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Evidence of Korea's Finance-Growth Nexus: VARX Analysis with Financial Crisis and Openness

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Korea's finance-growth nexus is empirically investigated by taking the elements of financial crisis and openness—trade and financial—by employing the newly developed approach of vector error correction models with weakly exogenous *I*(1) variables (VARX). Considering financial development as a more complex phenomenon, we matter two aspects of financial deepening that are measured by its size (private credit to GDP) and efficiency (private credit to total domestic deposits). The main findings are: (1) financial efficiency contributes to accelerating economic growth; (2) the causality between economic growth and financial size is bilateral and negative; and (3) financial crisis is negative to both economic growth and financial development, whereas the growth-promoting effects of trade and financial openness are confirmed.

Keywords: Finance-growth nexus, financial crisis, openness, cointegration, VARX, Korea.

JEL Classification Codes: E44, G10, O53

1. Introduction

The topic of the finance-growth nexus has been long debated in the literature, that is, whether/how financial development—the increasing extent of bank credit and/or stock market transactions—contributes to higher economic growth. Financial development has its impact on capital accumulation by raising the saving rate and then can promote economic growth by improving the productivity and efficiency in an economy. Therefore, setting up a well-functioning financial system is a key policy implication for developing economies. As the importance of financial deepening has been emphasized, (domestic) financial liberalization is validated in prescribing development polices[2]. Over the 1950s and 1960s, conventional policy advice was that governments in developing countries actively promote development by intervening in financial markets. By the early 1970s, the so-called "financial repression" was brought to the literature by McKinnon (1973)

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[2] In the literature, financial development, financial deepening, financial depth and finance are used as synonyms.

and Shaw (1973) who were in favor of liberalizing the financial system while criticizing such repression policies as ceilings on interest rates, high reserve requirements and administrative credit allocation[3].

While the finance-growth nexus has been empirically analyzed for decades, the following issues are witnessed in the literature. First of all, there is a controversy between cross-country studies and time series ones. Although the leading evidence—financial development exhibits a positive impact on economic growth—has been drawn from cross-country models (e.g., King and Levine, 1993; Levine and Zervos, 1998), there is a critique that those models implicitly presume homogeneity in different countries' growth patterns and thus mask country-specific factors in estimation (e.g., Demetriades and Hussein, 1996; Luintel and Khan, 1999). On the other hand, as far as time series studies—their main interest is in the Granger causality between economic growth and financial development[4]—are concerned, since the use of a bivariate causality test was standard in analyzing the finance-growth nexus, earlier studies of two variables—growth and finance only—were likely to suffer from the omission-of-variable bias. It is believed that other variables might have great impact on the finance-growth nexus; the omission of these variables could bias the direction of causality between economic growth and financial development. Consequently, an increasing number of empirical studies have introduced various third and more variables to the estimation of the finance-growth causality.

This argument directly links to this study's main interest, that is, whether and how the impact of finance (growth) on growth (finance) depends on a number of institutional and economic conditions prevailing in an economy (Herwartz and Walle, 2014). Among several variables that have been mattered in the literature, we are concerned with how trade and financial openness affect the finance-growth nexus. There is a view that trade and financial openness can lead to more efficient resource and production by allowing an economy to integrate into both goods and financial markets at the global level, which result in imports of modern technology and productivity improvements[5]. As openness thus enables developing countries to do what is necessary for higher economic growth, such international organizations as the IMF and the World Bank have strongly recommend those countries to open up their economies to the world. But it has been also pointed out that higher financial development coupled with high trade and financial

[3] The arguments of McKinnon (1973) and Shaw (1973) focus on liberalizing "domestic" financial markets, not assuming "external" financial liberalization.

[4] Cross-country studies investigate whether financial development matters for economic growth (finance→growth) but do not concern with the reverse causation (growth→finance).

[5] See Shahbaz (2011), Gries et al. (2009) and Yanikkaya (2003), Law (2008), Baltagi et al. (2009).

openness might significantly cause higher vulnerability to international shocks, leading to financial crisis that brought severe negative impact on an economy. Indeed, actual experiences with openness together with financial development over recent decades were filled with several crisis episodes in the developing world (e.g., Mexico in 1994-1995, Asian countries in 1997-1998). Quite rationally, therefore, financial deepening and openness have been acknowledged as the determinants of economic growth as well as have been suspected as the precursors of financial crisis (Kose et al., 2009). With our best knowledge, the simultaneous impact of openness and financial crisis on the finance-growth nexus has not been addressed yet, especially in terms of time series assessment. Moreover, while policy implications of the impact of either financial crisis or openness on the finance-growth nexus have been mostly drawn from cross-country studies, there are a few studies addressing those issues in the context of a single-country time series analysis.

