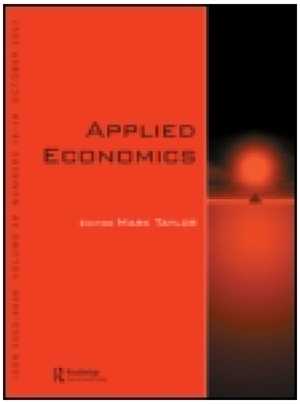

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Financial development and economic growth: the case of Taiwan

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Financial development and economic growth: the case of Taiwan

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This paper examines the relationship between financial development and economic growth in Taiwan from 1962 to 1998. Using a four-variable VAR model, the competing hypotheses of demand-following versus supply-leading are empirically tested. The results from Granger causality tests based on vector error-correction models (VECM) suggest unidirectional causality running from financial development (measured as the ratio of M2 to GDP) to economic growth. This result supports the supply-leading hypothesis for Taiwan. This finding highlights the importance of financial development in Taiwan's recent growth.

I. Introduction

Some economists hold the view that financial development is a necessary condition for achieving high rate of economic growth. This is what Patrick (1966) refers to as the 'supply-leading' role of financial development. The supply-leading hypothesis contends that financial development causes real economic growth. A distinctly opposite view has emerged in the literature, which Patrick (1966) terms the 'demand-following' role of financial development. The demand-following hypothesis argues for a reverse ordering from real economic growth to financial development.

The objective of this paper is to investigate whether financial development leads to economic growth or vice versa, using multivariate VAR models, in the small developing economy of Taiwan over the period 1962–1998. Taiwan is an interesting economy to examine for several reasons. First, Taiwan has made remarkable economic progress over the last several decades. Taiwan's average annual economic growth rate over the past decade is a very high 6.21%. In 1998, per capita GNP in Taiwan was US$12 040. Second, Taiwan has become the world's 14th largest trading country with a foreign exchange reserve estimated at US$90.34 billion at the end of 1998. Third, Taiwan liberalized economic institutions in the early 1980s, thus sufficient data are available for researchers to evaluate the impact of this liberalization.

II. Previous Research

The question of whether financial development precedes economic growth or economic growth precedes financial development has been empirically examined in the recent literature. For example, using data for 56 countries, Jung (1986) found that the supply-leading hypothesis holds for the LDCs and the demand-following hypothesis holds for the developed countries. In his study of ten sub-Saharan countries,

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Spears (1992) finds that financial development causes economic growth. Ahmed and Ansari (1998) investigate the relationship between financial development and economic growth for three major South-Asian countries, namely, India, Pakistan and Sri Lanka. Results from causality analysis indicate that financial development causes economic growth in these countries. Together, these results support the supply-leading hypothesis, at least for LDCs.

However, Thornton (1996) finds contradictory evidence. Using data for 22 Asian, Latin American and Caribbean developing economies, Thornton concludes that in many cases financial development does not make much difference to economic growth.

Given the differences in countries examined, time periods examined, variables measured, and statistical methodologies, it is not surprising that the empirical findings in these studies are somewhat contradictory. In particular, the statistical methodologies used in these studies limit them to an estimation of the short-run dynamics between financial development and economic growth and do not permit the estimation of long-run equilibrium states.

Recently, new time series methods, namely cointegration tests and the vector error-correction mechanism (VECM), have been used to investigate the demand-following versus supply-leading hypotheses in a number of studies. For example, Murinde and Eng (1994) investigate the causal relationship between financial development and economic growth in Singapore. They use recently developed econometric techniques to test for stationarity, cointegration, and Granger causality. Their study largely supports the supply-leading hypothesis for Singapore. In a similar study, Demetriades and Hussein (1996) conduct causality tests between financial development and economic growth using cointegration and Granger causality techniques for 16 countries. Their results provide little support for the notion that financial development is a leading factor in the process of economic development. They find considerable evidence of bidirectionality and some evidence of reverse causation. More recently, Ghali (1999) investigates whether financial development leads to economic growth in the small developing economy of Tunisia. His results suggest the existence of a stable long-run relationship between the development of financial sector and the evolution of per capita real output that is consistent with the view that financial development can be an engine of growth in this country. Using cointegration and Hsiao's version of the Granger causality method, Cheng (1999) finds causality running from financial development to economic growth with feedback in post-war South Korea and Taiwan. These results support the Patrick (1966) hypothesis that there is likely to be an interaction of supply-leading and demand-following phenomena.

