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Causal nexus between economic growth, banking sector development, stock market development, and other macroeconomic variables: The case of ASEAN countries

Rudra P. Pradhan [a,*], Mak B. Arvin [b], John H. Hall [c], Sahar Bahmani [d]

[a] Vinod Gupta School of Management, Indian Institute of Technology Kharagpur, WB 721302, India
[b] Department of Economics, Trent University, Peterborough, Ontario K9J 7B8, Canada
[c] Department of Financial Management, University of Pretoria, Pretoria 0028, South Africa
[d] Department of Economics, University of Wisconsin at Parkside, Kenosha, WI 53144, USA

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ABSTRACT

This paper examines the relationship between banking sector development, stock market development, economic growth, and four other macroeconomic variables in ASEAN countries for the period 1961–2012. Using principal component analysis for the construction of the development indices and a panel vector auto-regressive model for testing the Granger causalities, this study finds the presence of both unidirectional and bidirectional causality links between these variables. The study contributes to understanding the importance of the interrelationship between the variables and combines the different strands of the literature. It also contributes to the literature by focusing on a group of countries that have not been studied before. One particular policy recommendation is to make the banking sector more accessible for those country's inhabitants that do not have bank accounts. Another policy recommendation is to nurture stock market development, which will facilitate the increased raising of capital for investment purposes to enhance economic growth.

1. Introduction

The level of banking sector development and stock market development is among the most important variables identified by the empirical economic growth literature as being correlated with growth performance across countries (Fink, Haiss, & Vuksic, 2009; Beck & Levine, 2004; Garcia & Liu, 1999; Levine & Zervos, 1998; Naceur & Ghazouani, 2007; Yartey, 2008). These development challenges prevent developing countries from taking full advantage of technology transfer, causing some of these countries to diverge from the growth rate of the world production frontier (Aghion, Howit, & Mayer-Foulkes, 2005; Menyah, Nazlioglu, & Wolde-Rufael, 2014). In fact, it is debated that poor countries with a weakened financial system are trapped in a vicious circle, where low levels of financial development, in both the banking sector and the stock market, lead to low economic performance and low economic performance leads to low financial development (Fung, 2009). An inadequately supervised financial system may be crisis-prone, with potentially devastating effects (Moshirian & Wu, 2012; OECD, 1999). On the contrary, an efficient financial system, with a well-developed and integrated banking sector and stock market, provides better financial services, which enables an economy to increase its growth rate (Bencivenga, Smith, & Starr, 1995; Esso, 2010; King & Levine, 1993a). Hence, finance is not only pro-growth but it is also pro-poor, suggesting that financial development helps the poor catch up with the rest of the economy as it grows (Demirguc-kunt & Levine, 2009). Furthermore, the endogenous growth theory as articulated by Greenwood and Jovanovic (1990) and Bencivenga and Smith (1991) and others stresses that financial development, both banking sector development and stock market development, is a key factor that fosters long-run economic growth, as financial development along with advancement is able to facilitate economic growth through multiple channels. These channels include: (i) providing information about possible investments, so as to allocate capital efficiently; (ii) monitoring firms and exerting corporate

* Corresponding author.
E-mail addresses: rudrap@vgsom.iitkgp.ernet.in (R.P. Pradhan), marvin@trentu.ca (M.B. Arvin), john.hall@up.ac.za (J.H. Hall), bahmani@uwp.edu (S. Bahmani).

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governance; (iii) risk diversification; (iv) mobilizing and pooling savings; (v) easing the exchange of goods and services; and (vi) technology transfer (see, for example, Drake, 1980; Fritz, 1984; Garcia & Liu, 1999; Levine, 2005; Zhang, Wang, & Wang, 2012).

Not surprisingly, the relationship between financial development[1] and economic growth has been an important area of discussion among researchers and policy makers (see, for instance, Levine, 1999; Luintel & Khan, 1999; Al-Yousif, 2002; Ang, 2008a,b; Bangake & Eggoh, 2011; Beck, Levine, & Loayza, 2000; Chow & Fung, 2011; Fase & Abma, 2003; Herwartz & Walle, 2014; Jung, 1986; King & Levine, 1993a,b; Levine, 2003; Levine, Loayza, & Beck, 2000; Mukhopadhyay, Pradhan, & Feridun, 2011; Wachtel, 2003; Rousseau & Yilmazkuday, 2009; Yucel, 2009). However, what remains unclear is the issue of cointegration and causality between banking sector development and stock market development. Development economics studies two types of relationships: first, the link between banking sector development and economic growth (Christopoulos & Tsionas, 2004; Majid & Mahrizal, 2007; Menyah et al., 2014; Moshirian & Wu, 2012; Tang, 2005); and second, the link between stock market development and economic growth (Choong, Yusop, Law, & Venus, 2003; Khan, 2004; Levine, 1991; Singh, 1997). In a broad-spectrum, both banking sector development and stock market development are main forces that can bring about high economic growth in a country (Bilson, Brailsford, & Hooper, 2001; Castaneda, 2006; Fink, Haiss, & Vuksic, 2006; Garcia & Liu, 1999; Gjerde & Saettem, 1999; Kwon & Shin, 1999; Nieuwerburgh, Buelens, & Cuyvers, 2006; Pagano, 1993; Schumpeter, 1911; Shan, Morris, & Sun, 2001; Shaw, 1973; Trew, 2006). It has been argued in a subset of the finance-growth literature that both banking sector development and stock market development can cause each other (Allen, Gu, & Kowalewski, 2012; Cheng, 2012; Gimet & Lagoarde-Segot, 2011). While policymakers may vary on the degree to which these financial-sector developments contribute to economic growth, they generally concur that both do in fact matter. As a result, many countries have adopted development strategies that prioritize banking sector development and stock market development. ASEAN regional forum (ARF) 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 savings and increases in domestic and foreign investment (King & Levine, 1993a; Levine & Zervos, 1996; Masih & Masih, 1999; Reinhart & Tokatlidis, 2003; Thornton, 1994). However, to ascertain that such policies are undeniably guaranteed to be effective, it must be formally established that there is indeed a causal relationship between banking sector development, stock market development, and economic growth (Cheng, 2012; Choe & Moosa, 1999; Cole, Moshirian, & Wu, 2008; Colombage, 2009; Gries, Kraft, & Meierrieks, 2009; Hassan, Sanchez, & Yu, 2011; Naceur & Ghazouani, 2007; Panopoulou, 2009; Rousseau, 2009; Zivengwa, Mashika, Bokosi, & Makova, 2011; Zhang et al., 2012).

In this paper, we seek to answer questions concerning the nature of the causal relationship between economic growth, banking sector development, stock market development, and four other macroeconomic variables. The novel features of this study are that: (1) we use the group of 26 ARF countries over a long span of time, from 1961 to 2012; (2) we combine the different strands of the literature; and (2) we employ principal component analysis and a panel vector auto-regressive (VAR) model for testing the Granger causalities. These formulations are rarely used in the finance-growth literature.

The remainder of this paper is structured as follows: Section 2 provides a literature review on the connection between banking sector development, stock market development, and economic growth. Section 3 highlights the research questions and the proposed hypotheses. Section 4 presents the data structure, sample selection, and the variables. This is followed by Section 5, which outlines our empirical model. Results are discussed in Section 6, while the final section concludes with a summary and the policy implications of our results.

2. Literature review

Financial development is pivot to economic growth (Graff, 2003; Levine, 1997). The connection between the two variables has been the focus of an immense body of theoretical and empirical research since the seminal work Schumpeter (1911). A number of studies (Blackburn & Hung, 1998; Beck & Levine, 2004; Beck et al., 2000; Berthelemy & Varoudakis, 1996; Craigwell, Downes, & Howard, 2001; Dritsakis & Adamopoulos, 2004; Fase & Abma, 2003; Fung 2009; Greenwood & Bruce, 1997; Greenwood & Smith, 1997; Gregorio & Guidotti, 1995; Herwartz & Walle, 2014; Hsueh, Hu, & Tu, 2013; King & Levine, 1993a, b; Pradhan, 2013; Rajan & Zingales, 1998; Thornton, 1994; Uddin, Shahbaz, Arouri, & Teulon, 2014) examined the effect of financial development and economic growth using a number of econometric techniques, such as cross-sectional, time series, panel data, and firm-level studies.[2]

By large, the empirical evidence had demonstrated that there is a positive long-run association between the indicators of financial development and economic growth. In general, all these papers suggest that a well-developed financial system is growth-enhancing, and hence, consistent with the proposition of "more finance, more growth" (Law & Singh, 2014). At the same time, focus on causality between financial development and economic growth (i.e., the finance-growth link) has spawned considerable interest among economists in recent years. Subsequently, there have been many similar studies in this regard for both developed and developing countries. While most of these studies have confirmed the existence of a causal relationship from financial development to economic growth (Enisan & Olufisayo, 2009; Hassan et al., 2011; Menyah et al., 2014; Pradhan, Dasgupta et al., 2013; Rousseau & Wachtel, 2000), there are a few cases where there is no evidence of causality from financial development to economic growth (Eng & Habibullah, 2011; Lucas, 1988; Mukhopadhyay et al., 2011; Pradhan, Mukhopadhyay et al., 2013; Stern, 1989). Hence, the empirical studies on the relationship between financial development and economic growth do not provide any definite conclusion on the nature and direction of this relationship and currently there is no consensus among economists about the nature of this relationship. In summary, there are four possible relationships that have been emphasized in the empirical literature on the causal link between financial development and economic growth, namely the unidirectional financial development-led growth hypothesis, the unidirectional growth-led financial development hypothesis, the feedback hypotheses, and the neutrality hypothesis.

In response to the above focus on finance-growth nexus, this paper examines the nexus in the ARF countries. Specifically, we define financial development as both banking sector development and stock market development and study their impact on economic growth along with

[1] Financial development is defined in terms of the aggregate size of the financial sector, its sectorial composition, and a range of attributes of individual sectors that determine their effectiveness in meeting users' requirements. The evaluation of financial structure should cover the roles of the key institutional players, including the central bank, commercial and merchant banks, saving institutions, development financial institutions, insurance companies, mortgage entities, pension funds, the stock market, and other financial market institutions (see, for instance, IMF, 2005, Chap. 2; Zaman, Izhar, Khan, & Ahmad, 2012). Thus, financial development includes both banking sector development and stock market development.

[2] Levine (2003) provides an excellent overview of a large body of empirical literature that suggests that financial development can robustly explain differences in economic growth across countries.

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four other macroeconomic variables. In the next section, we highlight two bodies of literature in this regard.

2.1. Causality between banking sector development and economic growth

The first body of the literature examines the link between banking sector development and economic growth. In this regard, Menyah et al. (2014), Pradhan, Arvin, Norman and Nishigaki (2014), Hsueh et al. (2013), Bojanic (2012), Chaiechi (2012), Jalil, Feridun, and Ma (2010), Kar, Nazlioglu, and Agir (2011), Wu, Hou, and Cheng (2010), Abu-Bader and Abu-Qarn (2008), Ang (2008a,b), Naceur and Ghazouani (2007), Boulila and Trabelsi (2004), Christopoulos and Tsionas (2004), Calderon and Liu (2003), Al-Yousif (2002), Thakor (1996), Thornton (1994), Bencivenga and Smith (1991), and Greenwood and Jovanovic (1990) all demonstrated the validity of a "*supply-leading*" view, where unidirectional causality from banking sector development to economic growth is present. According to this view, banking sector development contributes to economic growth through two main channels: first, by raising the efficiency of capital accumulation and, in turn, the marginal productivity of capital (Goldsmith, 1969) and, second, by raising the savings rate and thus, the investment rate (McKinnon, 1973; Shaw, 1973).

In contrast to the "*supply-leading*" view, Kar et al. (2011), Odhiambo (2008, 2010), Panopoulou (2009), Ang and McKibbin (2007), Liang and Teng (2006), Demetriades and Luintel (1996), and Ireland (1994) claim evidence in favour of a "*demand-following*" view, where the causality runs from economic growth to banking sector development. According to this view, as the economy expands, demand for banking services increases, leading to the growth of these services. Studies such as those of Wolde-Rufael (2009), Lee and Chang (2009), Dritsakis and Adamopoulos (2004), Al-Yousif (2002), Craigwell et al. (2001), Ahmed and Ansari (1998), Greenwood and Smith (1997), and Demetriades and Luintel (1996) claim to have uncovered "*feedback*", whereby the causality runs in both directions. It is evident from the literature that the evidence on the direction of causality between these two variables needs more advanced statistical analysis than the literature has previously afforded it. Table 1 presents a synopsis of research on the causal nexus between banking sector development and economic growth.

2.2. Causality between stock market development and economic growth

A second strand of the literature examines the direction of causality between stock market development and economic growth. In this vein, Kolapo and Adaramola (2012), Colombage (2009), Enisan and Olufisayo (2009), Nieuwerburgh et al. (2006) and Tsouma (2009) support the validity of a "*supply-leading*" view, where unidirectional causality from stock market development to economic growth is present. By contrast, Kar et al. (2011), Panopoulou (2009), Liu and Sinclair (2008), Odhiambo (2008) Ang and McKibbin (2007), Liang and Teng (2006), and Dritsaki and Dritsaki-bargiota (2005) present evidence in support of a "*demand-following*" hypothesis, where unidirectional causality from economic growth to stock market development is present. Finally, Cheng (2012), Hou and Cheng (2010), Rashid (2008), Darrat, Elkhal, and McCallum (2006), Caporale, Howells, and Soliman (2004), Hassapis and Kalyvitis (2002), Wongbangpo and Sharma (2002), Huang, Yang, and Hu (2000), Muradoglu, Taskin, and Bigan (2000), Masih and Masih (1999), and Nishat and Saghir (1991) demonstrate

Table 1
Summary of the studies showing a causal link between banking sector development and economic growth.

Study	Study area	Method	Period covered
Group 1: Studies that support supply-leading hypothesis			
Menyah et al. (2014)	21 African countries	TVGC	1965–2008
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 (2008)	Egypt	TVGC	1960–2001
Ang (2008b)	Malaysia	MVGC	1960–2003
Naceur and Ghazouani (2007)	MENA region	MVGC	1979–2003
Boulila and Trabelsi (2004)	Tunisia	BVGC	1962–1987
Agbetsiafa (2003)	Sub-Saharan Africa	TVGC	1963–2001
Calderon and Liu (2003)	109 countries	MVGC	1960–1994
Thornton (1994)	Asian countries	BVGC	1951–1990
Group 2: Studies that support demand-following hypothesis			
Pradhan, Mukhopadhyay, Gunashekar, Bele and Pandey (2013)	15 Asian countries	MVGC	1961–2011
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
Group 3: Studies that support feedback hypothesis			
Pradhan, Arvin, Norman and Hall (2014)	Asian countries	MVGC	1960–2011
Pradhan, Dasgupta et al. (2013)	5 BRICS countries	BVGC	1989–2011
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

Note 1: The definition of banking sector development varies across studies.
Note 2: MMs: mature markets; EMs: emerging markets; BVGC: Bivariate Granger Causality; TVGC: Trivariate Granger Causality; QVGC: Quadvariate Granger Causality; and MVGC: Multivariate Granger Causality.

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Table 2
Summary of the studies showing a causal link between stock market development and economic growth.

Study	Study area	Method	Period covered
Group 1: Studies that support supply-leading hypothesis			
Pradha, Arvin, et al. (2013)	16 Asian countries	MVGC	1988–2012
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
Group 2: Studies that support demand-following hypothesis			
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
Group 3: Studies that support feedback hypothesis			
Cheng (2012)	Taiwan	MVGC	1973–2007
Hou and Cheng (2010)	Taiwan	MVGC	1971–2007
Rashid (2008)	Pakistan	MVGC	1994–2205
Darrat et al. (2006)	EMs	TVGC	1970–2003
Zhu, Ash, & Pollin (2004)	14 countries	MVGC	1995–2009
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

Note 1: The definition of stock market development varies across studies.
Note 2: MMs: mature markets; EMs: emerging markets; BVGC: Bivariate Granger Causality; TVGC: Trivariate Granger Causality; QVGC: Quadvariate Granger Causality; and MVGC: Multivariate Granger Causality.

that causation runs in both directions simultaneously. Once again, the existing literature does not provide a definitive answer as to the direction of causality. Table 2 presents a synopsis of research on the causal nexus between stock market development and economic growth.

In the next section, the research questions and proposed hypotheses, as identified by the literature review, are discussed.

3. Research questions and proposed hypotheses

This paper is not intended to be a comprehensive study of all the determinants of economic growth. Rather, it is the first of its kind to examine the nature of the relationship between economic growth, banking sector development, and stock market development, along with four other important macroeconomic variables — all within a panel vector auto-regressive model in order to detect the direction of causality between the variables. Evidently, among other things, our study melds several strands of the literature. We test the following six hypotheses:

- $H_{1A,\,B}$: *Banking sector development Granger-causes economic growth and vice versa.*
- $H_{2A,\,B}$: *Stock market development Granger-causes economic growth and vice versa.*
- $H_{3A,\,B}$: *A macroeconomic variable Granger-causes economic growth and vice versa.*
- $H_{4A,\,B}$: *Banking sector development Granger-causes stock market development and vice versa.*
- $H_{5A,\,B}$: *Banking sector development Granger-causes a macroeconomic variable and vice versa.*
- $H_{6A,\,B}$: *Stock market development Granger-causes a macroeconomic variable and vice versa.*

Fig. 1 summarizes the proposed hypotheses, which describes the direction of possible causality among these aforementioned variables.

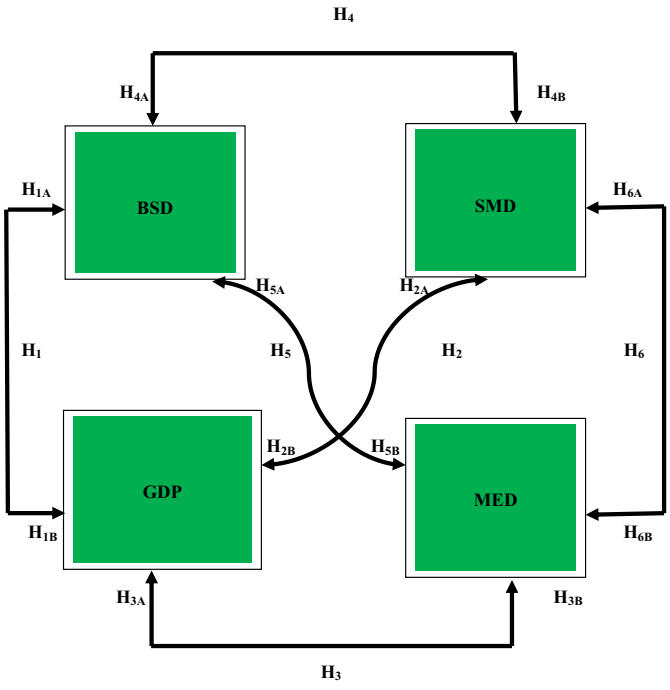

Fig. 1. The conceptual framework of the possible patterns of causality between the variables. *Note 1*: GDP is per capita economic growth rate; BSD is banking sector development; SMD is stock market development, and MED is macroeconomic development comprised of four macroeconomic variables: FDI, OPE, INF, and GCE. *Note 2*: FDI: foreign direct investment; OPE: trade openness; INF: inflation rate; and GCE: government consumption expenditure. *Note 3*: $H_{1A,\,B}$: Banking sector development Granger-causes economic growth and vice versa. $H_{2A,\,B}$: Stock market development Granger-causes economic growth and vice versa. $H_{3A,\,B}$: A macroeconomic determinant Granger-causes economic growth and vice versa. $H_{4A,\,B}$: Banking sector development Granger-causes stock market development and vice versa. $H_{5A,\,B}$: Banking sector development Granger-causes a macroeconomic determinant and vice versa. $H_{6A,\,B}$: Stock market development Granger-causes a macroeconomic determinant and vice versa. *Note 4*: All variables are defined in Tables 3–5.

Table 3
Definition of variables used in defining banking sector development.

Variable	Definition
BSD	*Composite index of banking sector development*: This utilizes four banking sector indicators: BRM, CPS, DCB, and DCP.
BRM	*Broad money supply*: Broad money supply, 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.
CPS	*Claims on private sectors*: Credit (expressed as a percentage of gross domestic product) refers to gross credit from the financial system to the private sector. It isolates credit issues to the private sector, as opposed to credit issued to government, government agencies, and public enterprises.
DCB	*Domestic credit provided by the banking sector*: It includes all credit to various sectors on a gross basis, with the exception of credit to the central government. It is expressed as a percentage of gross domestic product.
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, trade credits and other accounts receivable that establish a claim for payment.

Note 1: All monetary measures are in real US dollars.
Note 2: All variables above are defined in the *World Development Indicators* and published by the World Bank.
Note 3: We use the natural log of these variables in our estimation.

4. Data structure, sample selection, and variables

Our analysis utilizes annual time series data over the period of 1961–2012. The data are abstracted and transformed from two main sources: (i) *World Development Indicators*, published by the World Bank and (ii) *World Investment Reports*, published by the United Nations. We consider four samples of countries. The countries considered comprise the ARF-26 — a group of countries that have not been studied in this literature.[3] Our first broad sample consists of the ten countries among the ARF-26 that are recognized as ARF-Member Countries (AMC), which includes Brunei, Burma, Cambodia, Indonesia, Laos, Malaysia, Philippines, