The dynamics of banking sector and stock market maturity and the performance of Asian economies

Time series evidence

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Abstract

Purpose – The purpose of this paper is to examine the nature of causal relations between banking sector maturity, stock market maturity, and four aspects of performance and operation of the economy: economic growth, inflation, openness in trade, and the degree of government involvement in the economy.
Design/methodology/approach – The authors look for possible links between the variables by conducting panel cointegration and causality tests, using a large sample of Asian countries over the period 1960-2011. Novel panel data estimation methods allow for robust estimates, using both variation between countries and variation over time.
Findings – The study identifies interesting causal links among the variables deriving uniquely from our innovations. In particular, The paper finds that for all regions considered, banking sector maturity and stock market maturity are causally linked, sometimes in both directions. Furthermore, stock market maturity may lead to economic growth, both directly and indirectly through indicators such as inflation and trade openness. The findings also support the notion that economic growth affects the maturity of the stock market in most regions.
Practical implications – The results lend support to the notion that a mature financial sector is a key contributor to generating economic growth. Furthermore, economic growth itself has the potential to bring about maturity in the financial sector.
Originality/value – The paper uses sophisticated principal-component analysis, panel cointegration, and Granger causality tests, methods not used in this literature before. The method was applied to recent data pertaining to 35 Asian countries – a group of countries that has previously not been adopted in this literature.

Keywords Economic performance, Banking sector maturity, Panel cointegration test, Panel-Granger causality test, Stock market maturity
Paper type Research paper

1. Introduction

The identification of key factors and relationships that underlie sustained economic growth is critical in designing economic policies that lead to higher living standards and enhanced quality of life (Abu-Bader and Abu-Qarn, 2007). Nieuwerburgh *et al.*(2006), Pagano (1993), Shan *et al.* (2001), Shaw (1973), Schumpeter (1911), Trew (2006) all argue that two main forces that sustain economic growth are the maturity or sophistication of banking sectors and stock markets. While policy makers may vary on the degree to which these financial-sector maturities contribute to economic growth, they generally concur that both do matter. As a result, many countries have adopted development strategies that prioritize banking sector and stock market reforms. Asian countries are no exception. Since the end of the 1980s, these countries have bolstered their banking sector and stock market evolution by reducing governmental intervention in the financial sector generally and in the banking sectors and/or stock markets in particular. Such policies are expected to promote economic growth, among other things, through the enhanced mobilization of saving and increases in domestic and foreign investment (see, for instance, King and Levine, 1993; Levine and Zervos, 1996; Masih and Masih, 1999; Reinhart and Tokatlidis, 2003; Thornton, 1994). However, to ascertain that such policies are indeed guaranteed to be effective, it must be formally established that there is indeed a causal relationship between banking sector maturity, stock market maturity, and economic growth (Cheng, 2012; Zhang *et al.*, 2012; Choe and Moosa, 1999; Colombage, 2009; Gries *et al.*, 2009; Hassan *et al.*, 2011; Naceur and Ghazouani, 2007; Panopoulou, 2009; Rousseau, 2009).

It is debateable whether measures of banking sector maturity and stock market maturity have any causal connections to other aspects of the performance or operation of the modern economies, beyond their measured rates of economic growth. Hence, in addition to considering economic growth, this paper also looks at further related aspects of economic performance: first, rates of price inflation; second, the degree of government intervention in the economy; and third, an economy's degree of openness in relation to international trade.

Two additional novel features of the study are that:

(1) we use a large sample of Asian countries, both developed and emerging, over a long span of time (1961-2011); and

(2) we employ advanced econometrics and other empirical techniques. Neither has been previously adopted in this literature. We also seek to answer questions concerning the nature of the causal relationship between these variables, both in the short run and long run.

The remainder of this paper is structured as follows: Section 2 provides a literature review on the connection between banking sector and stock market maturity and economic growth. Section 3 defines our variables and identifies the data sources. This is followed by Section 4, which outlines our empirical model. Results are discussed in Section 5. The final section concludes with a summary and the policy implications of our results.

2. Literature review

The notion that banking sector and stock market maturity may matter in relation to economic growth appears in several papers[1] (see, for instance, Ang, 2008a; Arestis *et al.*, 2001; Beck and Levine, 2004; Calderon and Liu, 2003; Chari *et al.*, 1996; Choe and Moosa, 1999; Christopoulos and Tsionas, 2004; Colombage, 2009; Demetriades and Luintel, 1996; Enisan and Olufisayo, 2009; Greenwood and Smith, 1997; Haslag and Koo, 1999; Hassan *et al.*, 2011; Hou and Cheng, 2010; Hsueh *et al.*, 2013; Jalil *et al.*, 2010; Levine, 1991, 1997, 2003; Lee, 1997; Levine and Zervos, 1996; Levine *et al.* 2000; Luintel and Khan, 1999; Mukhopadhyay *et al.*, 2011; Muradoglu *et al.*, 2000; Odhiambo, 2007; Panopoulou, 2009; Pradhan *et al.*, 2013; Rousseau and Wachtel, 2000; Yu *et al.*, 2012; Zuo and Park, 2011). Two strands of the literature can be identified.

The first strand examines the link between banking sector maturity and economic growth (see Table I for a summary of the studies). In this context Abu-Bader and Abu-Qarn (2008b), Ang (2008b), Bojanic (2012), Boulila and Trabelsi (2004), Calderon and Liu (2003), Chaiechi (2012), Hsueh *et al.* (2013), Jalil *et al.* (2010), Kar *et al.* (2011), Naceur and Ghazouani (2007), Thornton (1994), and Wu *et al.* (2010) all demonstrate the validity of a supply-leading hypothesis (SLH), where unidirectional causality from banking sector maturity to economic growth is present. By contrast, Ang and McKibbin (2007), Kar *et al.* (2011), Liang and Teng (2006), Odhiambo (2008, 2010), and Panopoulou (2009) claim evidence in favor of a demand-following hypothesis (DFH), where the causality runs

Table I. Summary of the studies showing a connection between banking sector maturity and economic growth

Studies	Study area	Method of study	Period covered
Case 1: studies supporting SLH			
Hsueh *et al.* (2013)	Ten Asian countries	BVGC	1980-2007
Bojanic (2012)	Bolivia	MVGC	1940-2010
Chaiechi (2012)	South Korea, Hong Kong, UK	MVGC	1990-2006
Kar *et al.* (2011)	15 MENA countries	MVGC	1980-2007
Wu *et al.* (2010)	European Union	MVGC	1976-2005
Jalil *et al.* (2010)	China	TVGC	1977-2006
Abu-Bader and Abu-Qarn (2008b)	Egypt	TVGC	1960-2001
Ang (2008b)	Malaysia	MVGC	1960-2003
Naceur and Ghazouani (2007)	MENA region	MVGC	1979-2003
Boulila and Trabelsi (2004)	Tunisa	BVGC	1962-1987
Calderon and Liu (2003)	109 countries	MVGC	1960-1994
Thornton (1994)	Asian countries	BVGC	1951-1990
Case 2: studies supporting DFH			
Kar *et al.* (2011)	15 MENA countries	MVGC	1980-2007
Odhiambo (2010)	South Africa	MVGC	1969-2006
Panopoulou (2009)	5 countries	MVGC	1995-2007
Colombage (2009)	5 countries	MVGC	1995-2007
Odhiambo (2008)	Kenya	TVGC	1969-2005
Ang and McKibbin (2007)	Malaysia	MVGC	1960-2001
Liang and Teng (2006)	China	MVGC	1952-2001
Case 3: studies supporting FBH			
Chow and Fung (2011)	69 countries	TVGC	1970-2004
Wolde-Rufael (2009)	Kenya	QVGC	1966-2005
Dritsakis and Adamopoulos (2004)	Greece	TVGC	1960-2000
Craigwell *et al.* (2001)	Barbados	MVGC	1974-1998
Ahmed and Ansari (1998)	India, Pakistan, Sri Lanka	MVGC	1973-1991

Notes: MMs, mature markets; EMs, emerging markets; BVGC, bivariate granger causality; TVGC, trivariate granger causality; QVGC, quadvariate granger causality; MVGC, multivariate granger causality. Supply leading hypothesis (SLH): if unidirectional causality is present from an indicator of banking sector maturity (BANK) to economic growth (GDP); demand following hypothesis (DFH): if unidirectional causality form GDP to BANK is present; Feedback hypothesis (FBH): if bidirectional causality between BANK and GDP is present. The definition of banking sector maturity varies across studies instead from economic growth to banking sector maturity. Further studies, such as those of Ahmed and Ansari (1998), Craigwell *et al.* (2001), Dritsakis and Adamopoulos (2004), and Wolde-Rufael (2009), claim to have uncovered a feedback hypothesis (FBH), whereby the causality runs in both directions. It is evident from the literature that the evidence on the direction of causality between the two variables needs more advanced statistical treatment than the literature has hitherto afforded it.

The second strand of the literature considers the link between stock market maturity and economic growth (see Table II for a summary). In this context, Colombage (2009), Enisan and Olufisayo (2009), Kolapo and Adaramola (2012), Nieuwerburgh *et al.* (2006), and Tsouma (2009) support the validity of a SLH, where unidirectional causality from stock market maturity to economic growth is present. By contrast, Ang and McKibbin (2007), Dritsaki and Dritsaki-Bargiota (2005), Kar *et al.* (2011), Liang and Teng (2006), Liu and Sinclair (2008), Odhiambo (2008), and Panopoulou (2009) present evidence in support of a DFH, where unidirectional causality from economic growth to stock market maturity is present. Finally, Caporale *et al.* (2004), Cheng (2012), Darrat *et al.* (2006), Hassapis and Kalyvitis (2002), Hou and Cheng (2010), Huang *et al.* (2000), Masih and Masih (1999),

Table II. Summary of the studies showing a connection between stock market maturity and economic growth

Studies	Study area	Method of study	Period covered
Case 1: studies supporting SLH			
Kolapo and Adaramola (2012)	Nigeria	MVGC	1990-2010
Tsouma (2009)	22 MMs and EMs	BVGC	1991-2006
Enisan and Olufisayo (2009)	7 Sub-Saharan African	MVGC	1980-2004
Colombage (2009)	5 countries	MVGC	1995-2007
Nieuwerburgh *et al.* (2006)	Belgium	TVGC	1830-2000
Case 2: studies supporting DFH			
Kar *et al.* (2011)	15 MENA countries	MVGC	1980-2007
Panopoulou (2009)	5 countries	MVGC	1995-2007
Odhiambo (2008)	Kenya	TVGC	1969-2005
Liu and Sinclair (2008)	China	BVGC	1973-2003
Ang and McKibbin (2007)	Malaysia	MVGC	1960-2001
Liang and Teng (2006)	China	MVGC	1952-2001
Dritsaki and Dritsaki-Bargiota (2005)	Greece	TVGC	1988-2002
Case 3: studies supporting FBH			
Cheng (2012)	Taiwan	MVGC	1973-2007
Zhu *et al.* (2004)	14 countries	MVGC	1995-2009
Hou and Cheng (2010)	Taiwan	MVGC	1971-2007
Rashid (2008)	Pakistan	MVGC	1994-2205
Darrat *et al.* (2006)	EMs	TVGC	1970-2003
Caporale *et al.* (2004)	7 countries	BVGC	1977-1998
Wongbangpo and Sharma (2002)	ASEAN 5	MVGC	1985-1996
Huang *et al.* (2000)	US, Japan, China	TVGC	1992-1997
Muradoglu *et al.* (2000)	EMs	MVGC	1976-1997
Masih and Masih (1999)	8 countries	MVGC	1992-1997
Nishat and Saghir (1991)	Pakistan	BVGC	1964-1987

Notes: MMs, mature markets; EMs, emerging markets; BVGC, bivariate granger causality; TVGC, trivariate granger causality; QVGC, quadvariate granger causality; MVGC, multivariate granger causality. Supply leading hypothesis (SLH): if unidirectional causality from an indicator of stock market maturity (STOCK) to economic growth (GDP) is present; demand following hypothesis (DFH): if unidirectional causality form GDP to STOCK is present; Feedback hypothesis (FBH): if bidirectional causality between STOCK and GDP is present. The definition of stock market maturity varies across studies

Muradoglu *et al.* (2000), Nishat and Saghir (1991), Rashid (2008), and Wongbangpo and Sharma (2002) demonstrate that causation runs in both directions simultaneously. Once again, the existing literature does not provide a definitive answer as to the direction of causality.

The aim of this study is to apply a novel panel data estimation method (panel cointegration and causality tests) to establish the direction of causality between both banking sector and stock market maturity on the one hand, and economic growth on the other. Since economic growth is only one aspect of the performance of the economy, our paper also extends the literature by examining a possible link between these financial maturities and inflation. We also examine a possible nexus between these kinds of maturities and two aspects of operation in the economy: the level of government intervention and openness in trade. Finally, we entertain the possibility that banking sector maturity and stock market maturity are themselves linked. Hence, we also examine the possible causal connection between these two variables.

3. Definition of variables and data sources

Banking sector maturity is defined as a process of improvements in the quantity, quality, and efficiency of banking services. This process involves the interaction of many activities, and consequently cannot be captured by a single measure (see, for instance, Abu-Bader and Abu-Qarn, 2008a; Beck and Levine, 2004; Levine and Zervos, 1998; Naceur and Ghazouani, 2007; Rousseau and Wachtel, 1998). Accordingly, this study employs three commonly used measures of banking sector maturity: broad money supply (BRM), domestic credit provided by the banking sector (DCB), and domestic credit to the private sector (DCP). We adopt the World Bank definition of these variables (shown in Table III). The data for our testing procedures in relation to all these variables are obtained from the World Development Indicators as published by the World Bank. We create a composite indicator for banking sector maturity (BSM) using these three measures, through a principal-components analysis (see Appendix for a detailed discussion).

Table III. Definition of measures of banking sector maturity

Variables	Definition
BRM	Broad money: broad money (expressed as a percentage of gross domestic product) is the sum of currency outside banks; demand and term deposits, including foreign currency deposits of resident sectors (other than the central bank); certificates of deposit and commercial paper
DCB	Domestic credit provided by the banking sector: domestic credit provided by the banking sector (expressed as a percentage of gross domestic product) includes all credit to various sectors on a gross basis, with the exception of credit to the central government, which is net. The banking sector includes monetary authorities, deposit money banks, and other banking institutions such as mortgage and building loan associations
DCP	Domestic credit to the private sector: this credit (expressed as a percentage of gross domestic product) refers to financial resources provided to the private sector, such as through loans, purchases of non-equity securities, and trade credits and other accounts receivable, that establish a claim for payment

Notes: All monetary measures are in US dollars. Variables above are defined in the World Development Indicators, published by the World Bank. These measures are used to create a banking sector maturity composite indicator (BSM). Natural log values are used in estimation

Analogously, our indicator for stock market maturity (SMM) is derived from a principal component analysis (see Appendix) using three measures of stock market maturity (as defined in Table IV): market capitalization (MAC), traded stocks (TRA), and turnover ratio (TUR). Data on these variables are obtained from the database of the International Monetary Fund.

Economic growth in our model is defined as the growth rate in real per capita gross domestic product (denoted by GDP). Inflation (INF) is calculated as the annual percentage change in consumer price indexes. GCE is central government final consumption expenditure as a percentage of gross domestic product: it is a proxy variable for the level of government involvement in the economy. Finally, the degree of trade openness (OPE) is the total volume of trade (exports plus imports) as a percentage of gross domestic product. Data on these variables are obtained from the World Development Indicators database. These variables are defined in more detail under Table V.

4. Empirical approach

To examine the long-term causal relationship between banking sector maturity, stock market maturity, and our two aspects of performance (economic growth and inflation) or our two

Table IV. Definition of measures of stock market maturity

Variables	Definition
MAC	Market capitalization: percentage change in the market capitalization of the listed companies, used as a proxy for the evolution in the size of the stock market
TRA	Traded stocks: percentage change in the total value of traded stocks, used as a proxy for the evolution in stock market liquidity
TUR	Turnover ratio: percentage change in the turnover ratio in the stock market, used as a proxy for the evolution in stock market turnover

Notes: All monetary measures are in US dollars. Variables above are defined by the International Monetary Fund database. These measures are used to create a stock market maturity composite indicator (SMM). Natural log values are used in estimation

Table V. Definition of other variables

Variables	Definition
GDP	Percentage change in per capita gross domestic product: used as our indicator of economic growth
INF	The inflation rate (in percentage) calculated by using the Consumer Price Index
GCE	Central Government final consumption expenditure as a percentage of gross domestic product to capture the degree of government involvement in the economy through consumption. Central government final consumption expenditure includes all government current expenditures for purchases of goods and services, including the compensation of employees. It also includes most expenditures on national defence and security, but excludes military expenditures that are part of government capital formation. Governments that consume a more significant sum (measured against the size of their economies) occupy a more prominent position. In that sense, this variable measures the degree of government involvement in the economy through consumption
OPE	Trade openness measured as total trade (exports plus imports) as a percentage of gross domestic product used to gauge how open the economy is

Notes: All monetary measures are in US dollars. Variables above are defined in the World Development Indicators, published by the World Bank. Natural log values are used in estimation aspects of operation (government intervention and trade openness), we estimate six dynamic panel regressions, using pooled data on the 35 Asian countries. Following Holtz-Eakin *et al.*'s (1988) procedure, the six regressions are the following:

$$\begin{aligned}\Delta GDP_{it} = {} & \eta_{1j} + \sum_{k=1}^{p_1} \alpha_{1ik}\Delta GDP_{it-k} + \sum_{k=1}^{p_2} \beta_{1ik}\Delta BSM_{it-k} + \sum_{k=1}^{p_3} \delta_{1ik}\Delta SMM_{it-k} \\ & + \sum_{k=1}^{p_4} \mu_{1ik}\Delta INF_{it-k} + \sum_{k=1}^{p_5} \lambda_{1ik}\Delta GCE_{it-k} + \sum_{k=1}^{P_6} \theta_{1ik}\Delta OPE_{it-k} \\ & + \omega_{1i}ECT_{1it-1} + \varepsilon_{1it}\end{aligned} \tag{1}$$

$$\begin{aligned}\Delta BSM_{it} = {} & \eta_{2j} + \sum_{k=1}^{p_1} \alpha_{2ik}\Delta BSM_{it-k} + \sum_{k=1}^{p_2} \beta_{2ik}\Delta GDP_{it-k} + \sum_{k=1}^{p_3} \delta_{2ik}\Delta SMM_{it-k} \\ & + \sum_{k=1}^{p_4} \mu_{2ik}\Delta INF_{it-k} + \sum_{k=1}^{p_5} \lambda_{2ik}\Delta GCE_{it-k} + \sum_{k=1}^{P_6} \theta_{2ik}\Delta OPE_{it-k} \\ & + \omega_{2i}ECT_{2it-1} + \varepsilon_{2it}\end{aligned} \tag{2}$$

$$\begin{aligned}\Delta SMM_{it} = {} & \eta_{3j} + \sum_{k=1}^{p_1} \alpha_{3ik}\Delta SMM_{it-k} + \sum_{k=1}^{p_2} \beta_{3ik}\Delta BSM_{it-k} + \sum_{k=1}^{p_3} \delta_{3ik}\Delta GDP_{it-k} \\ & + \sum_{k=1}^{p_4} \mu_{3ik}\Delta INF_{it-k} + \sum_{k=1}^{p_5} \lambda_{3ik}\Delta GCE_{it-k} + \sum_{k=1}^{P_6} \theta_{3ik}\Delta OPE_{it-k} \\ & + \omega_{3i}ECT_{3it-1} + \varepsilon_{3it}\end{aligned} \tag{3}$$

$$\begin{aligned}\Delta INF_{it} = {} & \eta_{4j} + \sum_{k=1}^{p_1} \alpha_{4ik}\Delta INF_{it-k} + \sum_{k=1}^{p_2} \beta_{4ik}\Delta BSM_{it-k} + \sum_{k=1}^{p_3} \delta_{4ik}\Delta SMM_{it-k} \\ & + \sum_{k=1}^{p_4} \mu_{4ik}\Delta GDP_{it-k} + \sum_{k=1}^{p_5} \lambda_{4ik}\Delta GCE_{it-k} + \sum_{k=1}^{P_6} \theta_{4ik}\Delta OPE_{it-k} \\ & + \omega_{4i}ECT_{4it-1} + \varepsilon_{4it}\end{aligned} \tag{4}$$

$$\begin{aligned}\Delta GCE_{it} = {} & \eta_{5j} + \sum_{k=1}^{p_1} \alpha_{5ik}\Delta GCE_{it-k} + \sum_{k=1}^{p_2} \beta_{5ik}\Delta BSM_{it-k} + \sum_{k=1}^{p_3} \delta_{5ik}\Delta SMM_{it-k} \\ & + \sum_{k=1}^{p_4} \mu_{5ik}\Delta INF_{it-k} + \sum_{k=1}^{p_5} \lambda_{5ik}\Delta GDP_{it-k} + \sum_{k=1}^{P_6} \theta_{5ik}\Delta OPE_{it-k} \\ & + \omega_{5i}ECT_{5it-1} + \varepsilon_{5it}\end{aligned} \tag{5}$$

$$\begin{aligned}\Delta OPE_{it} = {} & \eta_{6j} + \sum_{k=1}^{p_1} \alpha_{6ik}\Delta OPE_{it-k} + \sum_{k=1}^{p_2} \beta_{6ik}\Delta BSM_{it-k} + \sum_{k=1}^{p_3} \delta_{6ik}\Delta SMM_{it-k} \\ & + \sum_{k=1}^{p_4} \mu_{6ik}\Delta INF_{it-k} + \sum_{k=1}^{p_5} \lambda_{6ik}\Delta GCE_{it-k} + \sum_{k=1}^{P_6} \theta_{6ik}\Delta GDP_{it-k} \\ & + \omega_{6i}ECT_{6it-1} + \varepsilon_{6it}\end{aligned} \tag{6}$$

where Δ is the first difference operator; p_1, p_2, p_3, p_4, p_5, and p_6 are lag lengths; i represents country i in the panel ($i = 1, 2, \ldots, N$); t denotes the year in the panel ($t = 1, 2, \ldots, T$); *GDP* is the per capita economic growth rate; *BSM* is our indicator of banking sector maturity; *SMM* is our indicator of stock market maturity; *INF* is the annual consumer price inflation rate in the economy; *GCE* is central government consumption expenditure as a percentage of the gross domestic product; *OPE* is the trade openness in the economy (volume of trade as a percentage of the gross domestic product); *ECT* is an error-correction term derived from the cointegration equation; and ε_{it} is a normally distributed random error term for all i and t with a zero mean and a finite heterogeneous variance.

We look for both a short-run and a long-run causal relationship among the variables. The short-run causal relationship is measured through the *F*-statistics and the significance of the lagged changes in the independent variables. The long-run causal relationship is measured through the significance of the *t*-test of the lagged ECTs. Based on Equations (1)-(6), Table VI presents various possible hypotheses concerning the causal nexus between banking sector maturity, stock market maturity, and the remaining four variables.

The above econometric specification, as presented in Equations (1)-(6), is meaningful if the time-series variables are integrated of order one (denoted by I (1)) and cointegrated. If the variables are I (1) and not cointegrated, then the ECT component is removed in the estimation process. Thus, the pre-condition to the estimation process is to check the order of integration and cointegration among the variables. We employ the Levin-Lin-Chu (LLC) panel unit root test (Levin *et al.*, 2002) and the Pedroni panel cointegration test (Pedroni, 2004) to check for I (1) and cointegration between the variables. A brief discussion on these two techniques appears below.

4.1 Testing for the order of integration

The present study uses the LLC test to ascertain the order of integration, where a time series variable attains stationarity. The test uses the principles of the conventional augmented Dickey-Fuller (ADF) test and allows for heterogeneity of the intercepts across members

Table VI. Hypotheses tested in this study

Causal flow	Restrictions	Causal flow	Restrictions
BSM => GDP	$\beta_{1ik} \neq 0$; $\omega_{1i} \neq 0$	GCE => BSM	$\lambda_{2ik} \neq 0$; $\omega_{2i} \neq 0$
GDP => BSM	$\beta_{2ik} \neq 0$; $\omega_{2i} \neq 0$	BSM => GCE	$\beta_{5ik} \neq 0$; $\omega_{5i} \neq 0$
SMM => GDP	$\delta_{1ik} \neq 0$; $\omega_{1i} \neq 0$	OPE => BSM	$\theta_{2ik} \neq 0$; $\omega_{2i} \neq 0$
GDP => SMM	$\delta_{3ik} \neq 0$; $\omega_{3i} \neq 0$	BSM => OPE	$\beta_{6ik} \neq 0$; $\omega_{6i} \neq 0$
INF => GDP	$\mu_{1ik} \neq 0$; $\omega_{1i} \neq 0$	INF => SMM	$\mu_{3ik} \neq 0$; $\omega_{3i} \neq 0$
GDP => INF	$\mu_{4ik} \neq 0$; $\omega_{4i} \neq 0$	SMM => INF	$\delta_{4ik} \neq 0$; $\omega_{4i} \neq 0$
GCE => GDP	$\lambda_{1ik} \neq 0$; $\omega_{1i} \neq 0$	GCE => SMM	$\lambda_{3ik} \neq 0$; $\omega_{3i} \neq 0$
GDP => GCE	$\lambda_{5ik} \neq 0$; $\omega_{5i} \neq 0$	SMM => GCE	$\delta_{5ik} \neq 0$; $\omega_{5i} \neq 0$
OPE => GDP	$\theta_{1ik} \neq 0$; $\omega_{1i} \neq 0$	OPE => SMM	$\theta_{3ik} \neq 0$; $\omega_{3i} \neq 0$
GDP => OPE	$\theta_{6ik} \neq 0$; $\omega_{6i} \neq 0$	SMM => OPE	$\delta_{6ik} \neq 0$; $\omega_{6i} \neq 0$
SMM => BSM	$\delta_{2ik} \neq 0$; $\omega_{2i} \neq 0$	GCE => INF	$\lambda_{4ik} \neq 0$; $\omega_{4i} \neq 0$
BSM => SMM	$\beta_{3ik} \neq 0$; $\omega_{3i} \neq 0$	INF => GCE	$\mu_{5ik} \neq 0$; $\omega_{5i} \neq 0$
INF => BSM	$\mu_{2ik} \neq 0$; $\omega_{2i} \neq 0$	OPE => INF	$\theta_{4ik} \neq 0$; $\omega_{4i} \neq 0$
BSM => INF	$\beta_{4ik} \neq 0$; $\omega_{4i} \neq 0$	INF => OPE	$\mu_{6ik} \neq 0$; $\omega_{6i} \neq 0$
		OPE => GCE	$\theta_{5ik} \neq 0$; $\omega_{5i} \neq 0$
		GCE => OPE	$\lambda_{6ik} \neq 0$; $\omega_{6i} \neq 0$

Notes: GDP, per capita economic growth rate; BSM, banking sector maturity; SMM, stock market maturity, INF, annual inflation rate; GCE, gross consumption expenditure; OPE, trade openness of the panel. The test involves an estimation using the following equation:

$$\Delta Y_t = \mu_i + \gamma_i Y_{it-1} + \sum_{j=1}^{p_i} \beta_{ij} \Delta Y_{it-j} + \lambda_i t + \varepsilon_{it} \tag{7}$$

where $i = 1, 2, \ldots, N$ represents the country in the panel; $t = 1, 2, \ldots, T$ represents the year in the panel; Y_{it} is the series for country i in year t; μ_i represents country-specific effects; p_i is the number of lags selected for the ADF regression; Δ is the first-difference filter; and ε_{it} is an independently and normally distributed random error with a zero mean and a finite heterogeneous variance (σ_i^2).

The model allows for fixed effects, unit-specific time trends, and common time effects. The coefficient β_j of the lagged dependent variable is restricted to be homogenous across all the units of the panel. Hence, the null hypothesis of non-stationarity is stated as:

$$H_0\colon \gamma_i = 0 \text{ tested against the alternative } H_A : \gamma_i = \gamma < 0 \qquad \text{for all } i \tag{8}$$

where the fixed effect model in Equation (7) is based on the usual t-statistics:

$$t_\gamma = \frac{\widehat{\gamma}}{s.e\left(\widehat{\gamma}\right)} \tag{9}$$

where γ is restricted by being kept identical across regions under both the null and the alternate hypotheses.