Most of the previous studies focus only on a two-variable case and their results may be biased due to the omission of relevant variables. Recent empirical studies have addressed this shortcoming. For example, Luintel and Khan (1999) examine the long-run relationship between financial development and economic growth using multivariate VAR models for ten countries. They find that the long-run financial development and output relationships are identified and bidirectional causality between financial development and economic growth exists for all sample countries. On the other hand, Darrat (1999) uses multivariate Granger causality tests within an error-correction framework to investigate the role of financial development in economic growth in three middle-eastern countries, namely, Saudi Arabia, Turkey, and the United Arab Emirates, and his results generally support the view that financial development is a necessary causal factor of economic growth.

Although much of the recent evidence seems to indicate that financial development causes economic growth, the issue for Taiwan is unresolved. In this paper these new time series methods are used to investigate the relationship between financial development and economic growth in Taiwan.

III. Data

The empirical analysis is based on annual data on real GDP per capita, M2, exports, and imports for Taiwan over the period of 1962 to 1998 (1991 = 100). Following most of the literature (Jung, 1986; Cheng, 1999; Darrat, 1999), financial development is calculated as the ratio of M2 to GDP.[1] All the data series are transformed into logarithms to achieve stationarity in variance. Data are obtained from the AREMOS database of the Taiwan Ministry of Education.

[1] An alternative measure calculated as the ratio of liquid liability to GDP was also used in this study. Results are similar to those reported here and are available upon request from the authors.

IV. Methodology and Empirical Results

Unit root tests

A number of authors have pointed out that the standard ADF test is not appropriate for variables that may have undergone structural changes.[2] For example, Perron (1989, 1990), Banerjee *et al.* (1992), and Zivot and Andrews (1992) have shown that the existence of structural changes biases the standard ADF test towards non-rejection of the null of unit root. Hence, it might be incorrect to conclude that the variables are nonstationary on the basis of the results using the standard ADF tests.[3] To address the problem, Perron (1990) developed a procedure for testing the hypothesis that a given series $\{Y_t\}$ has a unit root, given that an exogenous structural break occurs at time T_B. Zivot and Andrews (1992, hereafter ZA) criticized this assumption of an exogenous break point and developed a unit-root test procedure that allows an estimated break in the trend function under the alternative hypothesis. Therefore, it seems appropriate to treat the structural break as endogenous and test the order of integration by the ZA procedure. The ZA tests are represented by the following augmented regression equations:

$$\text{Model A:}\quad \Delta Y_t = \mu_1^A + \beta_1^A t + \mu_2^A DU_t + \alpha^A Y_{t-1} + \sum_{j=1}^{k} \theta_j \Delta Y_{t-j} + \varepsilon_t$$

$$\text{Model B:}\quad \Delta Y_t = \mu_1^B + \beta_1^B t + \gamma^B DT_t^* + \alpha^B Y_{t-1} + \sum_{j=1}^{k} \theta_j \Delta Y_{t-j} + \varepsilon_t$$

$$\text{Model C:}\quad \Delta Y_t = \mu_1^C + \beta_1^C t + \mu_2^C DU_t + \gamma^C DT_t^* + \alpha^C Y_{t-1} + \sum_{j=1}^{k} \theta_j \Delta Y_{t-j} + \varepsilon_t \quad (1)$$

