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Cointegration and Causality between Financial Development and Economic Growth in South Korea and Taiwan

Benjamin S. Cheng*

Applying cointegration and Hsiao's version of the Granger causality method, this paper finds a causality running from financial development to economic growth with feedback in postwar South Korea and Taiwan. The Phillips-Perron (PP) unit root test and the Engle-Granger two-step cointegration test are performed. This study supports the Patrick hypothesis that there is likely to be an interaction of supply-leading and demand-following phenomena. Patrick's hypothesis that the supply-leading pattern is more likely in early stage of development, which is upheld in both Korea and Taiwan, whereas the demand-following pattern is more likely at the later stage which is upheld only in Taiwan.

I. Introduction

The relationship between financial development (FD) and economic growth (EG) has been a contentious issue in the development literature (Schumpeter (1912), Robinson (1952), Patrick (1966), Shaw (1976), McKinnon (1973 and 1993), Laumas (1990), Greenwood and Jovanovic (1990), Bencivenga and Smith (1991), Demetriades and Hussein (1996), Levine and Zervos (1998)). The main argument of the McKinnon-Shaw school is that government restrictions on the banking system hamper the process of FD and thereby reduce EG. On the other hand, Schumpeter (1912) stressed the importance of finance in the process of development. That is, financial institutions finance entrepreneurs in their initiation of innovative activity and the bringing about new products to market. Thus finance is related to innovation of the entrepreneurs which is central to the process of economic growth (see also King and Levine (1993b)). Similar conclusions are also reached by the endogenous growth literature, in which the services provided by financial intermediateness are explicitly incorporated into the model (Greenwood and Jovanovic (1990), Bencivenga and Smith (1991), King and Levine (1993b)). The main feature of endogenous growth models is that the economy's capital stock does not suffer from diminishing returns; hence, growth is a positive function of the investment ratio and financial intermediation has a positive effect on economic growth. Robinson, however, argued that "where enterprise leads finance follows (Robinson (1952, p.86))."

Interestingly, Patrick (1966) identified two possible sequential patterns in the relationship between FD and EG. In the first pattern, termed "supply-leading," the creation of financial institutions and supply of their financial assets and related financial services precedes and causes economic growth by transferring resources from traditional sectors to modern sectors.

* Professor of Economics, Department of Economics, Southern University, Baton Rouge, LA 70813, USA.

the direction of causality, not the sign of causal relations between the variables.

The paper proceeds as follows. Section II presents the methodology and model, followed by a report and discussion of the empirical results, and conclusions.

II. Methodology and Model

Granger causality test (Granger (1969 and 1980)) is quite simple and straightforward. A variable x_t is said to Granger-cause y_t if the prediction of the current value of y_t is improved by using past values of x_t. Following Jung's study (Jung (1986)), economic growth is modeled as a function of financial development, which can be rewritten and transformed into a vector autoregressive (VAR) model as follows. Note that all variables are expressed in logs.

$$(1-L)\begin{bmatrix} \log y_t \\ \log x_t \end{bmatrix} = \begin{bmatrix} a_1 \\ a_2 \end{bmatrix} + \sum_{i=1}^{p}(1-L)\begin{bmatrix} \beta_{11i} & \beta_{12i} \\ \beta_{21i} & \beta_{22i} \end{bmatrix}\begin{bmatrix} \log y_{t-i} \\ \log x_{t-i} \end{bmatrix} + \begin{bmatrix} v_{1t} \\ v_{2t} \end{bmatrix}, \qquad (1)$$

where $y =$ GNP in constant dollars (EG),

$x =$ financial development (FD), measured by M_2/GNP, as explained below,

$L =$ lag operator and $(1-L) = d$ is the difference operator such that $(1-L)y_t = y_t - y_{t-1}$ represents the first difference,

$v =$ the white noise disturbance terms.

Following Gupta (1984) and Jung (1986), we use the M_2/GNP ratio as the indicator of FD.[1] As McKinnon (1973) noted, the conditions of money supply have a first-order impact on decisions to save and invest. Thus, a high and rising M_2/GNP ratio indicates a large flow of loanable funds towards real economy and that it is a widely regarded monetization variable.

1. There can be other proxies representing financial development as suggested in King and Levine (1993a and 1993b) and Demetriades and Hussein (1996). Instead, we followed Gupta (1984) and Jung (1986) by employing the M_2/GNP ratio as the indicator of FD for this study. We fully realized the fact that quantitative measures of financial development is bound to imperfect and open to challenge for this variable. As Rajan and Zingales (1998, p.569) note, "... there is little agreement on how these [variables] are appropriately measured, and we will have to make do with crude proxies even though they may miss many of the aspects we think vital to a modern financial system."

As indicated in the text, McKinnon (1973) noted that the conditions of money supply have a first-order impact on decisions to save and invest. M_2 (which includes currency, demand deposits, and time and savings deposits) as a ratio of GNP increases as a country's per capita income increases. The main function of money is to facilitate the transaction of goods and services. As the economy expands, the division of labor increases, leading to increases in interindustry and intraindustry transaction. All this requires the increased use of money and credit. Thus the extent of intermediation between savers and investors through financial institutions rises, leading to more savings and deposits. In other words, the economy's final output is produced, financed, and distributed in a more roundabout way, necessitating a proportionally greater money supply to support the economic activities.

We therefore choose M_2 over other proxied variables. As indicated in the text, a high and rising M_2/GNP ratio indicates a large flow of loanable funds towards real economy and that it is a widely regarded monetization variable. Accordingly, this monetization variable will capture quantitative and qualitative developments of the financial sector of the economy.

2. Cointegration Tests

Cointegration means that two variables have common trend. Thus two cointegrated variables will not drift too far apart over the long run. Technically, according to Engle and Granger (1987), if x_t and y_t are each integrated of order one, written I(1), yet the two variables may have the property that a particular combination of them, $e_t = x_t - by_t$, is integrated of order zero, denoted I(0). If such a property holds, then we say that x_t and y_t are cointegrated. Thus, cointegration is the statistical approach that tests for the existence of long-run equilibrium relationships among non-stationary variables that are integrated to the same order.

In the case of Korea, since both series are each I(0), no cointegration tests are necessary. We can conclude that the two variables are not cointegrated for cointegration requires at least the two series each be integrated of the same order. By contrast, for Taiwan, the Engle-Granger two-step cointegration test reveals that the series of EG and FD are each found to be I(1) and the linear combination of the two variables is also found to be I(1). We therefore conclude that the two integrated variables are not cointegrated either. Hence, the simple Granger causality method is appropriate for both Korea and Taiwan in determining the causality (Granger (1988)), as shown in Equations (1) and (2) in the appendix. Yet, this does not preclude the possible causal relationships between the two variables.

3. Hsiao's Version of the Causality Tests

The results of Granger causality test, however, depend critically on the choice of lag length. Most often, the choice of the lag length is done in an ad hoc, arbitrary manner in earlier studies of FD and EG (e.g., Jung (1986)). As Lee (1997) argued, this practice is susceptible to potential model misspecifications. More specifically, too short a lag length results in estimation bias, while too long a lag length causes a loss of degrees of freedom and thus estimation efficiency. To remedy this deficiency, Hsiao's approach (Hsiao (1981)) is employed in this study, a detailed discussion of which is given in the appendix. Further, Thornton and Batten (1985) demonstrated that Hsiao's method is superior to both arbitrary lag length selection and several other systematic procedures for determining lag length. The FPE criterion that we use in this study is appealing, as Hsiao (1981) pointed out, because it balances the risk of selecting a higher lag against the risk of a lower lag. When an additional lag is included, the first term in FPE is increased, but simultaneously the second term is decreased. When their product (FPE) reaches a minimum, the two opposing forces are balanced.

Finally, we proceed to perform Hsiao's version of the Granger causality test. Hsiao version test essentially follows a two-step procedure to determine the appropriate lag length (using the FPE criterion) and the direction of causality at the same time (for details of Hsiao's method, see the appendix). As indicated in the appendix, if FPE (m^*, n^*) < FPE (m^*), then FD Granger-causes EG and vice versa. The results for Korea, using the undifferenced data, as shown in Table 2A, indicate that for the EG equation, this condition is satisfied, and therefore we conclude that FD Granger-causes EG. Conversely, for the FD equation, the condition is also met, and

Table 3A Hsiao's Version of Causality Tests for Taiwan

Controlled Variable	The Manipulated Variable	FPE	Causality Inferences
(a) The EG Equation:			
EG (i=1)		0.01042	
EG (i=1)	FD(j=1)	0.00860	FD⇒EG
(b) The ED Equation:			
FD (i=3)		0.00995	
FD (i=3)	EG(j=3)	0.00875	EG⇒FD

Notes: FD denotes financial development, whereas EG represents economic growth. The figures in parentheses behind the variables are the optimal lag length.