4.2 Panel cointegration test

A cointegration test is used to check for the presence of long-run equilibrium relationships among the variables. The basic idea behind cointegration tests is simple. If the difference between two non-stationary series is itself stationary, then the two series are cointegrated. If two or more series are cointegrated, it is possible to interpret the variables in these series as being in a long-run equilibrium relationship. Lack of cointegration, on the other hand, suggests that the variables have no long-run relationship; in other words, in principle, they can move arbitrarily far away from each other.

When a collection of time-series observations becomes stationary only after being first-differenced, the individual time series might have linear combinations that are stationary without differencing. Such collections of series are usually termed "cointegrated" (Engle and Granger, 1987; Granger, 1988).

If an integration of "order one" is implied, the next step is to employ cointegration analysis in order to establish whether there is a long-run relationship among the set of such possibly "integrated" variables. In such investigations, Johansen's Vector Auto Regression (VAR) test of cointegration is usually employed (Johansen, 1988). VAR is a systemic approach to check for cointegration, allowing for the determination of up to r linearly independent cointegrating vectors ($r \leqslant g-1$, where g is the number of variables tested for cointegration). The estimated cointegration equation is of the following form:

$$Y_{it} = \beta_{i0} + \beta_{i1} X_{i1t} + \beta_{i2} X_{i2t} + \ldots. + \beta_{ik} X_{ikt} + \varepsilon_{it} \tag{10}$$

This equation may be re-written as:

$$\varepsilon_{it} = Y_{it} - (\beta_{i0} + \beta_{i1}X_{i1t} + \beta_{i2}X_{i2t} + ... + \beta_{ik}X_{ikt}) \tag{11}$$

with the cointegration vector defined as:

$$[1 - \beta_{i0} - \beta_{i1} - \beta_{i2}.... - \beta_{ik}] \tag{12}$$

We note that, as explained by Johansen (1988), the above test cannot deal with a panel setting. Thus, we use an enhancement, the Pedroni (1999, 2000, 2004) panel cointegration test, in order to test for the existence of cointegration among the variables. The Pedroni panel cointegration test is applied to the following time-series panel regression set-up:

$$Y_{i,t} = \alpha_i + \sum_{j=1}^{p_i} \beta_{ji}X_{jit} + \varepsilon_{it} \tag{13}$$

$$\varepsilon_{it} = \rho_i \varepsilon_{i(t-1)} + w_{it} \tag{14}$$

where Y_{it} and X_{jit} are the observable variables; ε_{it} represents the disturbance term from the panel regression; α_i allows for the possibility of country-specific fixed effects and the coefficients β_{ji} allow for variation across individual countries. The null hypothesis of no cointegration of the pooled (within-dimension) estimation is:

$$H_0 : \rho_i = 1 \text{ for all } i \text{ against } H_1 : \rho_i = \rho < 1 \tag{15}$$

Under the first hypothesis, the within-dimensional estimation assumes a common value for for ρ_{i} $(= \rho)$. In sum, this procedure excludes any additional source of heterogeneity between the individual country members of the panel. The null hypothesis of no-cointegration of the pooled (between-dimensions) estimation is expressed as:

$$H_0 : \rho_i = 1 \text{ for all } i \text{ against } H_0 : \rho_i < 1 \tag{16}$$

Under the alternative hypothesis, the between-dimensions estimation does not assume a common value for ρ_{i}. It thus allows for an additional source of possible heterogeneity across individual country members of the panel.

Pedroni suggests two types of test to determine the existence of heterogeneity of the cointegration vector. The first is a test which uses the within-dimension approach (a panel test). It uses four statistics, namely a panel v-statistic, a panel ρ-statistic, a panel PP-statistic, and a panel ADF-statistic. These statistics pool the autoregressive coefficients across different panel members for the unit root tests to be performed on the estimated residuals. The second is a test based on the between-dimensions approach (a group test). It includes three statistics: a group ρ-statistic, a group PP-statistic, and a group ADF-statistic. These statistics are based on estimators that simply average the individually estimated autoregressive coefficients for each panel member. Next, the

heterogeneous panel and heterogeneous group mean panel cointegration statistics are calculated as follows (Pedroni, 2000):
Panel v-statistic:

$$Z_v = \left[\sum_{i=1}^{N} \sum_{t=1}^{T} \hat{L}_{11i}^{-2} \hat{\varepsilon}_{it-1}^{2} \right]^{-1} \tag{17}$$

Panel ρ-statistic:

$$Z_\rho = \left[\sum_{i=1}^{N} \sum_{t=1}^{T} \hat{L}_{11i}^{-2} \hat{\varepsilon}_{it-1}^{2} \right]^{-1} \sum_{i=1}^{N} \sum_{t=1}^{T} L_{11i}^{-2} \left(\hat{\varepsilon}_{it-1} \Delta \hat{\varepsilon}_{it} - \hat{\lambda}_i \right) \tag{18}$$

Panel PP-statistic:

$$Z_t = \left[\hat{\sigma}^2 \sum_{i=1}^{N} \sum_{t=1}^{T} \hat{L}_{11i}^{-2} \hat{\varepsilon}_{it-1}^{2} \right]^{-0.5} \sum_{i=1}^{N} \sum_{t=1}^{T} L_{11i}^{-2} \left(\hat{\varepsilon}_{it-1} \Delta \hat{\varepsilon}_{it} - \hat{\lambda}_i \right) \tag{19}$$

Panel ADF-statistic:

$$Z_t^* = \left[\hat{s}^{*^2} \sum_{i=1}^{N} \sum_{t=1}^{T} \hat{L}_{11i}^{-2} \hat{\varepsilon}_{it-1}^{*2} \right]^{-0.5} \sum_{i=1}^{N} \sum_{t=1}^{T} \hat{L}_{11i}^{-2} \hat{\varepsilon}_{it-1}^{*} \Delta \hat{\varepsilon}_{it}^{*} \tag{20}$$

Group ρ-statistic:

$$\tilde{Z}_\rho = \sum_{i=1}^{N} \left(\sum_{t=1}^{T} \hat{\varepsilon}_{it-1}^{2} \right)^{-1} \sum_{t=1}^{T} \left(\hat{\varepsilon}_{it-1} \Delta \hat{\varepsilon}_{it} - \hat{\lambda}_i \right) \tag{21}$$

Group PP-statistic:

$$\tilde{Z}_t = \sum_{i=1}^{N} \quad \hat{\sigma}^2 \sum_{t=1}^{T} \hat{\varepsilon}_{it-1}^{2})^{-0.5} \sum_{t=1}^{T} \left(\hat{\varepsilon}_{it-1} \Delta \hat{\varepsilon}_{it} - \hat{\lambda}_i \right) \tag{22}$$

Group ADF-statistic:

$$\tilde{Z}_t^* = \sum_{i=1}^{N} \quad \sum_{t=1}^{T} \hat{s}_i^2 \hat{\varepsilon}_{it-1}^{*2})^{-0.5} \sum_{t=1}^{T} \left(\hat{\varepsilon}_{it-1}^{*} \Delta \hat{\varepsilon}_{it}^{*} \right) \tag{23}$$

where $\hat{\varepsilon}_{it}$ is the estimated residual appearing in Equation (12) and $\hat{L}_{11i}^{-2}$ is the estimated long-run covariance matrix for $\Delta\hat{\varepsilon}_{it}$. Similarly, $\hat{\sigma}_i^2$ and $\hat{s}_i^2$ ($\hat{s}_i^{*2}$) are the long-run and contemporaneous variances for an individual country i. All seven tests assume the existence of an asymptotically standard normal distribution given by the respective panel/group cointegration statistic. The panel v is a one-sided test where large positive values would reject the null hypothesis of no cointegration. The remaining statistics diverge to negative infinity, which means that large negative values also reject the null hypothesis. Each of these tests is able to accommodate country-specific short-run dynamics, country-specific fixed effects and deterministic trends, as well as country-specific slope coefficients (Pedroni, 2004).

It should be noted that prior to estimation, one has to specify the number of lag lengths in the estimation process. This is a crucial step, because the causality test results may depend critically on the lag structure. In general, both too few and too many lags may cause problems. On the one hand, too few lags mean that some important variables are omitted from the model, and such a specification error usually causes bias in the regression coefficients that are retained, leading to misleading conclusions. On the other hand, too many lags waste observations and will usually increase the standard error of the estimated coefficients, making the results less reliable.

Unfortunately, there is no simple rule for deciding the maximum lag length, though there are reliable formal model specification criteria available (Hendry, 1995). Ideally, the lag structure is allowed to vary across countries, variables, and equation systems. However, for a relatively large panel such as ours, this would increase the computational burden substantially. For this reason, under each system, we allow different maximum lag lengths for the three variables, but do not allow them to vary across countries. We estimate each equation accordingly and choose the combination of lags which minimizes the Akaike Information Criterion (AIC) and Schwartz-Bayes Information Criterion (SBC). These criteria are expressed in the equations below and are widely used in advanced applied econometric studies:

$$AIC_k = \ln|W| + \frac{2N^2 q}{T} \tag{24}$$

$$SBC_k = \ln|W| + \frac{N^2 q}{T}\ln(T) \tag{25}$$

where W is the estimated residual covariance matrix, N is the number of equations, q is the number of coefficients per equation, and T is the sample size, all in our system with $k = 1, 2$.

