International Journal of Management, Economics and Social Sciences
2017, Vol. 6(2), pp.89 – 106.
ISSN 2304 – 1366
http://www.ijmess.com

Financial Development and Economic Growth: Evidence from South Korea between 1961 and 2013

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This paper investigated the long run relationship between financial development and economic growth in South Korea using a four-variable Vector Autoregressive (VAR) model using time series data from 1961 to 2013. Applying unit root tests and co-integration analysis, the study revealed that real GDP per capita, financial development, real exports, and real imports were co-integrated with one vector. The empirical results from Granger causality tests based on vector error correction model (VECM) with one co-integrating vector suggested that financial development led to increase in economic growth and that there was unidirectional causality from financial development to economic growth but not from economic growth to financial development, supporting previous theoretical perspectives on the positive relationship between financial development and economic growth. This result emphasized the important role of financial development in South Korea's recent economic growth.

Key Words: Financial Intermediary, Economic Growth, VAR, VECM, Granger Causality

JEL: E44, G10, O16, O40

Economists hold the view that long-term sustainable economic growth depends on the ability to raise the rates of accumulation of physical and human capital and that resulting productive assets should be used more efficiently. They argue that financial development is a necessary condition to achieve a high rate of economic growth. Patrick (1966) referred to this as the "supply-leading" role of financial development. The supply-leading hypothesis argues that financial deepening causes real economic growth. A well-developed financial sector facilitates financial transactions, mobilizes savings, and transfers mobilized funding to developmental activities. Financial development accompanying these roles stimulates a country's economic growth by allocating financial resources into suitable financial demand (Levine, 1997). In contrast, Calomiris and Hubbard (1990) discussed that a lower level of financial development causes credit misallocation or low quality of borrowing and, thus, may have a negative influence on economic growth.

Nearly 50 percent of the world's population, more than 3 billion people lives on less than $2.50 per

Manuscript received March 5, 2017; revised June 3, 2017; accepted June 15, 2017. © The Author; Licensee IJMESS
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day, whereas, More than 1.3 billion people live in extreme poverty having just $1.25 per day. In the world, more than 50 countries have less than $5000 GDP per capita, illuminating that the key of economic growth still remains an important issue. The economy of South Korea is selected for its meteoric rise from being an extremely impoverished country fighting against population and resource restrictions to a developed country with a relatively large contribution to the world's GDP. Following the Korean War, South Korea was one of the poorest countries in the world. In 1960 the reported GDP per capita for South Korea was $155. Since 1960, however, its economy has achieved remarkable growth rates. By 2013, the GDP per capita grew to $25,976.95. South Korea has also risen to the eighth largest trading country in the world, with a foreign exchange reserve estimated to be $367,534 million in August, 2014. Joining the Organization of Economic Cooperation and Development (OECD) in 1996, South Korea achieved a position as one of the 20 largest economies of the world. South Koreans refer this remarkable economic progress as the "miracle of the Han River," an essential waterway to South Koreans. This "miracle" is an important case study to investigate how rapid development can occur within a country. Due to many dimensions of determinants of economic growth, it is unrealistic to consider that a surge of foreign direct investment and domestic saving are the main factors of economic growth in South Korea. More empirical work is needed to examine the dynamics of economic growth, investigate new contributing factors, and ensure ways to maintain high rate of economic growth. Thus, the main goal of this paper is to investigate the relationship between financial development and economic growth by applying Granger causality based on vector error correction model (VECM) to the economy of South Korea. The causality tests are preceded by co-integration testing, which shows the existence of long-run relationship between financial development and economic growth.

This paper is organized as follows. Section 2 reviews previous literature on the association between financial development and economic growth. In section 3, I briefly present the data, its properties, and the econometrics model applied in this paper. In the fourth section, the Granger causality test and VECM are conducted after applying exogenous and endogenous break test and the co-integration analysis. Lastly, in Section 5 the results of VECM on financial development and economic growth are provided.

LITERATURE REVIEW

This section reviews previous theoretical studies on the association between financial development and economic growth. The cost to obtain financial information or to enforce financial contracts requires the financial intermediary to be developed. Merton and Bodie (1995) argued that the degree of the financial intermediary's efficiency influences the redistribution of financial resources. When the efficiency of the banking sectors increases, the cost associated to acquire financial information and transactions decreases, making credit allocation efficient. Similarly, with the development of stock and bond markets, people are able to acquire more opportunities for investment activities and funding from well-developed stock and bond markets turn out to be more liquid than conventional savings. Thus, imperfect credit markets cause market frictions and motivate the development of financial intermediaries. Consequently, a more advanced financial system increases the efficiency of financial resource allocation, which positively influences economic growth. According to Boyd and Prescott (1986), a well-developed financial system decreases the cost to produce information and allocate capital. This may improve the efficiency of financial resource allocation for people who are confronted with the high transaction cost related with examining firms and managers' financial soundness when searching for investment opportunities. Therefore, the presence of financial intermediaries' lending loans and accepting savings reduce the cost to produce information on financial investment activities.

Greenwood and Jovanovic (1990) suggest a theoretical model to investigate the association between financial development and economic growth. Like Boyd and Prescott (1986), the author agree that the development of a financial intermediary creates relevant information with the low transaction cost and increases the efficiency of financial resource allocation, which stimulates economic growth. Unlike Boyd and Prescott (1986), however, Greenwood and Jovanovic (1990) argued that when people use financial intermediaries to reduce the cost associated with examining firms' and managers' soundness and investigating economic situations, it is still costly. In their argument, credit accessibility mostly provided by financial intermediaries is required for investment activities. Thus, as more people are able to access financial services provided by financial intermediaries, it will enhance the ability of financial

sectors to produce reliable information and, in turn, improve the efficiency of capital allocation. Lastly, Galor and Zeira (1993) suggested a linear relationship, indicating that a well-developed financial system leads to a reduction in income inequality. According to their argument, the misallocated credit keeps people away from investing into human capital due to imperfect financial markets. Again, the human capital accumulation is negatively affected by capital market imperfection. For this reason, imperfect financial markets impede economic growth.

Patrick (1966) identified two possible patterns in the causal relationship between financial development and economic growth. As the first hypothesis, Patrick found that economic growth causes an expansion of the financial system called "demand-following". According to demand-following hypothesis, the lack of financial growth is a manifestation of the lack of demand for services. Second, Patrick found that the expansion of the financial system precedes the demand for its services called "supply-leading". Using data from 56 countries, Jung (1986) found that the supply-leading hypothesis holds for less developed countries and the demand-following hypothesis holds for developed countries. In his study with 10 sub-Saharan countries, Spears (1992) discovered that financial development causes economic growth. Research that supports this argument include Ahmed and Ansari (1998), who investigated the relationship between financial development and economic growth of three major South-Asian countries. Using a four variable VAR model applying on data collected from Taiwan between the period 1962 to 1998, Chang and Caudill (2005) found that financial development Granger causes economic growth. However, Thornton (1996) found contradictory evidence using data from Asian, Latin American, and Caribbean developing economies.

A key point to this study is how to measure financial development. Extensive literature on financial development offers several proxies to the extent of financial activity (Gregorio and Guidotti, 1995). Previous research used the following measures as a measure of financial development: 1) the ratio of money stock (M2) to the nominal GDP per capita (Gupta, 1984; Fry, 1989; King and Levine, 1993a and 1993b), 2) the ratio of narrow money to GDP (FDM1), 3) the ratio of total deposit to GDP (FDM3), 4) the ratio of private sector credit to GDP (FDM4), 5) the ratio of total credit to GDP (FDM5), 6) the ratio of private sector credit to total domestic

credit (FDM6), and 7) the ratio of liquid liability to GDP.

The evidence from both theoretical and empirical literature suggests a well-developed financial system leads to increase in economic growth. Patrick (1966) argued the supply-leading role of financial development, which means that financial deepening is required to achieve high rate of economic development. In other words, the supply-leading hypothesis suggests that financial deepening causes real economic growth. On the other hand, the demand-following hypothesis, which holds the view that economic growth triggers financial development, has emerged in later studies. Based on VAR model, this study examines whether financial development causes economic growth or vice versa.

Data

Among the macro variables, four variables were selected based on their theoretical importance, performance measures of the economy, and their use and findings in previous empirical literature. The empirical analysis on the relationship between financial development and economic growth in South Korea is based on annual data on real GDP per capita as a traditional measure of economic growth, M2, which is money supply, real exports, and real imports for South Korea, ranging from 1961 to 2013. A time series dataset was obtained from two sources, United Nations Conference on Trade and Development (UNCTAD) and The World Bank (see Table 1).

Following previous literature (Chang and Caudill, 2005; Jung, 1986), the ratio of M2 to real GDP was chosen as the proxy to financial development. All variables were converted into natural log form since they exhibited exponential growth, as shown in Figure 1.

METHODOLOGY AND EMPIRICAL RESULTS

The stationary tests for all four series – Augmented Dickey Fuller (ADF), Phillips-Perron (PP), and the Kwiatkowski-Phillips-Schmidt-Shin (KPSS) tests – were utilized. As indicated in numerous papers, the standard ADF test is not sufficient for variables that may have undergone structural changes. To resolve this possible problem, the last two tests (PP and KPSS) were incorporated due to the fact that the ADF test has trouble anguishing between a near unit root process and a unit root process. The unit root *t*-statistics are shown in Table 2 (see Appendix-I) (Banerjee *et al*., 1992; Perron, 1989, 1990; Zivot and Andrews, 1992).

As shown in Table 2, I found some disagreements between the KPSS test and two

Acronym	Description	Source
Lrgdp	Natural logarithm of real GDP per capita	The World Bank
Lfd	Natural logarithm of Financial development (The ratio of M2 to real GDP)	The World Bank
lrexpt	Natural logarithm of real export	UNCTAD
lrimpt	Natural logarithm of real import	UNCTAD

Table 1: Description of variables

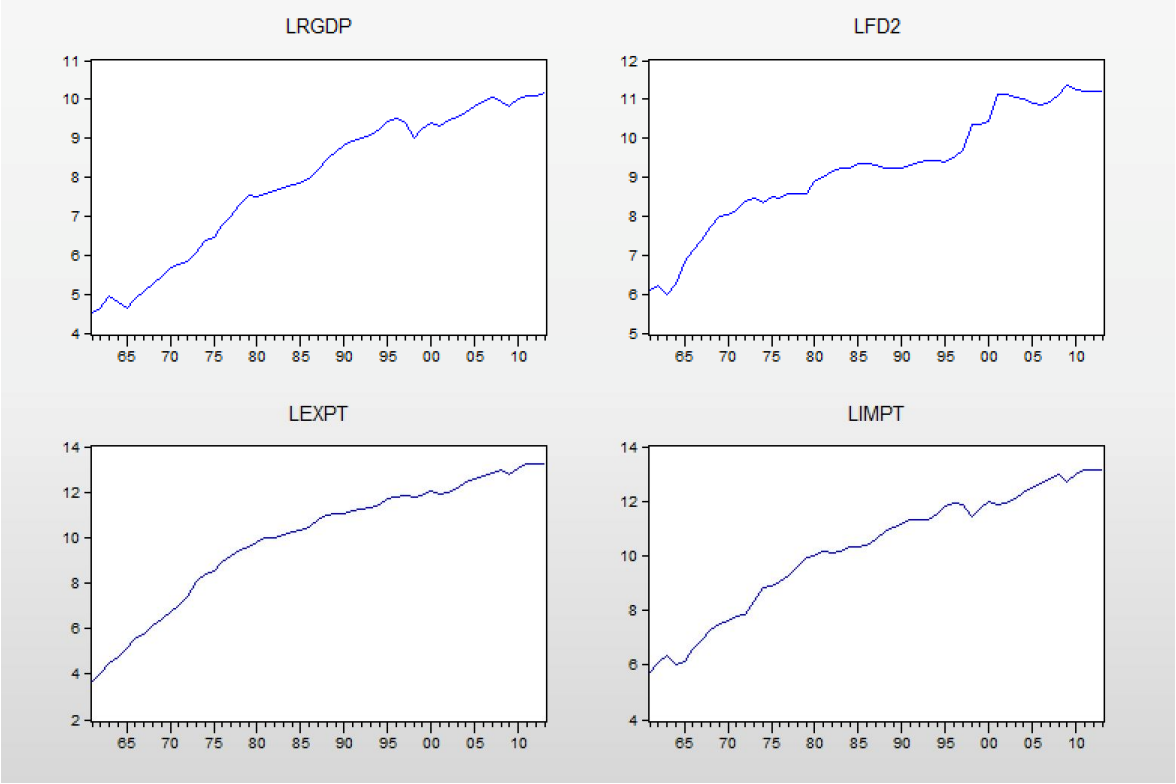

Figure 1: Plots for each variable

other tests but concluded that all series are I (1) unit root processes where the first difference of the series will be stationary. In the following sections, I used an endogenous break test to confirm all processes have a unit root (the null of the break test is a structural break for a unit root process). Looking at *lrgdp* and *lfd2*, in particular, the autocorrelation function (ACF) or correlogram for a stationary series should converge to 0 and for an AR (*p*) process, the partial Autocorrelation Function (PACF) should spike at lag 1. Looking at the ACF and PACF for lrgdp in Figures 2 and 3 (see Appendix-II), GDP per capita,

and lfd2, the ratio of M2 to GDP, ACF for both lrgdp and lfd2 converges to 0 and PACF for both have a spike at lag 1. These test results on ACF and PACF are consistent with those of the unit root tests.

The present study attempts to investigate the long run and short run relationship between economic growth, measured by GDP, and financial development, measured by the ratio of M2 and real GDP including real export and real import variables.

$$X_t = (lrgdp_t, lfd2_t, l\exp t_t, \lim pt_t)' \quad (1)$$

where, *lrgdp* is real GDP per capita, *lfd2* is financial development measured by the ratio of money stock (M2) to GDP per capita, *lexpt* is the real export, *limpt* is the real import, and X is a 4*1 vector of variables.

There were several economic crises in the history of South Korea's economy, including the global oil shock, the Asian financial crisis, and the global financial crisis. The Perron Structural Break test was conducted to see if there is a structural break in 1973 (and 1978), which corresponds to the global oil shock; in 1997, which corresponds to the Asian financial crisis; and in 2008, which corresponds to the global financial crisis. Results are shown in Table 3.

I then ran an endogenous break test to allow the data to point out the structural breaks. I specifically used the Zivot-Andrews test, which has shown that the existence of structural changes biases the standard ADF test towards non-rejection of the null of the unit root. It seems appropriate to treat the structural break as endogenous and test the order of integration by the Zivot-Andrews test. Table 4 (see Appendix-I) reports that there were some other structural breaks. These break tests help in the selection of possible dummies when running a VAR model and co-integration analysis. The drawback of the Zivot-Andrews test is the fact that the data are trimmed, which does not allow the test to test for breaks on the trimmed data. In summary, the plausible breaks for the series in the dataset should be included at 1965, 1973, 1978, 1988, 1997, 2001, and 2008 to investigate the relationship between financial development and economic growth.

Let us define $X_t = (lrgdp_t, lfd2_t, l\exp t_t, \lim pt_t)'$. In the VAR estimation, seven structural dummies were included $(d\_1965, d\_1973, d\_1978, d\_1988, d\_1997, d\_2001, d\_2008)$.

Writing the reduced VAR (n) or UVAR, we obtain

$$X_t = A_0 + \gamma t + \sum_{i=1}^{n} A_i X_{t-1} + \sum_{k=1}^{7} \beta_k d_k + e_t \quad (2)$$

where X_t is a 4*1 vector of I (1) variables A_0

is an n*1 vector of constants, A_i is an n*n matrix of coefficients, and e_t is an n*1 vector of white noise variables. In order to use Johansen's method, the UVAR needs to be turned into VECM, which can be written as:

$$\Delta X_t = -\Pi X_{t-1} + \sum_{i=1}^{n-1} \Phi_i X_{t-1} + \sum_{k=1}^{7} \beta_k d_k + u_t \quad (3)$$

where X_{it} denotes real GDP per capital, financial development measure, the ratio of M2 to real GDP, real exports, and real imports.

Finally, while it was not performed in the paper, I also conducted a structural vector autoregressive (SVAR) analysis with the purpose of plotting impulse response functions. As shown below, I rewrite the UVAR (Unstructured VAR) as:

$$BX_t = \Gamma_0 + \delta t + \sum_{i=1}^{n} \Gamma_i X_{t-1} + \sum_{k=1}^{7} \beta_k d_k + \upsilon_t \quad (4)$$

Based on an LR statistic, I found that 1 lag was preferred over 4 lag. According to the lag criteria, 2 lags are most optimal (Tables 5 and 6).

The Jarque-Bera test for residual normality and the LM test were conducted for autocorrelation in order to see how good my model specifications are. As shown in Table 7 for the Jarque-Bera test, the null is multivariate normality and the test is conducted by testing the skewness and kurtosis of the residuals. I would like both to be 0 but can settle with rejecting the null for kurtosis. Rejecting the null for skewness would invalidate the s statistic for the VAR. Normality is not rejected for both *lexpt* and *limpt*, but rejected for both *lrgdp* and *lfd2* due to skewness and kurtosis problems. However, according to Bai and Ng (2004), since measures of skewness are not informative in small samples, these problems are minor. The null of the LM test is that there is no autocorrelation up to some lag. Looking at the LM test in Table 8, it appears to have a problem with autocorrelation for the first two lags, but these problems are minor. Additionally, I fail to reject the null that there is no heteroskedasticity.

Table 9 reports the results of granger causality among the variables. I reject the null that financial development (*lfd2*) does not cause granger cause real export (*lexpt*), suggesting that financial development granger causes economic growth. However, inverse economic growth does not cause financial development. In other words, financial development measured by the ratio of M2 to real GDP per capita granger causes economic growth measured by growth in real GDP per capita. Therefore, unidirectional causality is captured from financial development to economic growth measured

by real GDP per capita. In addition, other strong unidirectional causalities from financial development to real export and import are suggested by the granger causality test. As for explanatory variables, real export granger causes real GDP per capita. This is very promising since the economy of South Korea is tied to real export. The rest of the block-exogeneity results appear in Table 9.

In Figure 4, the impulse response functions with two standard error confidence intervals for the *lrgdp* are plotted in response to shocks from all variables. Impulse response functions show that a shock to the *i*-th variable not only directly affects the *i*-th variable but is also transmitted to all of the other endogenous variables through the dynamic lag structure of the VAR and traces the effect of a one-time shock to one of the innovations on current and future values of the endogenous variables. As seen in Figure 4, the effect of a one-time shock to *lfd2* of the innovations on current and future values of *lrgdp* increases. In addition, the confidence interval expands with time.

I use the same variable in the same order as for the UVAR with the lag length of 1. Johansen (1988) and Johansen and Juselius (1990) proposed two test statistics for testing the number of cointegrating vectors: the trace and the maximum eigenvalue statistics. For the trace test, the null hypothesis to be tested is that there are, at most, *r* co-integrating vectors. That is, the number of co-integrating vectors is less than or equal to *r*, where *r* is 0, 1, or 2. The null hypothesis is tested against the general alternative. According to both the trace and max eigenvalue tests without restrictions, one co-integrating relationship was found (Table 10 and 11).

Next, one co-integrating equation was applied for *lrgdp*. Since this study is not based on a theoretical model but rather a mix of theory and empirical analysis, it is difficult to impose any restrictions. For VECM, the variables must be non-stationary at level, but when I convert the variables into first differenced, they become stationary with the same integrated orders. Using the first normalized eigenvector, we can estimate the co-integrating coefficients as follows

$$X_t = (lrgdp_t, lfd2_t, l\exp t_t, \lim pt_t)$$

$$B_1 = (1.000, -2.028, -4.732, 5.491)$$

The variables have been log transformed, so these values represent log-term elasticity measures. The co-integrating relationship can be re-expressed as:

$$\ln(rgdp) = 28.228 + 2.028\ln(fd2) + 4.732\ln(\exp t) - 5.491\ln(impt)$$

t-statistics [5.30] [-7.27] [5.40]

The coefficients of *lfd2* (financial development)

and *lexpt* (real export) are positive and significant. As expected, *lfd2* has a positive effect on *lrgdp*, which means financial development has a positive effect on economic growth. Also, since South Korea is an export country I expect *lexpt* to have a great positive effect on *lrgdp* (real GDP per capita). The error correction coefficient (speed of adjustment towards equilibrium / Short run dynamic / α) is -0.0307, which means that about 3.1 percent of the previous period's deviations from the long-run equilibrium are adjusted in this period. However, by the Wald test, this speed of adjustment is non-significant (t = -1.44). Therefore, there is no long-run causality running from *lfd2*, *lexpt*, and *limpt* to *lrgdp*. However, as shown in Table 13, there is short run causality running from *lfd2* to *lrgdp*. The short-run dynamics of co-integrating relations is shown in Table 12 (see Appendix-I).

Considering the co-integrating equation, I have the following system of equations

$$\beta_{11} lrgdp_t + \beta_{12} lfd2_t + \beta_{13} l\exp t_t + \beta_{14} \lim pt_t = 0$$

My set of restrictions are $\beta_{13} = 1$ and $\beta_{14} = -1$

The system can be re-written as

$$\beta_{11} lrgdp_t + \beta_{12} lfd2_t + l\exp t_t - \lim pt_t = 0$$

Running these restrictions with an LR statistic of 0.682, these restrictions are not rejected.

According to Granger (1988), if there is a co-integrating vector among the series of the dataset, they should have causality relations in more than one direction. The Granger causality test, which takes into account information provided by the co-integrated properties of series in the dataset, was introduced (Granger, 1986; Engle and Granger, 1987). The error correction model is followed by

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

where X_{it} denotes real GDP per capita, financial development measure, which is the ratio of M2 to real GDP, real exports, or real imports. $\beta' Z_{t-1}$ includes r co-integrating terms, suggesting long-run relationship among series of the dataset.

The Granger causality test results on VECM are presented in Table 13. The coefficient of *dlfd2 (-1)* is statistically different from zero, suggesting unidirectional causality running from financial development measured by M2 to GDP to economic growth. As for the other explanatory variables, financial development granger causes real imports between 1961 and 2013. However, the coefficients of real export and real import are not statistically significant, indicating the hypothesis of export-led growth does not seem to be shown between 1961

and 2013. Based on the VECM, I checked residual diagnostics based on the normality test (Jarque-Bera), LM test, and heteroskedasticity test. As a result, there is no serial correlation (*f*-statistic = 1.59) and no heteroskedasticity problem in the model (*f*-statistic = 0.83). However, the residuals are not normally distributed.

CONCLUSION

According to previous theoretical studies on financial development and economic growth (Boyd and Prescott, 1986; Galor and Zeira, 1993; Greenwood and Jovanovic, 1990; Merton and Bodie, 1995), a well-developed financial sector reduces the cost to produce information and reallocate capital. Thus, it may boost the efficiency of financial resource allocation for investors who are confronted with the high transaction cost related with examining firms' and managers' financial soundness when searching for investment opportunities. This paper investigated the association between financial development and economic growth in South Korea after controlling exports and imports between 1961 and 2013. Based on a four-variable VAR model, I tested the relationship between financial development and economic growth for South Korea between 1961 and 2013. I found that real GDP per capita, financial development, real exports, and real imports are co-integrated with one vector by utilizing the co-integration tests suggested by Johansen (1988) and Johansen and Juselius (1990). Finally, the Granger causality tests based on VECM with one co-integrating vector reveal unidirectional causality running from financial development to economic growth but not from economic growth to financial development, supporting previous theoretical perspectives on the positive association between financial development and economic growth. These results have important implications for economic policy in South Korea, suggesting that government policy makers should prioritize the development of the financial sector rather than economic growth itself to ensure sustainable economic growth. To reflect the requirements of the theory, however, more relevant data should be collected to measure financial development, including the relative size of local capital market to GDP and stock market capitalization to GDP. Additionally, in 1989 the first meeting of Asia-Pacific Economic Cooperation (APEC) was launched for more effective economic cooperation among Asian countries in response to the growing interdependence of Asia-Pacific economies. It means that geographic impact should be considered to investigate the association

between financial development and income inequality. Abreu *et al*. (2005) argued that empirical model specification excluding spatial dependence may have a serious misspecification issue. For further research, therefore, spatial data analysis based on cross Asian country dataset should be considered for better model specification with spatial dependence to examine the relationship between financial development and economic growth.

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Appendix-I

	ADF Test Trend & Intercept	PP Test Trend & Intercept	KPSS Test Trend & Intercept
Lrgdp	-0.586	-0.723	0.234***
Δlrgdp	-5.982***	-5.895***	0.065
lfd2	-2.052	-2.157	0.104*
Δlfd2	-5.920***	-5.907***	0.072
Limpt	-1.416	-1.174	0.235***
Δlimpt	-6.553***	-7.247***	0.125
Lexpt	-2.286	-2.286	0.242***
Δlexpt	-5.994***	-6.009***	0.166

***: 1% S.L, **: 5% S.L., and *: 10% S.L.

Table 2: Unit Root Tests

Variables	1965	1974	1978	1998
Lrgdp	-15.622*	7.34*	-3.805	-7.32*
lfd2	-12.684*	-9.77*	-11.395*	-11.31*
Limpt	-13.918*	-11.625*	-1.965	-7.54*
Lexpt	-7.918	-5.905	0.4239	-3.065

$\lambda = 0.9, T = 50$, ***: 1% S.L., **: 5% S.L., and *: 10% S.L.

Table 3: Perron Structural Break Test

Variables	ZA t-statistic	Break Date
lrgdp	-2.509	1988 (intercept and trend)
lfd2	-2.964	2001 (intercept and trend)
lexpt	-5.662	1973 (intercept and trend)
limpt	-4.825	1978 (intercept and trend)

Table 4: Zivot-Andrews Test

	4 to 3	3 to 2	2 to 1
LR Statistic	28.85	17.72	38.48*

***: 1% S.L., **: 5% S.L., and *: 10% S.L.

Table 5: LR Statistics

Sequential LR	FPE	AIC	SC	HQ
2	4	4	1*	1*

***: 1% S.L., **: 5% S.L., and *: 10% S.L.

Table 6: Lag Criteria

Variables	Skewness	Kurtosis	Jarque-Bera
Lrgdp	-1.448	8.914	93.960
lfd2	0.642	4.343	7.473
Lexpt	0.419	2.920	1.533
Limpt	-0.158	2.751	0.351

Table 7: Jarque-Bera Test

Lags	LM Statistics
1	35.704***
2	28.199***
3	13.327
4	21.052
5	26.986**
6	16.928
7	9.435
8	13.339
9	13.608
10	9.009
11	14.808
12	15.838

***: 1% S.L., **: 5% S.L., and *: 10% S.L.

Table 8: LM Test

Dept. var/excluded	**lrgdp**	**lfd2**	**lexpt**	**limpt**
lrgdp	-	6.441***	8.490***	2.428
lfd2	1.049	-	0.457	0.962
lexpt	1.454	5.937***	-	3.048*
limpt	0.049	8.046***	3.048*	-

***: 1% S.L., **: 5% S.L., and * 10% S.L

Table 9: Granger Causality

No. of Cointegrating eq.	**Eigenvalue**	**Trace Statistic**
None*	0.6243	81.997
At most 1	0.3719	32.067
At most 2	0.1087	8.347
At most 3	0.0474	2.476