The main objective of this study is to investigate South Korea's (hereafter Korea) finance-growth nexus, taking into estimation the above issues. Korea possesses a rich experience of economic growth, financial deepening and openness since the 1970s, thus providing the database considered relatively good in terms of developing country standards. In this study quarterly data are employed for the estimation; the use of quarterly time series covering the period 1960–2011 are long enough to allow for a meaningful time series investigation, which addresses the concerns raised about the lack of time series-based individual country studies. The rest of the paper is organized as follows. The empirical strategy and data are put forward in Section 2, and methodology is elucidated in Section 3. Empirical findings are presented and discussed in Section 4, and conclusion comes in Section 5.

2. Empirical strategy and data

To address Korea's finance-growth nexus in the present study, the Granger causalities between economic growth and those financial development indexes of financial size (FS) and financial efficiency (FE) are analyzed, respectively. The role of financial institutions has been defined mainly by the size of the sector's activity, as an economy with more intermediary activity was assumed to be doing more to generate efficient allocations. However, it has been wondered if the proxies for financial development commonly used are suitable to investigate the finance-growth nexus (Wachtel, 2011). We argue that financial development is a more complex phenomenon for which both size and efficiency should be mattered; a better understanding of the finance-growth nexus needs a better measurement of financial depth. To this end, we

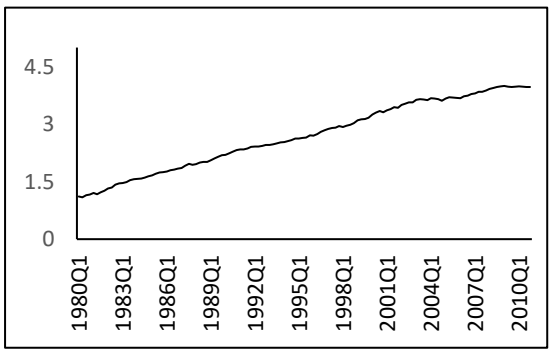
employ the two financial indexes of FS and FE for the Korean analysis. Furthermore, to avoid the omission-of-variable bias in the estimation, Korea's finance-growth nexus is exposed to such weakly exogenous variables as the financial crisis index (FC), trade openness index (TOP) and financial openness index (FOP). Based on these arguments, the following model specifications are given:

$$EG_t = f_1(FS_t, FC_t, TOP_t, FOP_t) \quad (1)$$
$$FS_t = f_2(EG_t, FC_t, TOP_t, FOP_t) \quad (2)$$
$$EG_t = f_3(FE_t, FC_t, TOP_t, FOP_t) \quad (3)$$
$$FE_t = f_4(EG_t, FC_t, TOP_t, FOP_t) \quad (4)$$

Equations 1 and 2 address the question of "Does financial size matter for Korea's finance-growth nexus?", that is, whether the causation runs either FS→EG or EG→FS or bilaterally. Likewise, the causality of either FE→EG or EG→FE or bilaterally (Does financial efficiency matter for Korea's finance-growth nexus?) is examined by equations 3 and 4. As a quantitative measure of financial deepening, the financial size index (FS) is the credit provided by commercial banks to the private sector, which is deflated by the GDP deflator; the private credit is a readily available series of financial depth measuring opportunities for new firms[6]. On the other hand, the financial efficiency index (FE)—as a qualitative measure of financial depth—is calculated by the ratio of credit provided by commercial banks to the private sector to the total domestic deposit (demand deposit + time deposit) (Beck et al., 2009). Interestingly, as given in Figure 1, the plots of FS and FE have totally different depictions showing divergent aspects of Korea's financial development.

Figure 1: Financial size index (FS) and financial efficiency index (FE)

(a) FS



(b) FE

[6] The rational of using the private credit is that a financial system, in which more credit is allocated to the private sector than to the public sector, is considered as more efficient and more competitive.

Treated as the weakly exogenous variables in estimation, financial crisis, trade openness and financial openness are assumed to have certain impacts on economic growth and financial development. The financial crisis index (FC) is produced by computing the volatilities in real exchange rate (ER) and the ratio of money supply to foreign exchange reserve (MTF) respectively and by integrating those two volatilities through the principal component method (Fukuda, 2013). Based on the idea of Lane and Milesi-Ferretti (2007) who proposed the indexes of external assets and liabilities (net foreign assets) for 145 countries, the financial openness index (FOP) is produced by compositing three elementary variables of financial openness: 1) foreign exchange reserve, 2) net foreign assets held by commercial banks, and 3) financial account plus net errors and omissions. All these elementary variables are deflated by the GDP deflator and are combined through the principal component method to create FOP. Moreover, in accordance with the standard procedure in the literature, the trade openness index (TOP) is measured by Korea's trade volume (exports + imports) divided by the GDP deflator. All the underlying and weakly exogenous variables are converted into logarithm. For this study we use quarterly data series—drawn from IMF's *International Financial Statistics* (IFS) online database—ranging from 1980Q to 2010Q4; this period covers the era of high economic growth, financial deepening and trade and financial openness in Korea.

3. Methodology

The present study of Korea's finance-growth nexus is founded on vector autoregressive (VAR) techniques. Considering the argument that a VAR process should be estimated in terms of dynamic adjustment (Engle and Granger, 1987), we adopt error correction models (ECMs) to explore a long-run equilibrium relationship. To this end, the vector error-correcting autoregressive model with exogenous variables (VARX) of Pesaran et al. (2000) is employed to investigate the Korean case. One of the important features of the VARX approach is to allow us to demonstrate a definite direction through the sign of each underlying variable's coefficient in the cointegrating space. Another feature is that the VARX model enables us to treat some underlying variables as weakly exogenous variables which are in the cointegrating space but are not treated as endogenous variables.

Since time series data are used for the VARX analysis, it is essential to check the stationarity or the absence of unit root of each underlying variable. Non-stationary time series do not hold a long-run mean (i.e., their variance is time dependent), so that the presence of unit root can cause the inaccuracy of the VARX assessment. We perform two unit root tests: the GLS augmented Dickey-Fuller (ADF-GLS) test (Elliott et al., 1996)

and the Phillips and Perron (PP) test (Phillips and Perron, 1988)[7]. The next step is the Johansen (1988) cointegration test so as to check the presence of the long-run relationship among the underlying variables. In performing the Johansen test, we look for the existence of a single cointegrating relationship.

Given that cointegrated variables must have an error correction representation in the VARX specification, the following error correction models are structured:

$$\begin{bmatrix} \Delta EG_t \\ \Delta FS_t \end{bmatrix} = \alpha_{1i} \begin{bmatrix} EG \\ FS \\ FC \\ TOP \\ FOP \end{bmatrix} + \sum_{j=1}^{p-1} \delta_{1j} \Delta EG_{t-j} + \sum_{j=1}^{p-1} \delta_{2j} \Delta FS_{t-j} \qquad (5)$$

$$\sum_{j=1}^{p-1} \delta_{3j} \Delta FC_{t-j} + \sum_{j=1}^{p-1} \delta_{4j} \Delta TOP_{t-j} + \sum_{j=1}^{p-1} \delta_{5j} \Delta FOP_{t-j} + inpt + u_{1it}$$

$$\begin{bmatrix} \Delta EG_t \\ \Delta FE_t \end{bmatrix} = \alpha_{2i} \begin{bmatrix} EG \\ FE \\ FC \\ TOP \\ FOP \end{bmatrix} + \sum_{j=1}^{p-1} \delta_{6j} \Delta EG_{t-j} + \sum_{j=1}^{p-1} \delta_{7j} \Delta FE_{t-j} \qquad (6)$$

$$\sum_{j=1}^{p-1} \delta_{8j} \Delta FC_{t-j} + \sum_{j=1}^{p-1} \delta_{9j} \Delta TOP_{t-j} + \sum_{j=1}^{p-1} \delta_{10j} \Delta FOP_{t-j} + inpt + u_{2it}$$

where [ΔEG, ΔFS] and [ΔEG, ΔFE] are a 2 × 1 vector of the dependent variables, respectively, [EG, FS, FC, TOP, FOP] and [EG, FE, FC, TOP, FOP] are the cointegrating vector—the error correction term (ECT)—of the endogenous variables (EG and either FS or FE) and $I(1)$ exogenous variables (FC, TOP, FOP), respectively, p is the lag order chosen for the system, and u_{1it} and u_{2it} are error terms. To give interference to Korea's finance-growth nexus, three types of the Granger causality test are conducted. First of all, the short-run non-causality test estimates the significance of the lagged dynamic terms, that is, the null of H_0: δ_{ij}'s = 0. The weak exogeneity test looks at the null of H_0: $\alpha = 0$; indeed, this test shows the evidence of long-run causality or the significance of the ECT coefficient. And the strong exogeneity test imposes the strongest nulls of H_0: all δ_{ij}'s = α = 0 for the VARX estimation. Thus, the strong exogeneity test examines the overall causality in the system, regardless of long run or short run, i.e. time spans (see, Charemza and Deadman, 1997)[8]. Finally, it is noted that the three tests are implemented on the basis

[7] Elliott et al. (1996) suggested an efficient test that has modified the Dickey-Fuller test statistics with generalized least squares (GLS) rationale thus dominating the standard Dickey-Fuller test.

[8] The three types of the Granger causality test have been widely used by several time series studies (e.g., Demetriades

of chi-square (X^2) statistics from the Wald test.

One invention of the present study is that two types of dummy variable are taken into the VARX assessment, mainly for the purposes of seeking a single cointegration ($r = 1$) and of avoiding serial correlation. First, following Johansen et al. (2000) and Pesaran and Pesaran (2009) who proposed techniques taking the element of structural break—in the form of level shift dummy—into the cointegration analysis, we allot the structural break in economic growth dummy (SBGD) in the VARX estimation. To this end, break dates in Korea's EG (real GDP) series are specified by the Lee and Strazicich (2003; 2004) (hereafter the LS test). The LS test is a Lagrange multiplier unit root test that endogenously pinpoints at most two breaks in each series[9]. Based on break dates given by the LS test in Table 1, a level shift dummy (i.e. SBGD) is produced and allocated[10]. For example, as illustrated in Figure 2, we plot the two breaks dummy given by Model CC (SBTWOC). Second, either SEGD (the shock in economic growth dummy) or SFSD (the shock in financial size) or SFED (the shock in financial efficiency dummy) is also allocated in estimation (Fukuda and Dahalan, 2012). Those dummies take the value of one for negative EG/FS/FE growth periods otherwise zero (see the plot of SFSD in Figure 2). Although there are a number of combinations of those dummies, the pairs reported in Table 2 are confirmed as optimal for each model investigating Korea's finance-growth nexus. As mentioned initially, the selection is dominated by whether the dummy allocation exhibits a single cointegration and no serial correlation in estimation.

