decide that change in the foreign exchange reserves causes change in the domestic credits; that is, the sterilization policy is pursued to isolate the Korean money supply from change in the balance of payments. As can be seen in Table 3, the long run sterilization coefficient ($= \sum_{j=1}^{5} g_j$) is −.468. Consequently, we can say that approximately half of change in the money supply arising from change in the foreign exchange reserves is sterilized by change in the domestic credits within several quarters.[4] Though first order serial correlation among residuals of the estimated equation is checked by Durbin's(1970) h test of lagged dependent variables case, the results (not reported to save the space) show that the residuals in equation (2) are not serially correlated at the 5% level of significance. Furthermore, the calculated Shapiro−Wilk(1965) test statistic W (= .972) shows that the hypothesized normality of the error terms is not rejected at any reasonable level of significance.

4. Conclusion

4) In case of choosing 8 quarters as the maximum number of lags in the right hand side variables, separate regressions are also performed using 1980:1 − 1982:1 as the pre−sample data. The basic results are similar to those in Tables 1 and 2; first, causality running from the domestic credits to the foreign exchange reserves is rejected at any reasonable level of significance, and, second, causality running from the foreign exchange reserves to the domestic credits is not rejected at the 5% level of significance.

The Causality between the Domestic Credits and the Foreign Exchange Reserves

This paper examines the causal relationship between the domestic credits and the foreign exchange reserves change for Korea. The data period runs from 1980:1 to 1990:1, Dickey—Fuller (1979) and Phillips (1987) unit root test results suggest that both of the series are stationary. The Granger causality test is employed to test the null hypothesis of a lack of causality from the domestic credits to the foreign exchange reserves and vice versa. Optimal lag numbers are selected following Akaike's FPE criterion.

The results show, first, a mixed conclusion regarding the causality from the domestic credits to the foreign exchange reserves, and, second, a significant causal relationship from the latter to the former, that is, the existence of the sterilization policy. They imply that we cannot be sure of the application of the conventionally used monetary approach to issues in the international finance regarding the less developed countries. Finally, the regression results pass the often used diagnostic checking such as Durbin's (1970) h serial correlation test and Shapiro—Wilk (1965) test of the normal distribution.

REFERENCES

Akaike, H. "Fitting Autoregressive models for Prediction". *Annals of the Institute of Statistical mathematics* 2(1969) : 243－247.

Cumby, Robert E., and Maurice Obstfeld. "Capital Mobility and the Scope for Sterilization: Mexico in the 1970s". in Armella, Pedro A., Rudiger Dornbusch, and Maurice Obstfeld, eds., *Financial Policies and the World Capital Market: The Problem of Latin American Countries,* (1983): 245—269.

Dickey, David A., and Wayne A. Fuller. "Distribution of the Estimators for Autoregressive Time Series With a Unit Root". *Journal of American Statistical Association* 74(June 1979): 427－431.

Durbin, J. "Testing for Serial Correlation in Least Squares Regression when Some of the Regressors are Lagged Dependent Variables". *Econometrica* 38 (May 1970):410－421.

Feige, Edgar L., and James M Johannes. "Testing the Causal Relationship between the Domestic Credit and Reserve Components of a Country's Monetary Base". *Journal of Macroeconomics* 3 (Winter 1981):55－76.

Gasos, Pablo, and Wolfgang Maennig. "Sterilization Policles in the EMS Countries, an Empirical Analysis". *Economics Letters* 25 (1987):271－277.

Guilkey, David K., and Michael K. Salemi, "Small Sample Properties of Three Tests for Granger－Causal Ordering in a Bivariate Stochastic System". *Review of Economics and Statistics* 64 (November 1982):668－680.

Hsiao, Cheng. "Autoregressive Modelling and Money－Income Causality Detection". *Journal of Monetary Economics* 7 (January 1981):85－106.

Kamas, Linda. "The Balance of Payments Offset to Monetary Poicy: Monetarist, Portfolio Balance, and Keynesian Estimates for Mexico and Venezuela". *Journal of Money, Credit and Banking* 18 (November 1986):467－481.

Kholdy, Shady, and Ahmad Sorabian. "Exchange Rates and Prices: evidence from Granger Causality Tests". *Journal of Post Keynesian Economics* 13 (Fall 1990):71−78.

Mah, Jai S. "A Note on the Exchange Market Pressure: the Korean Experience, 1980−87". *Applied Economics 23* (April 1991):587−590

McMillin, W., and J. Fackler. "Monetary vs. Credit Aggregates: An Evaluation of Monetary Policy Targets". *Southern Economic Journal* 50 (1984):711−723.

Obstfeld, Maurice. "Can We Sterilize? Theory and Evidence". *American Economic Review papers and proceedings* 72 (May 1982):45−50.

_______________, "Exchange Rates, Inflation and the Sterilization problem, Germany 1975 − 1981". *European Economic Review* 21 (March/April 1983):161−189.

Phillips, P. C. B., "Time Series Regression with a Unit Root". *Econometrica* 55 (March 1987):277−301.

Shapiro, S. S., and M. B. Wilk. "An Analysis of Variance Test for Normality". *Biometrika* 52 (December 1965):591−611.

Thornton, Daniel L., and Dallas S. Batten. "Lag−Length Selection and Tests of Granger Causality between Money and Income". *Journal of Money, Credit and Banking* 17 (May 1985):164−178.

《부 록》

Table 1. Causality Test from the Domestic Credits to the Foreign Exchange Reserves

	m	n	FPE(m, n)	R^2	F－statistic
univariate	2	0	61.704	0.071	
bivariate	2	3	50.943	0.303	F(3, 23) = 3.881

Note : Critical values for F(3, 23) are 3.03 at the 5% and 4.76 at the 1% level of significance.

Table 2. Causality Test from the Foreign Exchange Reserves to the Domestic Credits

	p	h	FPE(p, h)	R^2	F－statistic
univariate	7	0	95.144	0.613	
bivariate	7	5	58.785	0.791	F(5, 16) = 4.569

Note : Critical values for F(5, 16) are 2.85 at the 5% and 4.44 at the 1% level of significance.

Table 3. OLS Regression Result for the Domestic Credits

RHS variable	lags	Coefficients	Standard Errors
D	1	－1.170	0.241
	2	－0.483	0.247
	3	－0.643	0.283
	4	0.267	0.354
	5	0.817	0.383
	6	－0.401	0.224
	7	－0.340	0.223
R	1	－1.193	0.368
	2	－0.375	0.360
	3	－0.051	0.362
	4	－0.112	0.382
	5	1.263	0.432

Note : R^2 = 0.876, adjusted R^2 = 0.791

국 문 요 약

이 논문은 한국에서 외환보유고의 변화와 국내여신 변화 간의 인과관계를 따져보는데 그 목적이 있다. 시계열의 안정성을 점검하기 위하여 단위근 검증을 해보았고, 위의 두 변수간의 인과관계 검증을 위하여 그레인져 인과관계 검증법을 이용하였다. 이때 최적 시차항의 수는 아카이케의 최종예측오차 기준을 선택하여 뽑아 보았다.

결과를 보자면 외환보유고는 국내여신 변화의 원인임을 알 수 있으나, 그 역의 인과관계는 보이지 않았다. 이는 개발도상국 경제의 국제수지에 통화론적 접근을 적용함에 있어서 주의를 요함을 의미한다.