***: 1% S.L., **: 5% S.L., and * 10% S.L.

Table 10: Unrestricted Co-integration Rank Test: Trace

No. of Co-integrating Eq.	Eigenvalue	Max-Eigen Statistic
None*	0.6243	49.929
At most 1	0.3719	23.721
At most 2	0.1087	5.871
At most 3	0.0474	2.476

***: 1% S.L., **: 5% S.L., and * 10% S.L.

Table 11: Unrestricted Co-integration Rank Test: Max Eigenvalue

CI Eq.	Δ lrgdp	Δ lfd2	Δ lexpt	Δ limpt
1	-0.0307	-0.0139	0.0233	-0.0713

Table 12: Short-run Dynamics (α)

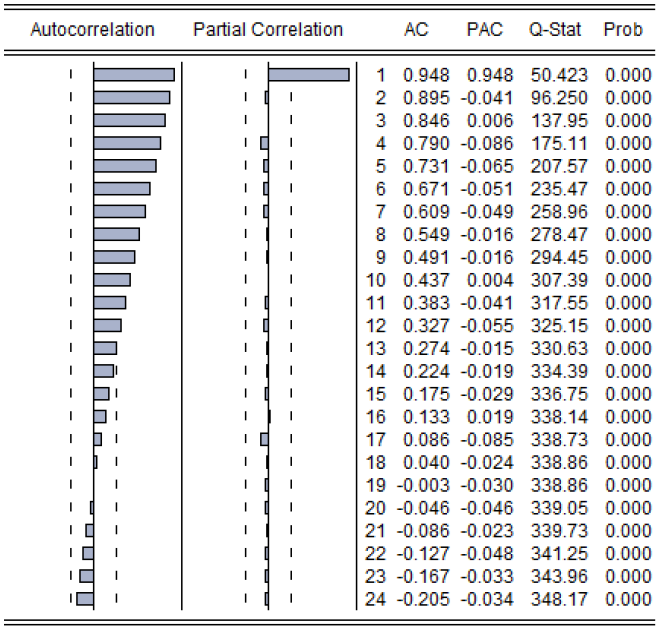
Explanatory Variable	Dlrgdp	dlfd2	dlexpt	dlimpt
Short run: *t*-statistic				
dlrgdp(-1)	-	-1.33	1.10	2.12
dlfd2(-1)	2.57***	-	0.72	2.76***
dlexpt(-1)	1.01	-1.11	-	0.93
dlimpt(-1)	-1.06	1.81**	-1.79**	-
ECT: *t*-statistic				
Joint (Short run & ECT): *f*-statistic				
dlrgdp & ECT	-	0.96	1.25	5.69***
dlfd2 & ECT	4.60***	-	0.93	7.40***
dlexpt & ECT	2.01	0.64	-	4.34***
dlimpt & ECT	2.04	1.64	1.94	-

ECT: Error Correction Term

Table 13: Granger causality results

Appendix-II

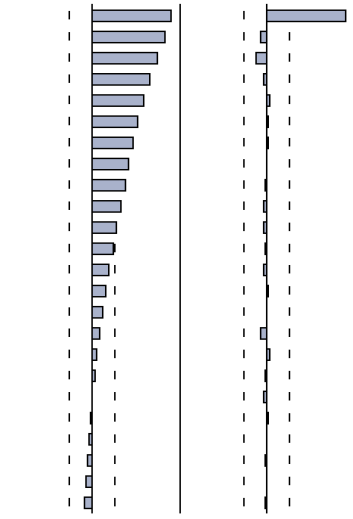
Date: 11/10/14 Time: 14:04
Sample: 1961 2013
Included observations: 53



Autocorrelation	Partial Correlation		AC	PAC	Q-Stat	Prob
		1	0.948	0.948	50.423	0.000
		2	0.895	-0.041	96.250	0.000
		3	0.846	0.006	137.95	0.000
		4	0.790	-0.086	175.11	0.000
		5	0.731	-0.065	207.57	0.000
		6	0.671	-0.051	235.47	0.000
		7	0.609	-0.049	258.96	0.000
		8	0.549	-0.016	278.47	0.000
		9	0.491	-0.016	294.45	0.000
		10	0.437	0.004	307.39	0.000
		11	0.383	-0.041	317.55	0.000
		12	0.327	-0.055	325.15	0.000
		13	0.274	-0.015	330.63	0.000
		14	0.224	-0.019	334.39	0.000
		15	0.175	-0.029	336.75	0.000
		16	0.133	0.019	338.14	0.000
		17	0.086	-0.085	338.73	0.000
		18	0.040	-0.024	338.86	0.000
		19	-0.003	-0.030	338.86	0.000
		20	-0.046	-0.046	339.05	0.000
		21	-0.086	-0.023	339.73	0.000
		22	-0.127	-0.048	341.25	0.000
		23	-0.167	-0.033	343.96	0.000
		24	-0.205	-0.034	348.17	0.000