where $DU_t = 1$ and $DT_t^* = t - T_B$ if $t > T_B$ and 0 otherwise. Here T_B refers to a possible break point. Model A allows for a change in the level of the series, Model B allows for a change in the slope of the trend function, and Model C combines changes in the level and the slope of the trend function of the series.[4] The sequential ADF test procedure estimates a regression equation for every possible break point within the sample and calculates the *t*-statistic for the estimated coefficients. This tests the null hypothesis of a unit root against the alternative hypothesis of trend stationarity with a one-time break (T_B) in the intercept and slope of the trend function at unknown point in time. The null of a unit root is rejected if the coefficient of Y_{t-1} is significantly different from zero. The selected break point for each data series is that value of T_B for which the *t*-statistic for the null is minimized. Since the choice of lag length k may affect the test results, the lag length is selected according to the procedure suggested by Perron (1989). This procedure involves starting with an upper bound $k_{\max}$ for k. If the last included lag is significant, then choose $k = k_{\max}$. If not, reduce k by 1 until the last lag becomes significant. $k_{\max} = 4$ is set for the annual series. For comparison, standard Augmented Dickey–Fuller (ADF) and KPSS (Kwiatkowski *et al.*, 1992) tests are also incorporated into this study.

Panels A and B in Table 1 report the results of nonstationary tests for real GDP per capita (*lprgdp*), financial development (*lfd*2), real exports (*lrexpt*), and real imports (*lrimpt*) using both Augmented Dickey–Fuller (ADF) and Kwiatkowski *et al.* (1992, KPSS) tests. Each data series is found to be nonstationary in levels and stationary in first differences, suggesting that all the data series are integrated of order one. Table 2 reports the minimum *t*-statistics that correspond to Models A and C. The test results summarized from Table 2 provide evidence for the existence of a unit root when breaks are allowed. The test results are identical to those of the standard ADF and KPSS tests reported in Table 1, suggesting that all the data series are integrated of order one, even when breaks are allowed. The plausible breaks for the series occur at 1976, 1985, 1971 and 1973, for real GDP per capita, financial development, real exports, and real imports, respectively. On the basis of these results, it is tested whether these four variables are cointegrated using Johansen's method.

Cointegration tests

Following Johansen (1988) and Johansen and Juselius (1990), a *p*-dimensional (4×1) vector

[2] The sample period for the data, 1962–1998, covered two oil-price shocks and the economic liberalization in Taiwan, so structural breaks are expected for the data series studied.
[3] Regarding the KPSS test, Lee *et al.* (1997) also show that the test suffers from a size distortion problem if a structural break exists but is ignored. The problem parallels the power loss problem of unit root tests when an existing break is ignored.
[4] When the coefficients of both dummy variables are not significantly different from zero, Model C reduces to the standard ADF equation.

Table 1. ADF and KPSS unit root tests

	Panel A: ADF		Panel B: KPSS (η_μ)	
	level	difference	level	difference
lprgdp	−1.702 (1)	−4.306* (1)	1.324* [2]	0.273 [2]
*lfd*2	−0.589 (1)	−4.045* (1)	1.315* [2]	0.098 [2]
lrexpt	−2.604 (1)	−3.589* (1)	1.266* [2]	0.317 [2]
lrimpt	−2.608 (1)	−3.378* (1)	1.267* [2]	0.337 [2]

Notes: 1. Numbers in parentheses indicate the selected lag order of the ADF model. Lags were chosen based on Perron's (1989) method.
2. Numbers in brackets indicate the lag truncation for Bartlett kernel suggested by Newey–West test (1987).
3. *Indicates significance at 5% level.
4. Critical values for KPSS are taken from Kwiatkowski *et al*. (1992).

Table 2. Zivot–Andrews unit root tests for one break

	Model	Break	$t\ (\hat{\lambda}_{\text{inf}})$
lprgdp	C	1976	−2.089
*lfd*2	A	1985	−3.326
lrexpt	C	1971	−3.332
lrimpt	C	1973	−3.682

Notes: 1. Model specification (i.e., which model, A, B, or C, is appropriate) is determined by first running each data series on Model C, with the possibility of both a slope and a level break. Model C is chosen if both dummy variables are significant. If only the slope dummy variable is significant, Model B is estimated. If only the level dummy is significant, Model A is estimated.
2. Critical values are taken from Zivot and Andrews (1992). The 10% and 5% critical values are −4.58 and −4.80, respectively, for Model A, and −4.82 and −5.08, respectively, for Model C.