Table 1: Break dates in Korea's EG series

Model	Break Date(s)
A (one break)	1983Q4
AA (two breaks)	1983Q4, 1998Q2
C (one break)	1992Q2
CC (two breaks)	1985Q1, 1994Q1

Notes: Models A and AA = the clash models (break(s) only in the intercept); Models C and CC = the trend break models (break(s) in both the intercept and trend).

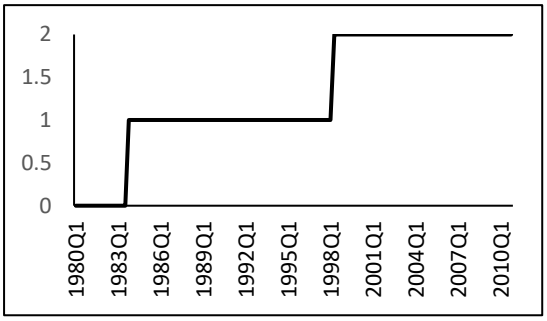
and Hussein, 1996; Ang and McKibbin, 2007).

[9] Lee and Strazicich (2003; 2004) argue that ADF-type endogenous break unit root tests hold size distortion that causes spurious rejection of the null hypothesis when those tests are applied to unit root processes subject to break(s). We stay away from this argument as the purpose of using the LS test in our study is to look for break dates in EG series correctly. To check unit root/stationarity of each underlying variable, we use both ADF-GLS and PP tests.

[10] Models B and BB of "changing growth", which assume break(s) in a trend only, are omitted because most economic time series are described by four models of A, AA, C and CC (Lee and Strazicich (2003; 2004).

Figure 2: Dummy variables

(a) SBTWOC



(b) SDFS

Table 2: Optimal combinations of dummy variables

Financial development variable: FS	
Model	Dummy variable
EG-FS	SBTWOC, SFS
FS-EG	SBTWOC, SFS
Financial development variable: FE	
Model	Dummy variable
EG-FE	SBTWOC, SFE
FE-EG	SBTWOC, SFE

4. Empirical results

4.1 Initial procedures

In analysing Korea's finance-growth nexus, the total of four VARX models is estimated being subject to various diagnostic tests in order to confirm the robustness of the findings. The statistics of Table 3 report that while some models show the evidence of heteroscedasticity, non-normality and functional form problem, all the models are free from serial correlation at the 5% significance level or better. Hence, empirical findings of this study are statistically acceptable to draw policy implications for the Korean case. As the first step, the ADF-GLS and PP tests are conducted for all the underlying variables at the lag order 4 (k =4) and the statistics are reported in Table 4. The results indicate that all EG, FS, FE, FC, TOP and FOP are non-stationary in their levels but become stationary after taking their first-differences (i.e. $I(1)$). Hence we validate all the underlying variables as adequate for the cointegration assessment. The next step is to carry out the Johansen cointegration test in which TOP and FOP are treated as $I(1)$ exogenous variables in the cointegrating vector. In performing the Johansen test, the lag order should be treated carefully as the test is highly sensitive to the choice of lag length. Referring to the Akaike

information criteria (AIC) selecting the optimal lag order of VAR (p), we set the lag order at 4. The trace statistics in Table 5 show that there is a single cointegration relationship (r = 1) between EG and FS and between EG and FE, respectively, implying that there must be a single long-run relationship between the underlying variables.

Table 3: Diagnostic test results (LM version)

Test statistic	EG-FS	FS-EG	EG-FE	FE-EG
Serial correlation	2.785 [.031]	2.191 [.076]	2.441 [.052]	0.871 [.484]
Functional form	10.98 [.001]	0.770 [.382]	10.21 [.002]	5.400 [.022]
Normality	24.09 [.000]	0.580 [.748]	62.22 [.000]	1.127 [.569]
Heteroscedasticity	0.083 [.774]	2.947 [.089]	0.005 [.942]	31.76 [.000]

Note: The normality test is based on chi-statistics. The other three are on F-statistics.