4.3 Sub-samples

Our empirical analysis is based on a panel of 35 Asian countries – a group of countries that have not been examined before in this literature. Three sub-samples based on region are created: North East Asia (NEA), South East Asia (SEA), and West Central Asia (WCA). NEA consists of eight countries, namely Moldova, Russia, Ukraine, China, Hong Kong, Japan, Korea, and Mongolia. SEA consists of ten countries, namely Bangladesh, India, Indonesia, Malaysia, Nepal, Philippines, Singapore, Sri Lanka, Thailand, and Vietnam. WCA includes seventeen countries, namely Armenia, Bahrain, Cyprus, Georgia, Iran, Israel, Jordan, Kazakhstan, Kuwait, Kyrgyz, Lebanon, Oman, Pakistan, Qatar, Saudi Arabia, Turkey, and UAE. We present results for the three regions separately, as well as for the group as a whole (total Asia: TOA).

The data period covers the period from 1960 to 2011. The countries are selected on the basis of data availability. The variables used are transformed to their natural logarithm forms for our estimations. Table VII provides a summary of the statistics on the variables, while Table VIII shows the correlation matrix.

Table VII. Summary statistics on the variables

Variables	Mean	Med	Max	Min	Std	Skew	Kur
Case 1: North-East Asia (NEA)							
GDP	1.31	1.33	1.51	0.41	0.14	−3.0	17.3
BSM	1.87	1.93	2.41	1.02	0.40	−0.37	1.87
SMM	1.47	1.69	2.61	−0.39	0.72	−0.78	2.54
INF	1.02	1.00	2.50	−0.01	0.35	0.82	6.23
GCE	1.15	1.17	1.39	0.85	0.11	−0.68	2.92
OPE	1.87	1.84	2.65	1.20	0.36	0.24	2.61
Case 2: South-East Asia (SEA)							
GDP	1.31	1.32	1.47	0.43	0.10	−4.66	35.5
BSM	1.76	1.71	2.17	1.30	0.23	0.15	1.90
SMM	1.29	1.43	2.29	−0.78	0.61	−0.90	3.54
INF	1.03	1.03	1.80	0.62	0.17	0.52	4.70
GCE	0.97	0.99	1.24	0.62	0.17	0.52	4.70
OPE	1.91	1.87	2.66	1.17	0.35	0.25	2.51
Case 3: West-Central Asia (WCA)							
GDP	1.27	1.28	1.49	−0.31	0.16	−4.88	43.0
BSM	1.67	1.61	2.47	0.93	0.32	−0.01	2.93
SMM	1.21	1.29	2.42	−1.13	0.64	−1.01	2.93
INF	1.05	1.00	2.05	−0.86	0.32	0.02	8.99
GCE	1.22	1.23	1.48	0.76	0.16	−0.25	2.11
OPE	1.87	1.92	2.24	1.45	0.19	−0.41	2.37
Case 4: Total Asia (TOA)							
GDP	1.29	1.31	1.51	−0.31	0.14	−4.65	41.0
BSM	1.75	1.71	2.47	0.93	0.32	−0.01	2.54
SMM	1.29	1.43	2.61	−1.13	0.66	−0.82	3.45
INF	1.04	1.02	2.50	−0.86	0.28	0.43	9.45
GCE	1.11	1.11	1.48	0.62	0.18	−0.20	2.95
OPE	1.89	1.89	2.66	1.17	0.30	0.25	3.16

Notes: Med, median; Max, maximum; Min, Minimum; Std, standard deviation; Skew, Skewness; Kur, Kurtosis; GDP, per capita economic growth rate; BSM, banking sector maturity; SMM, stock market maturity, INF, inflation rate; GCE, gross consumption expenditure; OPE, trade openness; NEA, North-East Asian countries; SEA, South-East Asian countries; WCA, West-Central Asian countries; TOA, total Asian countries. It includes all 35 countries covering NEA, SEA, and WCA. Values reported here are the natural logs of the variables. We use natural log forms in our estimation

5. Empirical results

The empirical results are reported in three stages: first, we comment on the nature of the stationarity of the time series variables; second, we discuss the nature of the cointegration among them; and third, we present evidence on the direction of the Granger causality between the cointegrated variables.

The estimation process involves treating four different samples: NEA, SEA, WCA, and TOA. In each case, the same variables are used but the sample size is obviously different.

The results shown in Tables IX and X indicate that all the variables are integrated of order one (they become stationary after first differencing), as well as cointegrated. These results suggest the presence of a long-run equilibrium relationship between banking sector maturity (BSM), stock market maturity (SMM), economic growth (GDP), inflation (INF), government consumption expenditure (GCE), and trade openness (OPE). Remarkably, this is true in all the four samples.

Table VIII. The correlation matrix

	GDP	BSM	SMM	INF	GCE	OPE
Case 1: North-East Asia (NEA)						
GDP	1.00	0.03	0.13	−0.19	−0.15	0.04
BSM		1.00	0.74*	−0.69*	−0.34	−0.15
SMM			1.00	−0.56*	−0.45*	0.01
INF				1.00	0.21	0.05
GCE					1.00	−0.06
OPE						1.000
Case 2: South-East Asia (SEA)						
GDP	1.00	−0.02	0.09	−0.18	0.05	−0.02
BSM		1.00	0.69*	−0.47	0.35	0.72
SMM			1.00	−0.38	0.50*	0.55
INF				1.00	−0.18	−0.44
GCE					1.00	0.31
OPE						1.000
Case 3: West-Central Asia (WCA)						
GDP	1.00	−0.02	−0.11	−0.02	−0.14	−0.11
BSM		1.00	0.43*	−0.28	0.39*	0.37
SMM			1.00	−0.04	0.24	0.06
INF				1.00	−0.40	−0.47
GCE					1.00	0.45
OPE						1.00
Case 4: Total Asia (TOA)						
GDP	1.00	−0.06	0.03	−0.10	−0.14	−0.02
BSM		1.00	0.61*	−0.46	0.09	0.27
SMM			1.00	−0.28	0.12	0.23
INF				1.00	−0.13	−0.23
GCE					1.00	−0.06
OPE						1.000

Notes: Variables shown above are defined earlier. *Statistically significant at 1% level

Table IX. Results of panel unit roots test (LLC statistic)

Variables	LLC statistics	NEA	SEA	WCA	TOA	Inference
GDP	LE	−0.65	1.16	−0.18	0.59	
	FD	−11.2*	−16.5*	13.5*	−23.3*	1 (1)
BSM	LE	2.78	3.54	2.55	4.98	
	FD	−5.38*	−7.74*	−5.81*	−10.9*	1 (1)
SMM	LE	1.09	0.87	0.54	1.47	
	FD	−9.33*	−10.8*	−8.84*	−16.4*	1 (1)
INF	LE	2.49	−0.84	−1.11	−2.25	
	FD	−11.3*	−16.5*	−12.3*	−22.7*	1 (1)
GCE	LE	2.18	1.60	−2.39	0.79	
	FD	−6.75*	−8.37*	−10.4*	−14.5*	1 (1)
OPE	LE	2.33	2.17	0.43	2.59	
	FD	−8.26*	−8.74*	−10.6*	−16.0*	1 (1)

Notes: Variables and regions shown above are defined earlier. LE is level data; FD is first difference data. The Levin-Lin-Chu (LLC) test statistics are reported at no intercept and trend. *Statistically significant at the 1% level; I (1) indicate integration of order one

Table X. Results of Pedroni panel cointegration test

Test statistics	No deterministic intercept or trend	Deterministic intercept and trend
Case 1: North-East Asia (NEA)		
Panel v-statistics	−0.28 [0.99]	−1.43 [0.38]
Panel ρ-statistics	−0.43 [0.00]	1.89 [0.91]
Panel PP-statistics	−5.46 [0.00]	−7.71 [0.82]
Panel ADF-statistics	−1.26 [0.05]	−1.36 [0.92]
Group ρ-statistics	0.78 [0.00]	3.08 [0.99]
Group PP-statistics	−7.77 [0.00]	−13.1 [0.81]
Group ADF-statistics	−2.81 [0.00]	−2.08 [0.93]
Case 2: South-East Asia (SEA)		
Panel v-statistics	−1.26 [0.99]	−1.88 [0.38]
Panel ρ-statistics	0.48 [0.00]	1.74 [0.91]
Panel PP-statistics	−6.79 [0.00]	−10.8 [0.82]
Panel ADF-statistics	−3.01 [0.05]	−4.89 [0.92]
Group ρ-statistics	1.05 [0.00]	2.36 [0.99]
Group PP-statistics	−9.41 [0.00]	−16.5 [0.81]
Group ADF-statistics	−1.99 [0.00]	−5.05 [0.93]
Case 3: West-Central Asia (WCA)		
Panel v-statistics	−1.15 [0.99]	−1.69 [0.38]
Panel ρ-statistics	−2.72 [0.00]	−0.01 [0.91]
Panel PP-statistics	−12.1 [0.00]	−11.4 [0.82]
Panel ADF-statistics	−0.25 [0.05]	−0.20 [0.92]
Group ρ-statistics	2.85 [0.00]	3.33 [0.99]
Group PP-statistics	−13.6 [0.00]	−14.5 [0.81]
Group ADF-statistics	−2.73 [0.00]	−1.54 [0.93]
Case 4: Total Asia (TOA)		
Panel v-statistics	−1.43 [0.99]	−2.84 [0.38]
Panel ρ-statistics	−2.24 [0.00]	1.93 [0.91]
Panel PP-statistics	−14.2 [0.00]	−16.8 [0.82]
Panel ADF-statistics	−2.47 [0.05]	−3.33 [0.92]
Group ρ-statistics	2.08 [0.00]	5.05 [0.99]
Group PP-statistics	−18.8 [0.00]	−25.4 [0.81]
Group ADF-statistics	−4.31 [0.00]	−4.96 [0.93]