Figure 2: ACF and PACF of lrgdp

Date: 11/10/14 Time: 14:05
Sample: 1961 2013
Included observations: 53



	AC	PAC	Q-Stat	Prob
1	0.930	0.930	48.515	0.000
2	0.856	-0.071	90.391	0.000
3	0.770	-0.122	125.00	0.000
4	0.685	-0.043	152.91	0.000
5	0.609	0.026	175.43	0.000
6	0.542	0.017	193.65	0.000
7	0.485	0.018	208.56	0.000
8	0.435	0.000	220.83	0.000
9	0.389	-0.019	230.86	0.000
10	0.342	-0.049	238.77	0.000
11	0.294	-0.032	244.77	0.000
12	0.248	-0.012	249.14	0.000
13	0.202	-0.026	252.12	0.000
14	0.163	0.015	254.12	0.000
15	0.129	-0.003	255.40	0.000
16	0.090	-0.077	256.04	0.000
17	0.061	0.034	256.34	0.000
18	0.034	-0.015	256.44	0.000
19	0.004	-0.047	256.44	0.000
20	-0.018	0.021	256.47	0.000
21	-0.038	-0.005	256.60	0.000
22	-0.055	-0.010	256.89	0.000
23	-0.069	-0.005	257.36	0.000
24	-0.083	-0.023	258.06	0.000

Figure 3: ACF and PACF of lfd2

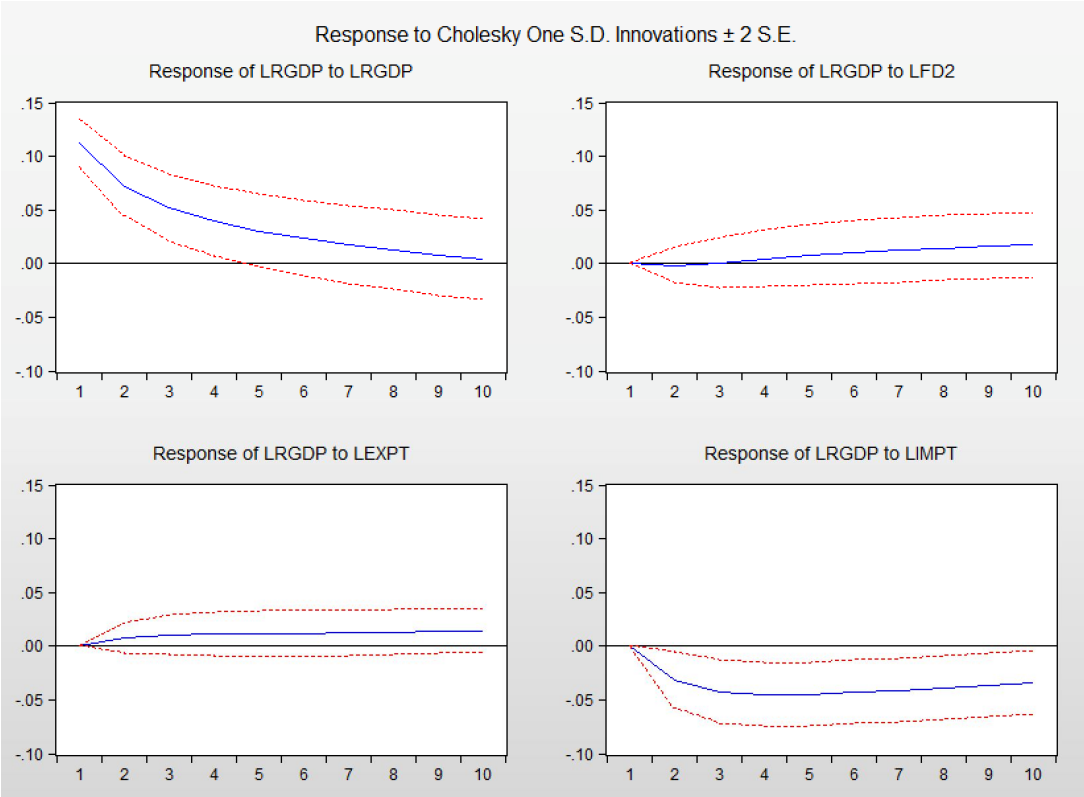


Figure 4: Impulse Response Functions: lrgdp