Table 4: ADF-GLS and PP test results (k = 4)

	ADF Test		PP Test	
	Inpt.	Inpt. & trend	Inpt.	Inpt. & trend
EG	-2.060	-0.825	-2.247	-0.316
ΔEG	-5.300**	-7.462**	-5.609**	-6.069**
FS	-1.823	-1.218	-2.042	-0.297
ΔFS	-3.306**	-3.888**	-11.054**	-11.490**
FE	-2.767*	-2.963	-1.829	-2.007
ΔFE	-3.203**	-3.192*	-9.693**	-9.679**
FC	-2.335	-2.768	-2.887**	-3.602**
ΔFC	-5.437**	-5.419**	-10.322**	-10.277**
TOP	0.118	-3.570**	-0.053	-4.332**
ΔTOP	-6.670**	-6.680**	-13.184**	-13.128**
FOP	-1.713	-2.942	-1.592	-2.875
ΔFOP	-3.310**	-3.281*	-12.540**	-12.503**

Notes: (**) 5% and (*) 10% level of significance. (§) The null cannot be rejected at the 1% level.

Table 5: Johansen cointegration test results (trace statistics, $k = 4$)

Panel A		
Endogenous variables: EG, FS		
I (1) exogenous variables: FC, TOP, FOP		
Deterministic components: intercept (restricted), SBTWOC (unrestricted), SDFS (unrestricted)		
Johansen cointegration test		
Null	Alternative	Statistic
$r = 0$	$r > = 1$	76.013***
$r < = 1$	$r = 2$	9.373
Panel B		
Endogenous variables: EG, FE		
I (1) exogenous variables: FC, TOP, FOP		
Deterministic components: intercept (restricted), SBTWOC (unrestricted), SDFE (unrestricted)		
Johansen cointegration test		
Null	Alternative	Statistic
$r = 0$	$r > = 1$	67.442***
$r < = 1$	$r = 2$	15.888

Notes: (***) 1% significance level.

4.2 Identified cointegrating vectors

Identified cointegrating vectors together with α (ECT coefficient) and weak exogeneity test statistics of four VARX models are reported in Table 6. The ECT coefficients indicate the adjustment speed back to a long-run, steady state equilibrium whenever there is a short-run shock in the cointegrating relationship. Importantly, each ECT coefficient is supposed to have a negative sign, otherwise a long-run equilibrium is not established in the system. According to the second columns of Table 6, the ECT coefficients of three models—EG-FS, FS-EG and EG-FE—are statistically significant at the 1% significance level exhibiting a negative sign. For these three models, it is considered that all the underlying variables shape the cointegrating system and so collectively exhibit impact on each dependent variable. On the other hand, as the ECT coefficient of the FE-EG model has a positive sign, a long-run equilibrium is not detected in the causality in which the financial efficiency is the dependent variable, thus implying that the hypothesis of economic growth improving the financial efficiency is not confirmed. Later on, the FE-EG model is not taken in the analysis.

By normalizing the coefficient of EG/FS/FE to one in the cointegrating vector, we look at the direction of each underlying variable with respect to other variables. Whether

one variable is either positive or negative to others is checked by the variable's sign in the cointegrating vector. As described in the second columns of Table 6, the relationship between Korea's economic growth and financial size is identified as bilateral (EG↔FS) and negative. On the other hand, the EG-FE model shows that financial efficiency is positive to economic growth, but the latter has no impact on the former because the FE-EG model exhibits a positive ECT coefficient. Interestingly, both the EG-FS and EG-FE models demonstrate that financial crisis is negative to economic growth, whereas both trade and financial openness are positive to economic growth. Furthermore, the FS-EG model indicates that while financial crisis is negative to financial size, both trade and financial openness are positive to financial size.

Table 6: VARX cointegrating vectors

Panel A Financial development indictor: FS			
Model	Cointegrating vector	ECT coefficient	W.E. test
EG-FS	$EG = -1.099_{(2.133)}FS - 0.223_{(0.246)}FC + 0.774_{(1.394)}TOP + 0.202_{(0.212)}FOP + 3.044_{(2.764)}$	-0.007***	47.78[.000]
FS-EG	$FS = -0.910_{(1.766)}EG - 0.203_{(0.194)}FC + 0.704_{(0.445)}TOP + 0.184_{(0.213)}FOP - 2.770_{(3.377)}$	-0.018***	36.10 [.000]
Panel B Financial development indicator: FE			
Model	Cointegrating vector	ECT coefficient	W.E. test
EG-FE	$EG = 0.165_{(0.501)}FE - 0.202_{(0.071)}FC + 0.027_{(0.300)}TOP + 0.022_{(0.075)}FOP + 1.138_{(0.613)}$	-0.013***	46.90[.000]
FE-EG	$FE = 6.065_{(18.42)}EG + 1.223_{(3.792)}FC - 0.163_{(1.967)}TOP - 0.131_{(0.475)}FOP - 6.901_{(22.69)}$	0.001	—

Notes: (***) 1% significance level. Standard errors are provided in brackets.