autoregressive model with Gaussian errors was constructed and can be expressed by its first-differenced error correction form as

$$\Delta Y_t = \Gamma_1 \Delta Y_{t-1} + \Gamma_2 \Delta Y_{t-2} + \cdots + \Gamma_{k-1} \Delta Y_{t-k+1} - \Pi Y_{t-1} + \mu + \varepsilon_t \quad (2)$$

where Y_t are data series studied, ε_t is i.i.d. $N(0, \Sigma)$, $\Gamma_i = -I + A_1 + A_2 + \cdots + A_i$, for $i = 1, 2, \ldots, k-1$, and $\Pi = I - A_1 - A_2 - \cdots - A_k$. The Π matrix conveys information about the long-run relationship between Y_t variables, and the rank of Π is the number of linearly independent and stationary linear combinations of variables studied. Thus, testing for cointegration involves testing for the rank of Π matrix r by examining whether the eigenvalues of Π are significantly different from zero.

Johansen (1988) and Johansen and Juselius (1990) propose two test statistics for testing the number of cointegrating vectors (or the rank of Π): the trace (T_r) and the maximum eigenvalue (L-max) statistics. The likelihood ratio statistic for the trace test is

$$-2 \ln Q = -T \sum_{i=r+1}^{p=4} \ln(1 - \hat{\lambda}_i), \quad (3)$$

where $\hat{\lambda}_{r+1} \ldots, \hat{\lambda}_p$ are estimated p–r smallest eigenvalues. The null hypothesis to be tested is that there are at most r cointegrating vectors. That is, the number of cointegrating vectors is less than or equal to r, where r is 0, 1, or 2. In each case, the null hypothesis is tested against the general alternative.

Alternatively, the L-max statistic is

$$-2 \ln Q = -T \ \ln(1 - \hat{\lambda}_{r+1}) \quad (4)$$

In this test, the null hypothesis of r cointegrating vectors is tested against the alternative of $r+1$ cointegrating vectors. Thus, the null hypothesis $r = 0$ is tested against the alternative that $r = 1$, $r = 1$ against the alternative $r = 2$, and so forth.

It is well known that Johansen‘s cointegration tests are very sensitive to the choice of lag length. The Schwartz Information Criterion (SIC) is used to select the number of lags required in the cointegration test.[5] A VAR model is first fit to the data to find an appropriate lag structure. The SIC suggests 1 lag for the VAR model used. Table 3 presents the results from the Johansen (1988) and Johansen and Juselius (1990) cointegration test. According to Cheung and

[5] Using Monte Carlo simulations, Cheung and Lai (1993) showed that for autoregressive processes, standard selection criteria, like the SIC and Akaike Information Criterion (AIC), can be useful for selecting the correct lag structure for the Johansen's cointegration test. They found that the SIC performs slightly better than the AIC.

Table 3. Cointegration tests based on the Johansen (1988) and Johansen and Juselius (1990) approach

	Trace test	5% critical value	10% critical value
lprgdp lfd2 lrexpt lrimpt (VAR lag = 1)			
H_0: $r = 0$	48.74*	47.21	43.95
H_0: $r \leq 1$	26.12	29.68	26.79
H_0: $r \leq 2$	9.97	15.41	13.33
H_0: $r \leq 3$	1.23	3.76	2.69

Notes: 1. Critical values are taken from Osterwald–Lenum (1992).
2. r denotes the number of cointegrating vectors.
3. Schwartz Information Criteria (SIC) is used to select the number of lags required in the cointegrating test. The computed Ljung–Box Q-statistics indicate that the residuals are white noise.