Notes: Variables and regions shown above are defined in the text. Natural log forms are used in our estimation. Figures in square brackets are probability levels indicating significance

The existence of I (1) and cointegration among these variables imply the possibility of Granger causality among them. Hence, we perform a causality test, using a vector error correction model (VECM) and using Equations 1 to 6. The results are shown in Table XI. This table reports the panel Granger causality test results for both the short run, represented by the significance of the F-statistic, and the long run, represented by the significance of error correction term (ECT). A summary of these results for our four samples is as follows:

Case 1: For NEA

In this case, we find the existence of bidirectional causality between stock market maturity and economic growth [SMM <=> GDP], inflation and banking sector maturity [BSM <=>INF], economic growth and trade openness [OPE <=> GDP], inflation and stock market maturity [SMM <=> INF], and government consumption expenditure and trade openness

Table XI. Granger causality test results

Dependent variables	Independent variables ΔGDP	ΔBSM	ΔSMM	ΔINF	ΔGCE	ΔOPE	ECT	Inferences
Case 1: North-East Asia (NEA)								
ΔGDP	–	0.95	3.17*	1.55	4.11*	3.13*	−3.35*	SMM => PGDP; GCE => GDP; OPE => GDP
ΔBSM	4.24*	–	0.15	5.76*	2.65	6.11*	0.14	GDP => BSM; INF => BSM; OPE => BSM
ΔSMM	10.6*	8.27*	–	7.81*	4.92*	1.27	0.83	GDP => SMM; BSM => SMM; GCE => SMM
ΔINF	3.36*	13.9*	5.33*	–	7.66*	3.57*	−3.04*	GDP => INF; BSM => INF; SMM => INF; GCE => INF; OPE => INF
ΔGCE	2.19	15.9*	0.40	0.98	–	6.31*	−0.03	BSM => GCE; OPE => GCE
ΔOPE	2.56*	2.07	0.31	0.90	4.64*	–	−2.71*	GDP => OPE; GCE => OPE
AIC (2)	−1.14	−3.68	−0.52	−0.69	−4.37	−3.66		
SBC (2)	−0.80	−3.34	−0.19	−0.36	−4.03	−3.32		
Case 2: South-East Asia (SEA)								
ΔGDP	–	2.56	4.28*	0.80	4.68*	1.01	−5.41*	SMM => PGDP; GCE => GDP
ΔBSM	1.54	–	8.62*	0.12	0.08	2.42	2.52	SMM => BSM
ΔSMM	5.19*	4.87*	–	4.63*	0.83	0.15	1.70	GDP => SMM; BSM => SMM; INF => SMM
ΔINF	4.73*	3.02**	1.21	–	0.30	2.09	3.31	GDP => INF; BSM => INF
ΔGCE	4.92*	1.34	0.55	8.06*	–	0.86	−2.40	GDP => GCE; INF => GCE
ΔOPE	6.59*	7.21*	6.58*	7.89*	5.07*	–	−0.47	GDP => OPE; BSM => OPE; SMM => OPE; INF => OPE; GCE => OPE
AIC (2)	−1.61	3.67	−0.42	−1.33	−4.33	−3.59		
SBC (2)	−1.36	−3.42	−0.17	−1.08	−4.08	−3.34		
Case 3: West-Central Asia (WCA)								
ΔGDP	–	0.54	10.5*	4.55*	2.76	0.27	−5.75*	SMM => GDP; INF => GDP; OPE => GDP
ΔBSM	5.29*	–	4.76*	0.19	0.41	1.44	4.63	GDP => BSM; SMM => BSM
ΔSMM	1.00	0.82	–	1.50	0.71	3.92*	0.09	OPE => SMM
ΔINF	4.11*	1.33	0.85	–	0.12	5.72*	2.07	GDP => INF; OPE => INF
ΔGCE	1.96	0.73	1.67	2.04	–	1.61	2.57	
ΔOPE	3.88*	1.48	5.18*	0.47	1.64	–	−0.82*	GDP => OPE; SMM => OPE
AIC (2)	−1.50	−2.50	0.03	−0.31	−3.11	−3.71		
SBC (2)	−1.25	−2.26	0.28	−0.06	−2.87	−3.47		

	Independent variables							
Dependent variables	ΔGDP	ΔBSM	ΔSMM	ΔINF	ΔGCE	ΔOPE	ECT	Inferences
Case 4: Total Asia (TOA)								
ΔGDP	–	0.11	20.0*	6.71*	2.29	4.71*	−10.1*	SMM => GDP; INF => GDP; OPE => GDP
ΔBSM	10.8*	–	9.13*	1.47	2.06	1.97	5.89*	GDP => BSM; SMM => BSM
ΔSMM	3.84*	2.95*	–	0.52	2.18	2.69*	0.13	GDP => SMM; BSM => SMM; OPE => SMM
ΔINF	4.50*	7.19*	4.27*	–	0.21	9.38*	4.64*	GDP => INF; BSM => INF; SMM => INF; OPE => INF
ΔGCE	5.72*	3.73*	1.75	0.76	–	0.57	1.92	BSM => GCE; BSM => GCE
ΔOPE	13.0*	5.68*	9.67*	13.4*	5.59*	–	−0.52*	GDP => OPE; BSM => OPE; SMM => OPE; INF => OPE; GCE => OPE
AIC (2)	−1.51	−3.08	−0.27	−0.72	−3.69	−3.68		
SBC (2)	−1.39	−2.96	−0.15	−0.59	−3.56	−3.55		

Notes: GDP, per capita economic growth rate; BSM, banking sector maturity; SMM, stock market maturity; INF, inflation rate; GCE, gross consumption expenditure; OPE, trade openness; NEA, North East Asia; SEA, South East Asia; WCA, West Central Asia; TOA, total Asia; ECT, error correction term; AIC, Akaike Information Criterion; SBC, Schwartz Bayesian Criterion. Variables and regions shown above are defined earlier and are summarized below for ease of reference. Natural log forms are used in our estimation. The figure inside the parentheses in front of AIC and SBC stands for the number of lags; a length of 2 is selected to minimize AIC and SBC, respectively. *,**Significant at 1, 5 percent levels, respectively

[GCE <=> OPE]. Moreover, we find unidirectional causality from economic growth to banking sector maturity [GDP => BSM], banking sector maturity to stock market maturity [BSM => SMM], economic growth to inflation [GDP => INF], and banking sector maturity to government consumption expenditure [BSM => GCE]. The latter result may be explained as follows. Greater degree of banking sector maturity can facilitate more efficient government borrowing both at home and overseas, thus creating the potential for the government to become more involved in the economy through greater expenditure.

Case 2: For SEA

For this group, we find the existence of bidirectional causality between stock market maturity and economic growth [SMM <=> GDP], stock market maturity and banking sector maturity [BSM <=> SMM], and government consumption expenditure and economic growth [GCE <=> GDP]. In addition, we find unidirectional causality from inflation to stock market maturity [INF => SMM], banking sector maturity to inflation [BSM => INF], economic growth to inflation [GDP => INF], inflation to government consumption expenditure [INF => GCE], economic growth to trade openness [GDP => OPE], banking sector maturity to trade openness [BSM => OPE], stock market maturity to trade openness [SMM => OPE], inflation to trade openness [INF => OPE], and government consumption expenditure to trade openness [GCE => OPE]. The intuition for the latter result is that greater government involvement through institutions that can develop, facilitate, or support, trade (for example, through Export Development Banks in many countries, which subsidize exporters and assist companies with expansion into international markets) can enhance trade, thus leading to a more open economy. These institutions would not exist without government support and expenditure[2].

Case 3: For WCA

Here we find the existence of bidirectional causality between inflation and economic growth [INF <=> GDP], between economic growth and trade openness [GDP <=> OPE], and between trade openness and stock market maturity [OPE <=> SMM]. In addition, we find unidirectional causality from economic growth to banking sector maturity [GDP => BSM], stock market maturity to banking sector maturity [SMM => BSM], and trade openness to inflation [GDP => INF].

Case 4: For TOA

For the sample taken as a whole, we find the existence of bidirectional causality between stock market maturity and economic growth [SMM <=> GDP], inflation and economic growth [GDP <=>INF], economic growth and trade openness [OPE <=> GDP], banking sector maturity and stock market maturity [BSM <=> SMM], trade openness and stock market maturity [OPE <=> SMM], and trade openness and inflation [OPE <=> INF]. Furthermore, we uncover existence of unidirectional causality from economic growth to banking sector maturity [GDP => BSM], banking sector maturity to inflation [BSM => INF], stock market maturity to inflation [SMM => INF], banking sector maturity to government consumption expenditure [BSM => GCE], economic growth to government consumption expenditure [GDP => GCE], banking sector maturity to trade openness [BSM => OPE], and government consumption expenditure to trade openness [GCE => OPE].

Finally, to complement our analysis, we employed generalized impulse response functions (GIRFs) to trace the effect of a one-off shock to one of the innovations on the current and future values of the endogenous variables. The generalized impulse responses offer additional insight into how shocks to each of our indicators of banking sector maturity and stock market maturity can affect and be affected by each of the other four variables: inflation, trade openness, government consumption expenditure, and economic growth. These results are graphed in Figures 1 to 4, one for each of our samples. This analysis provides additional support for the argument that there is demonstrated causality among the variables on our VECM model.