4.3 Causality test results

Three types of the Granger causality test are conducted to give formal interference to the Korean case. First of all, according to the test statistics reported in Tables 7 and 8, since no significant results of the short-run non-causality test are detected both between EG and FS and between EG and FE, Korea's finance-growth nexus is not considered as

a short-run phenomenon. As far as the causality between EG and FS is concerned, the weak exogeneity statistics are significant in two models of EG-FS and FS-EG. These findings are further supported by the strong exogeneity statistics by which the overall causality (short-run + long-run) is estimated. Hence, we identify the bilateral causal link between economic growth and financial size (EG↔FS). Importantly, as confirmed by the coefficients' signs in the cointegrating vectors (see Table 6), the two-way relationship of EG↔FS is negative. Although this finding disagrees with theory and the majority of empirical findings in the literature, such a bilateral causality is possible in the present framework of the VARX analysis in which those weakly exogenous variables of financial crisis and trade and financial openness plus structural break—in the form of a level shift dummy—are mattered[11]. On the other hand, when the financial development indicator is proxied by financial efficiency, we find a one-way causality FE→EG, that is, more efficient financial system can contribute to economic growth with no feedback—economic growth improves financial efficiency—as supported by both weak and strong exogeneity tests[12]. Thus, Korea's finance-growth nexus is sensitive, depending on whether financial development is measured by its size or efficiency.

Next, we look at the causal effects of financial crisis and trade and financial openness either on economic growth or on financial development. As far as financial crisis is concerned, the weak and strong exogeneity statistics in Tables 7 and 8 show that financial crisis has significant negative impact on economic growth, financial size and financial efficiency, respectively. Since short-run evidence of financial crisis causing financial size is also identified as statistically significant, the short-run changes in financial crisis are responsible for Korea's financial size. On the other hand, as supported by all the three causality tests in two models of EG-FS and EG-FE, both trade and financial openness are significant for Korea's economic growth irrespective of timespan. And the causality of trade openness causing financial size is confirmed as significant by both weak and strong exogeneity tests, whereas the causality of financial openness causing financial size is found out as significant by the strong exogeneity test only.

[11] The negative impact of financial development on economic growth has been found in Mexico. Kassimatis and Spyrou (2001) detect a negative bilateral causality between economic growth and financial development in Mexico and argue that such causality is due to repeated banking crises. Likewise Fukuda and Daharan (2011) confirm a negative bilateral relationship between growth and finance in Mexico by taking trade openness as a weakly exogenous variable into estimation.

[12] Yang and Yi (2008) and Fukuda and Dahalan (2012) also detected a one-way causality of financial development→economic growth in Korea. But their conclusions do not agree with ours of financial efficiency→economic growth because the former's measures of financial depth are size-based.

Table 7: VARX causality test results

Panel A

H_0: Financial size/Financial crisis/Trade openness/Financial openness does not cause economic growth.

Model	Test	Regressors	Result
EG-FS	SR non causality	ΔFSs	CHSQ(3) = 4.566
		ΔFCs	CHSQ(4) = 3.693
		ΔTOPs	CHSQ(4) = 12.49**
		ΔFOPs	CHSQ(4) = 11.02**
	Weak exogeneity	ECT(-1)	CHSQ(1) = 44.78***
	Strong exogeneity	ΔFSs & ECT(-1)	CHSQ(4) = 56.90***
		ΔFCs & ECT(-1)	CHSQ(5) = 50.09***
		ΔTOPs & ECT(-1)	CHSQ(5) = 59.58***
		ΔFOPs & ECT(-1)	CHSQ(5) = 54.84***

Panel B

H_0: Economic growth/Crisis/Trade openness/Financial openness does not cause financial size.

Model	Test	Regressors	Result
FS-EG	SR non causality	ΔEGs	CHSQ(3) = 4.681
		ΔFCs	CHSQ(4) = 11.33**
		ΔTOPs	CHSQ(4) = 23.74***
		ΔFOPs	CHSQ(4) = 3.421
	Weak exogeneity	ECT(-1)	CHSQ(1) = 36.10***
	Strong exogeneity	ΔEGs & ECT(-1)	CHSQ(4) = 53.09***
		ΔFCs & ECT(-1)	CHSQ(5) = 51.07***
		ΔTOPs & ECT(-1)	CHSQ(5) = 50.52***
		ΔFOPs & ECT(-1)	CHSQ(5) = 42.43***

Notes: (***) 1% and (**) 5% level of significance.

Table 8: VARX causality result

H_0: Financial efficiency/Financial crisis/Trade openness/Financial openness does not cause economic growth.

Model	Test	Regressors	Result
EG-FE	SR non causality	ΔFEs	CHSQ(3) = 5.471
		ΔFCs	CHSQ(4) = 5.071
		ΔTOPs	CHSQ(4) = 18.43***
		ΔFOPs	CHSQ(4) = 17.52***
	Weak exogeneity	ECT(-1)	CHSQ(1) = 46.90***
	Strong exogeneity	ΔFEs & ECT(-1)	CHSQ(4) = 59.43***
		ΔFCs & ECT(-1)	CHSQ(5) = 51.04***
		ΔTOPs & ECT(-1)	CHSQ(5) = 65.49***
		ΔFOPs & ECT(-1)	CHSQ(5) = 56.53***

Notes: (***) 1% level of significance.