Table 3B F-Test Statistics for Taiwan

(a) The EG Equation:

$$(1-L)EG_t = \alpha_0 + \sum_{i=1}^{1}\alpha_i(1-L)EG_{t-1} + \sum_{j=1}^{1}\beta_j(1-L)FD_{t-1}$$

(1.07592) (10.57710)

0.31 0.00*

(b) The FD Equation:

$$(1-L)FD_t = \alpha_0 + \sum_{i=1}^{3}\alpha_i(1-L)FD_{t-1} + \sum_{j=1}^{3}\beta_j(1-L)EG_{t-1}$$

(9.33433) (3.72021)

0.01* 0.02**

Note: FD = financial development and EG = economic growth. The number in the parenthesis beneath the equation is the joint coefficient and number beneath each coefficient represents the p-value.

* denotes significant at the 1% level.

** denotes significant at the 5% level.

By contrast, as reported in Table 3A, the results for Taiwan indicate that for EG equation, using the differenced data, the condition, FPE (m*, n*) < FPE (m*), is satisfied, and therefore we conclude that FD Granger-causes EG. Conversely, for the FD equation, the requirement is also met, and we therefore conclude that EG Granger-causes FD. Our causality results are consistent with Jung's earlier study of Taiwan.

The t- and F-tests are also performed for Taiwan and the results (Table 3B) fully corroborate those of the causality tests that are reported in Table 3A. While the F-test results show the existence of bi-directional causality between EG and FD (at the 1% level of significance), these results also demonstrate that Taiwan follows both the demand-following and supply-leading patterns, supporting the study by Jung (1986). Besides, we also conducted tests by breaking down the sample of each country into two sub-samples and found Patrick's hypothesis that the supply-leading pattern is more likely in early stage of development, which is upheld in both Korea and Taiwan, whereas the demand-following pattern is more likely at the later

with the nature of corporate structure and the role of these corporations. As indicated, Korea's industrialization being based on large-scale enterprises organized in family-owned conglomerates (chaebol), the financial sector consequently is dominated by a relatively small number of large financial institutions and the entrepreneurs. Nevertheless, in the 1970s it appeared that the size of the Korean organized financial system was generally compatible with its level of development.

It is important to note that finance is important to economy in that endogenous growth economists have viewed capital accumulation (savings) and investment as the driving forces of EG. Further, financial deepening, as measured by the degree of monetization in an economy, is found to affect the technological rate of the production and in turn economic growth rate in Korea (Saltzman and Duggal (1995)). During the period 1960-90, both savings and investment increased remarkably in Korea, exceeding the performance of other developing countries. The saving rate in Korea was 23 per cent in 1980 and climbed rapidly to an all-time high of nearly 40 percent in 1990 (Lim (1994)). Both FD and EG could be driven by a common variable such as the propensity to save (Rajan and Zingales (1998)). Prior to the early 1980s, when savings were low, Korea had to rely heavily on foreign loans. Saving determines the rate at which productive capacity and hence income, can grow (World Bank (1989)). Note that savings are the major component of M_2, which naturally affects the main domestic flow of loanable funds in the system and private investment (and economic growth as well) in the country, thus manifesting a supply-leading pattern at this beginning stage of Korea's development.

Furthermore, to promote exports, several financial measures were adopted by the Korean government in the early 1960s. These measures included: (i) adopting a simple unified exchange rate, (ii) providing trading companies with loans for exports at preferential interest rates that were usually lower than the market rate, and (iii) other export incentive programs (see Cheng (1997)). Other selective interventions included mild financial repression - a measure to keep interest rates positive but at relatively low level. Other measures consisted of direct credit, selective industrial promotion, and export-led policies. The availability of financial resources has propelled export growth and in turn boosted EG--that is, supply-leading in Patrick's framework. The growth of the economy in general and exports in particular has in turn led to a growing demand for loans and other financial services--that is, demand-following. Further, as indicated, the growth of economy simultaneously resulted in increases in various types of business and household deposits, which are a major component of M_2. This supports the bidirectional causation between Korea's postwar FD and EG that we have found in our empirical study.