Figure 1. Plot of generalized impulse functions for the variables for North-East Asia (NEA)

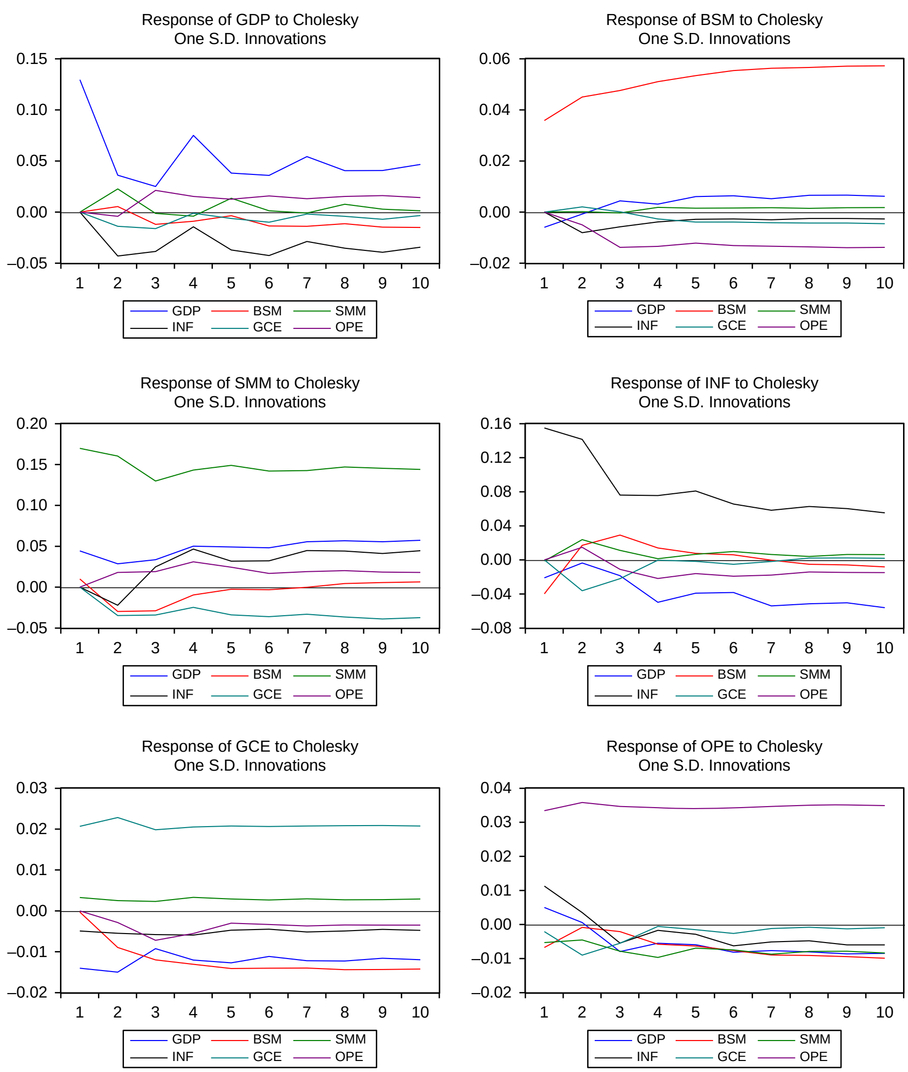
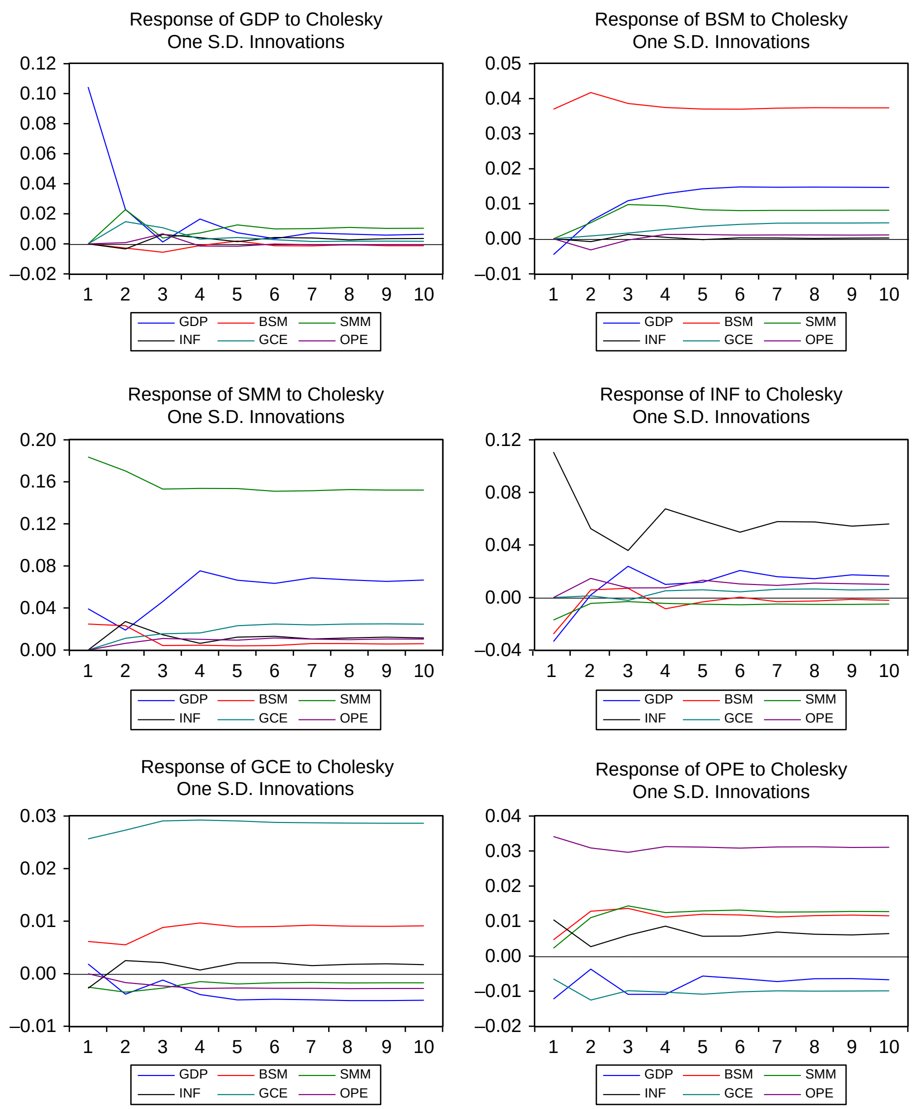


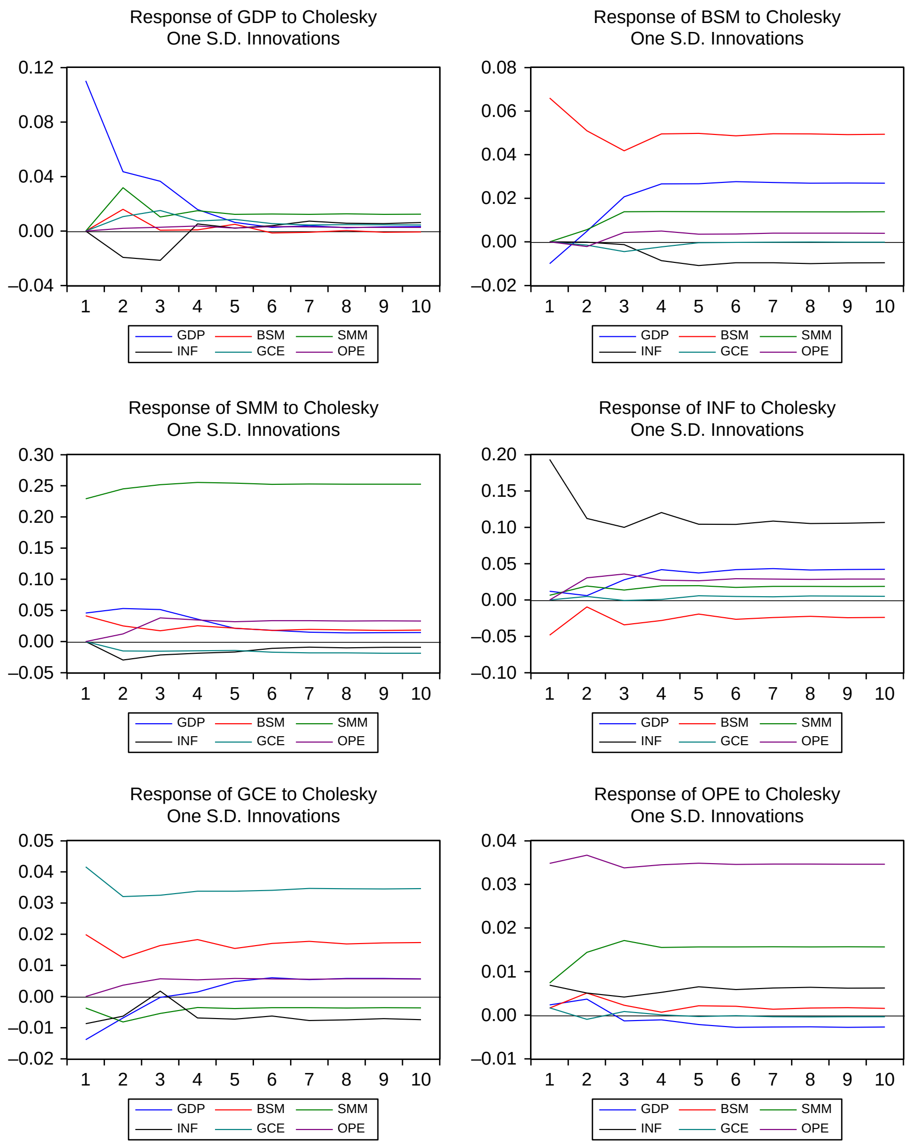
Figure 2. Plot of generalized impulse functions for the variables for South-East Asia (SEA)