5. Conclusion

Korea's finance-growth nexus was examined in the VARX framework with the weakly exogenous variables of financial crisis and trade and financial openness. We have detected that the financial system's efficiency—as measured by the ratio of bank credit to the private sector to total domestic deposit—is more important than the expansion of financial size which is proxied by the ratio of bank credit to the private sector to GDP. As supported by a positive unilateral Granger causality FE→EG, higher economic growth is achieved by enhancing the financial efficiency or by allocating more total domestic deposit to private entities that are considered as more productive than governmental entities. Thus, priority should be put on forming such policies that can contribute to an efficient financial system in Korea. In addition, since there is no evidence of economic growth causing financial efficiency, it should not be misunderstood that financial efficiency is spontaneously formed in the process of economic growth. On the other hand, the finding of a negative bilateral causality between economic growth and financial size (EG↔FS) suggests a crucial warning to policy makers: unmanaged expansion of financial size is harmful for Korea that has been crisis-prone over recent decades most likely due to the on-going globalization[13]. Furthermore, while financial development is confirmed as growth-promoting so long as its efficiency is mattered, globalization

[13] It is rationally suspected that Korea's finance-growth nexus may take a non-liner or U-shaped form (see Chou-Wei et al., 2010). In the context of the VARX analysis, however, the present study cannot properly address the empirical issue of non-linearity that is important for future studies.

consisting of both trade and financial openness is essential to accelerate Korea's economic growth. Specially, since all the test statistics of short-run non causality and strong exogeneity unanimously agree on the growth effects of TOP→EG and FOP→EG.

By assembling these empirical findings together, policy implication drawn from this study is that since the phase of quantitative expansion of financial deepening has been seemingly over in Korea's economic development, policy makers should focus on how to boost the quality of financial development under globalizing circumstances where both trade and financial openness are powerful tools for economic growth. Some caution, however, should be always put on openness in seeking Korea's sustainable economic growth. Although whether and how financial crisis—as the dependent variable—is Granger-caused by other underlying variables is not addressed by the present VARX analysis, the increasing extent of trade and financial openness (economic growth and financial development as well) is rationally suspected as potential factors of financial crisis. Therefore, it is vital to address the "finance-growth-crisis" nexus not only in Korea but also in other emerging economies where globalization is in progress.

References

Ang, J. B. and McKibbin, W. J. 2007. Financial liberalisation, financial sector development and growth: Evidence from Malaysia. *Journal of Development Economics*, 84:1, 215-233.

Baltagi, B. H., Demetriades, P. O. and Law, S. H. 2008. Financial development and openness: Evidence from panel data. *Journal of Development Economics*, 89:2, 285-296.

Beck, T., Demirgüç-Kunt, A. and Levine, R. 2009. Financial institutions and markets across countries and over time: data and analysis. World Bank Policy Research Working Paper, No. 4943.

Charemza, W. W. and Deadman, D. F. 1997. *New Directions in Econometric Practice*, 2nd ed. Edward Elgar, Cheltenham.

Chiou-Wei, S. Z., Zhu, Z. and Wu, W. (2010) Financial development and economic growth in South Korea: An application of smooth transition error correction analysis, *Applied Economics,* 42:16, 2041-2052.

Demetriades, P. O. and Hussein, K. A. 1996. Does financial development cause economic growth?: Time-series evidence from 16 countries. *Journal of Development Economics*, 51:2, 87-411.

Elliott, G., Rothenberg, T. J. and Stock, J. H. 1996. Efficient test for an autoregressive unit root. *Econometrica*, 64:4, 813-836.

Engle, R. F. and Granger, C. W. J. 1987. Co-integration and error correction:

Representation, estimation, and testing. *Econometrica*, 55:2, 251-276.
Fukuda, T. (2014). Linkage between financial development, financial crisis and globalization in India: VARX and ARDL co-integration assessments. *Journal of Applied Economics and Business Research,* 3:4, 232-248.
Fukuda, T. and Dahalan, J. (2012). Finance-growth-crisis nexus in Asian Emerging economies: evidence from VECM and ARDL assessment. *International Journal of Economic Sciences and Applied Research,* 5:2, 69-100.
Fukuda, T. and Dahalan, J., (2011). Finance-growth-crisis nexus in emerging economies: evidence from India, Indonesia and Mexico. *International Business and Economics Research Journal,* 10:12, 59-78.
Gries, T., Kraft, M. and Meierrieks, D. (2009). Linkages between financial deepening, trade Openness and economic development: Causality evidence from Sub-Saharan Africa. *World Development,* 37:12, 1849-1860.
Herwartz, H. and Walle, Y. M. (2014). Openness and the finance-growth nexus. *Journal of Banking and Finance,* 48, 235-247.
Johansen, S. 1988. Statistical analysis of cointegration vectors. *Journal of Economic Dynamics and Control*, 12:2-3, 231-254.
Johansen, S., Mosconi, R. and Nielsen, B. (2000). Cointegration analysis in the presence of structural breaks in the deterministic trend. *Econometrics Journal,* 3:2, 216–249.
Kassimatis, K. and Spyrou, S. I. (2001). Stock and credit market expansion and economic development in emerging markets: further evidence utilizing cointegration analysis. *Applied Economics,* 33:8, 1057-1064.
King, R. G. and Levine, R. 1993. Finance and growth: Schumpeter might be right. *Quarterly Journal of Economics*, 108:3, 717-737.
Kose, M. A., Prasad, E. S. and Terrones, M. E. 2006. How do trade and financial integration affect the relationship between growth and volatility? *Journal of International Economics*, 69:1, 176– 202.
Lane, P. R. and Milesi-Ferretti, G. M. 2007. 'The external wealth of nations mark II: Revised and extended estimates of foreign assets and liabilities, 1970–2004. *Journal of International Economics*, 73:2, 223-250.
Law, S. H. 2008. Does a country's openness to trade and capital accounts lead to financial development?: Evidence from Malaysia. *Asian Economic Journal,* 22:2, 161-177.
Lee, J. and Strazicich, M. C. 2003. Minimum LM unit root test with two structural breaks. *Review of Economics and Statistics*, 85:4, 1082-1089.
Lee, J. and Strazicich, M. C. 2004. Minimum LM unit root test with one structural break. Appalachian State University Working Paper.