Table 4. Granger causality results based on parsimonious vector error-correction models (VECM)

Explanatory variables	*dlprgdp*	*dlfd2*	*dlrexpt*	*dlrimpt*
Short run: *F*-statistic				
dlprgdp(−1)	–	1.88	0.11	1.89
dlfd2(−1)	3.60**	–	8.21*	0.91
dlrexpt(−1)	4.48*	0.33	–	1.72
dlrimpt(−1)	0.16	0.01	0.03	–
ECT: *t*-statistic	−1.65**	−0.01	0.42	−0.06
Joint (Short run/ECT): *F*-statistic				
dlprgdp/ECT	–	1.31	1.72	1.62
dlfd2/ECT	6.23*	–	4.12*	0.78
dlrexpt/ECT	2.71**	0.18	–	0.88
dlrimpt/ECT	1.35	0.01	0.90	–

Note: * and ** indicate significance at the 5% and 10% levels, respectively.

Lai (1993), the Trace test shows more robustness to both skewness and excess kurtosis in the residuals than the L-max test; therefore, only Trace statistics are used in this study. As shown in this table, Trace statistic suggests that there exists one cointegrating vector among these four variables. This result suggests that these four variables would not move too far away from each other through time. That is, a comovement phenomenon for real GDP per capita, financial development, real exports, and real imports is observed in Taiwan over the sample period.

Granger causality results based on error-correction model (ECM)

Granger (1988) points out that if there exists a cointegrating vector among variables, there must be causality among these variables at least in one direction. Granger (1986) and Engle and Granger (1987) provide a test of causality which takes into account information provided by the cointegrated properties of variables. The model can be expressed as an error-correction model (ECM) as follows (see Engle and Granger, 1987):

$$\Delta Y_{it} = \mu_{it} + \beta' Z_{t-1} + \sum_{i=1}^{m} a_i \, \Delta Y_{1,t-i} + \sum_{i=1}^{m} b_i \, \Delta Y_{2,t-i} + \sum_{i=1}^{m} c_i \, \Delta Y_{3,t-i} + \sum_{i=1}^{m} d_i \, \Delta Y_{4,t-i} + \varepsilon_{it} \quad (5)$$

where Y_{it} denotes real GDP per capita, financial development, real exports, or real imports and $\beta' Z_{t-1}$ contains r cointegrating terms, reflecting the long-run equilibrium relationship among variables. Granger causality tests are conducted by examining whether the coefficients of $\Delta Y_{2,t-i}$, $\Delta Y_{3,t-i}$, and $\Delta Y_{4,t-i}$ are statistically different from zero as a group, based on a standard F-test, and/or the coefficient of the error-correction term is also significant. Because Granger causality tests are known to be very sensitive to the lag length selection, Hsiao's (1979, 1981) sequential procedure is used to determine the lags. This procedure is based on the Granger definition of causality and Akaike's (1974) minimum final prediction error (FPE) criterion. This procedure is known as the stepwise Granger causality technique. Thornton and Batten (1985) have found Hsiao's method to be superior to arbitrary lag length selection and several systematic procedures for determining lag length.

Table 4 reports the results from Granger causality tests based on vector error-correction models (VECM). The results indicate unidirectional causality running from financial development to economic growth. This finding supports the supply-leading hypothesis for Taiwan over this sample period. Furthermore, the export-led growth hypothesis is found also to hold for this sample period. Finally, it is also found that financial development Granger-causes real exports over this sample period.

V. Conclusions

Using a four-variable VAR model, two competing hypotheses are empirically tested regarding the relationship between financial development and economic growth for Taiwan over the period 1962–1998. These hypotheses are called supply-leading and demand-following. Using Johansen (1988) and Johansen and Juselius (1990) cointegration tests, it is found that real GDP per capita, financial development, real exports and real imports are cointegrated with one vector. The results from Granger causality tests based on vector error-correction models (VECM) suggest unidirectional causality running from financial development to economic growth. This result supports the supply-leading hypothesis for Taiwan. Furthermore, unidirectional causality is also found running from financial development to real exports and from real exports to economic growth. These findings have important implications for the conduct of economic policy in Taiwan. There is a high degree of confidence that the development of the financial sector and the promotion of the exports are effective policies towards promoting Taiwan's economic growth.

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