Additionally, government intervention in finance seems to have contributed to correcting financial market failures that could have presented serious obstacles to the promotion of export-led development. We agree with Park (1993) who noted that government alters the incentive structure to boost industries that would not otherwise have succeeded. One advantage of the repressive financial system in Korea--another form of supply-leading pattern--may have been its ability to supply long-term finance, which we risky yet critical at the early stage of export promotion. This risk-absorption function by financial institutions, as noted by Amsden (1989), in fact, raised the effective rate of return on investment in export-oriented industries (and thereby rapid economic growth rate as well), which has provided strong incentive to exporters

are mostly small, aggressive, family-owned businesses (see Biggs (1988), Cole and Park (1983)). These small enterprises, however, have manufactured a variety of products. Taiwanese banks and other financial institutions have not met the credit or liquidity needs of these small and medium-sized enterprises. These small firms have to obtain loans through large and public and private enterprises (Park (1993), Shea (1994)). The government in Taiwan, could have followed Korea by creating a number of financial institutions to serve the credit needs of small firms. Instead, these firms had to obtain the financial services from financial installment companies, investment companies, credit unions and the like. Even so, what Rajan and Zingales (1998) have suggested--financial development plays a helpful role in the rise of new firms--may be relevant to explaining the emergence and the rise of million of small firms in Taiwan.

It is worth noting that in the early 1960s, many of the nations's banks were government controlled and financial markets are also relatively underdeveloped. During the 1950s-1970s period, there were only three commercial banks (and tens of their branches) and a host of credit cooperative associations in Taiwan that provided banking services to millions of households and businesses on the island. These banks were jointly owned by public and private sectors. Although financial markets were liberalized to some extent after the 1960s, allowing interest rates to adjust to the market equilibrium rates, selective credit controls were introduced to promote exports and industrialization. Thus, the provision of financial services has played a catalytic role in begetting a large number of entrepreneurs and in export expansion and economic growth in the early stage of Taiwan's economic development, which displayed the supply-leading characterization that is partially upheld by our empirical finding.

Unfortunately, financial liberalization began in Taiwan in the 1970s with small, slow steps. From the mid-1980s, following the footsteps of the Western countries, the reform that was undertaken because of pressures from home and abroad came into full swing in the early 1990s. As a result, an exceedingly financial deepening took place after the mid-1980s, which exhibited demand-following description. The financial interrelation ratio (FIR)--the ratio of total financial assets to nominal GNP--rose from nearly 2.8 in 1975 to 4.6 in 1990. The deregulation and expansion of financial services took place essentially in response to rapid economic growth after the early 1980s, which was demand-following and was fully concurred by our empirical finding. As indicated previously, Park (1994) also argued that the rapid financial growth that Taiwan experienced in the 1980s was mainly attributed to high rates of growth of the economy. In his view, the causality ran from changes in the real to the financial sector, not the other way around.

VI. Concluding Remarks

As mentioned before, Patrick suggested that there is likely to be an interaction of supply-leading and demand-following phenomena. Looking at the Korean and Taiwanese experience between the early 1950s and the early 1990s, our empirical study seems to suggest that FD plays a catalytic role in producing entrepreneurs and in promoting EG, and EG also creates a need for more financial services and in turn faster FD in both countries.

Apart from human capital investment, private domestic investment along with outward-looking entrepreneurs is another principal factor that precipitates Korea and Taiwan's rapid

Appendix

The procedure used to implement the Hsiao's version of Granger-causality tests reported in the paper is as follows:

(i) Equation (1) in the text can be broken up and transformed into two autoregressive equations: EG equation and FD equation. The EG equation in turn can be converted into two one-sided causality equations (univariate equation and bivariate equation) as follows. As indicated in the text, all variables are in logs.

$$(1-L)y_t = \alpha_0 + \sum_{i=1}^{M} \alpha_i (1-L)y_{t-i} + v_{1t}, \tag{1}$$

$$(1-L)y_t = \alpha_0 + \sum_{i=1}^{M} \alpha_i (1-L)y_{t-i} + \sum_{j=1}^{N} \beta_j (1-L)x_{t-j} + v_{2t}. \tag{2}$$

(ii) Using Equation (1) in the appendix for illustration, in step one we initially treat the dependent variable, y_t, as a one-dimensional autoregressive process. We then compute the sum of squared errors (SSE) using the same equation with the maximum order of lags varying from 1 to M. The corresponding final prediction error (FPE) as defined by Akaike (1969) is calculated by using the following Equation (3) and then choose the order which yields the smallest FPE, m^*.

$$FPE(m) = \frac{(T+m+1)}{(T-m-1)} \cdot \frac{SSE}{T}, \tag{3}$$

where T = number of observations,
m = the order of lags varying from 1 to M, and
SSE = the sum of squared errors.

(iii) In step two, focusing on Equation (2) in the appendix, we treat y_t as a controlled variable, with the order of lags set at m^*, and x_t as a manipulated variable. Using the same equation, we again compute the FPE of y_t by varying the order of lags of x_t from 1 to N and determine the order which yields the smallest FPE, say n^*. The corresponding two-dimensional FPE is calculated using the Equation (4) below:

$$FPE(m^*, n) = \frac{(T+m^*+n+1)}{(T-m^*-n-1)} \cdot \frac{SSE(m^*, n)}{T}, \tag{4}$$

where n = the order of lags on $x(t)$ varying from 1 to N, and
m^* = the optimum number of lags computed from (3).

References

Akaike, H. (1969), "Fitting Autoregressive Models for Prediction," *Annals of the Institute of Statistical Mathematics*, 21, July, 243-47.

Amsden, A.H. (1989), *Asia's Next Giants: South Korea and Late Industrialization*, New York: Oxford University Press.

Bencivenga, V.R., and B.D. Smith (1991), "Financial Intermediation and Endogenous Growth," *Review of Economic Studies*, 58, 195-209.

Biggs, T.S. (1988), "Financing the Emergence of Small and Medium Enterprise in Taiwan: Heterogenous Firm Size and Efficiency Intermediation," EEPA Discussion Paper No. 16.

Cheng, B.S. (1997), "Government Expenditure and Economic Growth in South Korea: A VAR Approach," *Journal of Economic Development*, 22, June, 11-24.

Chiu, P.C. (1992), "Money and Financial Markets: The Domestic Perspective," in Taiwan: *From Developing to Mature Economy*, ed. by G. Ranis, Boulder, Westview Press, 121-193.

Cho, Y.J. (1989), "Finance and Development: The Korean Approach," *Oxford Review of Economic Policy*, 5, 99-102.

Cole, D.C., and Y.C. Park (1983), *Financial Development in Korea 1945-78*, Cambridge, Harvard University Press.

Demetriades, P.O., and K.H. Hussein (1996), "Does Financial Development Cause Economic Growth? Time-Series Evidence from 16 Countries," *Journal of Development Economics*, 51, December, 387-411.

Engle, R.F., and C.W.J. Granger (1987), "Cointegration and Error-Correction: Representation, Estimation and Testing," *Econometrica*, 55, March, 251-276.

Fry, M.J. (1995), *Money, Interest, and Banking in Economic Development*, (2nd ed.), Baltimore, The Johns Hopkins University Press.

Granger, C.W.J. (1969), "Investigating Causal Relation by Econometric and Cross-Sectional Method," *Econometrica*, 37, July, 424-438.

_____ (1980), "Testing for Causality," *Journal of Economic Dynamic and Control*, 4, November, 229-252.

_____ (1988), "Some Recent Developments in a Concept of Causality," *Journal of Econometrics*, 39, June, 199-211.

Greenwood, J., and B. Jovanovic (1990), "Financial Development, Growth, and the Distribution of Income," *Journal of Political Economy*, 98, 1077-1107.

Gupta, K.L. (1984), *Finance and Economic Growth in Developing Countries*, Croom Helm, London.

Hafer, R.W., and D.W. Jansen (1991), "The Demand for Money in the United States: Evidence from the Cointegration Tests," *Journal of Money, Credit, and Banking*, 23, May, 155-168.

Hallman, J.J., R.D. Porter, and D.H. Small (1989), "M_2 per Unit of Potential GNP as an Anchor for the Price Level," *Board of Governors of the Federal Reserve System Staff Study*, 157, April, 11-18.

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