6. Conclusion and policy implications

Our study used sophisticated principal-component analysis, panel cointegration and Granger causality tests, methods not used in this literature before. The method was applied to recent data pertaining to 35 Asian countries; it sheds light on the real underlying relationship between banking sector maturity, stock market maturity, economic growth, inflation, government consumption expenditure, and trade openness. We establish in the first place that there is evidence of a long-run equilibrium relationship among these variables. We also demonstrate a myriad of remarkable causal links between the variables. Our results indicate the relevance of banking sector maturity and stock market maturity to economic growth, inflation,

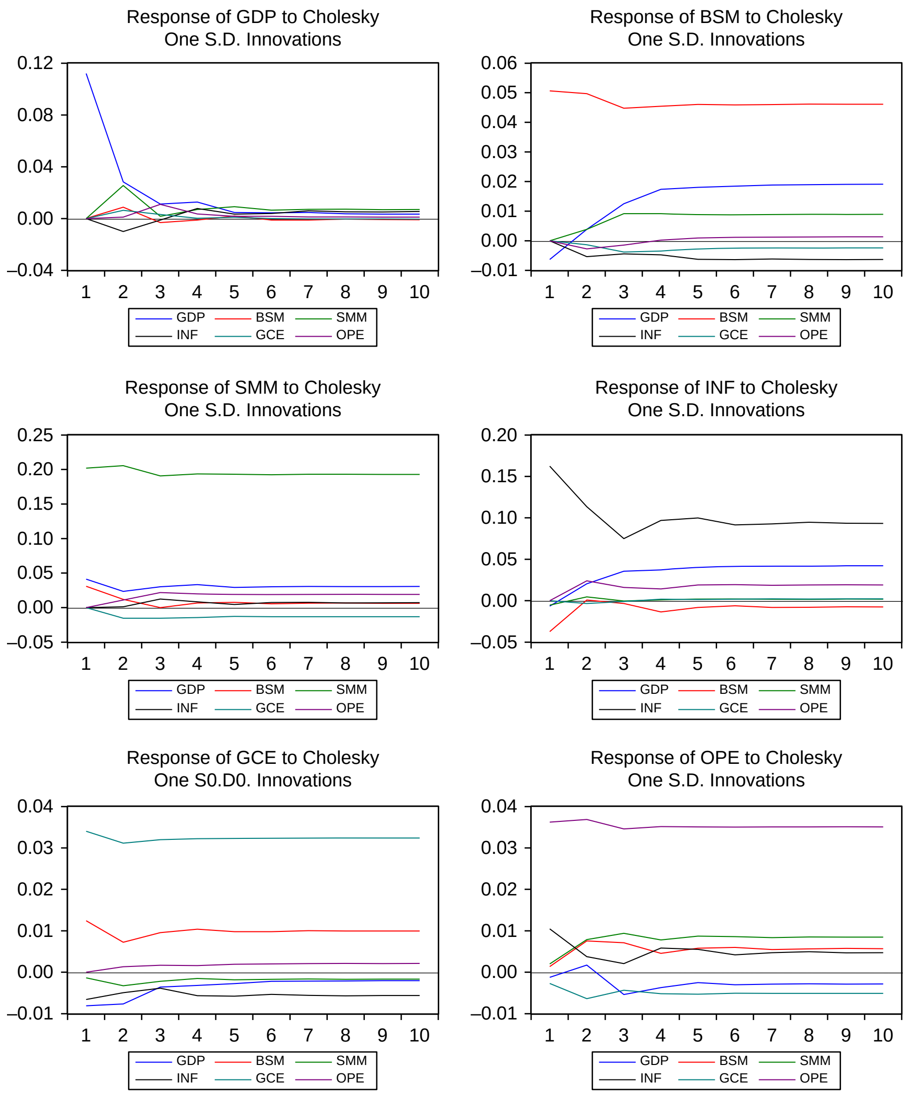
Figure 3. Plot of generalized impulse functions for the variables for West-Central Asia (WCA)



government consumption expenditure, and trade openness of countries.

In particular, we find that stock market maturity may lead to economic growth, both directly and indirectly through other indicators such as inflation and trade openness. To be clear, since there is some evidence that SMM is causally linked with inflation and trade openness, and since there is often a nexus between inflation, trade openness and economic growth, we can conclude through this transitive chain that SMM may affect economic growth. Our results also provide strong support for the notion that economic growth itself affects the maturity of the stock markets in most regions (NEA, SEA, and TOA in general). Interestingly, for all regions considered, banking sector

Figure 4. Plot of generalized impulse functions for the variables for Total Asia (TOA)



maturity and stock market maturity are causally linked, sometimes in both directions.

Thus, from our analysis, it seems that macroeconomic policies that bring inflation under control, combined with a mature financial sector (one that is not crisis-prone and is encouraged to grow in size, efficiency, and sophistication) are both key contributors to generating higher economic growth. Finally, it should be recognized that economic growth itself has the potential to promote further stock market maturity (and sometimes, in turn, banking sector maturity) and hence bring about additional economic prosperity through this feedback effect, although this result appears to be region specific.

Notes

1. Many authors in this literature refer to banking sector and stock market development. We prefer to use the term "maturity", especially given the set of variables we use in our analysis.
2. Export Development Banks also support direct investment abroad and investment into a country.

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Appendix. Principal component analysis (PCA)

The PCA is a special case of a more general method of factor analysis. The PCA is well documented in the literature (see, for instance, Banos *et al.*, 2011; Iqbal and Nadeem, 2006; Jalil *et al.*, 2010; Joliffe, 2002; Manly, 1994; Sharma, 1996) and consists of several steps, such as constructing a data matrix, using standardized variables, calculating a correlation matrix, finding eigenvalues (to rank principal components) and eigenvectors, selecting principal components (based on stopping rules) and interpretating results (Hosseini and Kaneko, 2011). The idea of PCA is to transform the original set of variables into a smaller set of linear combinations that account for most of the variance of the original set. The aim of the PCA method is to construct, out of a set of variables, X_j's ($j = 1, 2, \ldots, n$), new variables P_i ($i = 1, 2, \ldots, m$) called "principal components," which are linear combinations of the X's. This can be represented mathematically as follows:

$$\begin{aligned} P_1 &= a_{11}X_1 + \ldots\ldots\ldots\ldots\ldots\ldots + a_{1n}X_n \\ P_m &= a_{m1}X_1 + \ldots\ldots\ldots\ldots\ldots\ldots + a_{mn}X_n \end{aligned} \tag{26}$$

Here, $X_1, X_2, \ldots, X_n$ are the row vectors of the standardized data matrix (p number of row vectors for p number of variables), $P_1, P_2, \ldots, P_m$ are principal components and a_{ij} are the constants indicating the degree of relation of each principal component with a corresponding variable.

The a_{ij} constants are called component loadings. Component loadings are the weights showing the variance contribution of principal components to variables. Since the principal components are selected orthogonal to each other, a_{ij} weights are proportional to the correlation coefficient between variables and principal components.

The first principal component (P_1) is determined as the linear combination of $X_1, X_2, \ldots, X_n$ provided that the variance contribution is maximal. The second principal component (P_2), independent from the first principal component, is determined to provide a maximum contribution to the total variance left after the variance explained by the first principal component, then the third and the other principal components are determined to provide the maximum contribution to the remaining variance and independent from each other. The aim here is to determine a_{ij} coefficients providing the linear combinations of variables based on the specified conditions.

It should be noted that the PCA method could be applied by using the original values of the X_j's, or by their deviations from their means ($x_j = X_j - \bar{X}_j$), or by the standardized variables ($Z_j = x_j/s_{xj}$, $x_j = X_j - \bar{X}_j$). The present study adopts the last procedure, as it is assumed to be more general and can be applied to variables measured in different units. It may be interesting to note that the values of the principal components differ, depending on the way in which the variables are used (original values, deviations or standardized values). The coefficients' a's, called loadings, are chosen in such a way that the construct principal components satisfy two conditions:

(1) principal components are uncorrelated (orthogonal); and

(2) the first principal component P_1 absorbs and accounts for the maximum possible proportion of total variation in the set of all X's; second principal component absorbs the maximum of the remaining variation in the X's (after allowing for the variation accounted for by the first principal component), and so on.

There are different rules to define a high magnitude, known as stopping rules (OECD, 2008). Here, variance-explained criteria are implemented based on the rule of keeping enough PCs to account for 90 percent of the variation (Hosseini and Kaneko, 2011, 2012). The following formulas are used to construct the composite index of banking sector maturity and stock market maturity:

$$BSM = \sum_{i=1}^{3} a_i \frac{X_{ij}}{Sd(X_i)} \quad (27)$$

$$SMM = \sum_{i=1}^{3} a_i \frac{X_{ij}}{Sd(X_i)} \quad (28)$$

where BSM is the composite index of banking sector maturity, SMM is the composite index of stock market maturity, Sd is the standard deviation, X_{ij} is the ith items in jth year; $a_{i,}$ is the factor loadings derived by means of PCA.

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