Levine, R. and Zervos, S. (1998) Stock markets, banks and economic growth, American Economic Review, 88(3), 537-558.
Luintel, K. B. and Khan, M. (1999) A quantitative reassessment of the finance-growth nexus: evidence from a multivariate VAR, Journal of Development Economics, 60(2), 381-405.
McKinnon, R. (1973) Money and Capital in Economic Development, Brookings Institution, Washington DC.
Pesaran, M. H. and Pesaran, B. 2009. *Time Series Econometrics Using Microfit 5.0.* Oxford University Press, Oxford.
Pesaran, M. H., Shin, Y. and Smith, R. J. 2000. Structural analysis of vector error correction models with exogenous I(1) variables. *Journal of Econometrics*, 97:2, 293-343.
Phillips, P. C. B. and Perron, P. (1988) Testing for unit root in time series regression. *Biometrika*, 75:2, 335-346.
Shahbaz, M. (2012) Does trade openness affect long run growth?: Cointegration, causality and forecast error variance decomposition tests for Pakistan. *Economic Modelling,* 29:6, 2325–2339
Shaw, E. (1973) Financial Deepening in Economic Development, Oxford University Press, London.
Yanikkaya, H. (2003). Trade openness and economic growth: A cross-country empirical investigation. *Journal of Development Economics*, 72:1, 57-89.
Yang, Y. Y. and Yi, M. H. (2008) Does financial development cause economic growth?: Implication for policy in Korea. *Journal of Policy Modeling,* 30:5, 827-840.
Wachtel, P. (2011). The Evolution of the Finance Growth Nexus. *Comparative Economic Studies*, 53:3, 475–488.

Appendix

Table A.1: Underlying variables

Underlying Variable	Description
Financial size (FS)	FS = log (PC/GDF) where PC is private credit (line 32D) and GDF is GDP deflator (line 99BIP).
Financial efficiency (FE)	FE = log [PC/(DD + TD)] where DD is demand deposits (line 24) and TD is time deposits (line 25).
Financial crisis (FC)	FC = ER + MTF (The elementary variables are merged by the principal component method to make FC. See Table A.2).
Trade openness (TOP)	TOP = log [(X + I)/GDF] where X is exports (line 70) and I is imports (line 71).
Financial openness (FOP)	FOP = FRTM + FATM + FETM (The elementary variables are merged by the principal component method to make FOP. See Table A.3)

Notes: All the "lines" refer to those of the International Financial Statistics (IFS).

Table A.2: Elementary variables of financial Crisis

Elementary Variable	Description
Exchange rate (ER)	ER = NER × (USGDF/GDF) where NER is nominal exchange rate (line RF) and USGDF is US GDP deflators.
Money supply/ foreign exchange reserve (MTF)	MTF = M/FR where M is money supply (line 35L) and FR is foreign exchange reserve (line 1D).

Notes: All the "lines" refer to those of the International Financial Statistics (IFS). Each variable is measured as a four-quarter rolling average of squared returns, that is, $[\log (ER_t/ER_{t-1})]^2$ and $[\log (MTF_t/MTF_{t-1})]^2$.

Table A.3: Elementary variables of financial openness

Elementary Variable	Description
Foreign exchange reserve/money supply (FRTM)	FRTM = log (FR/M) where FR is foreign exchange reserve (line 1D) and M is money supply (line 35L).
Commercial banks' net foreign assets/ money supply (FATM)	FATM = log (FA/M) where FA is commercial banks' net foreign assets (line 31N).
Financial account plus net errors & omissions/money supply (FETM)	FETM = log (FE/M) where FAE is financial account plus net errors & omissions (lines 78BJD & 78CAD).

Notes: All the "lines" refer to those of the International Financial Statistics (IFS).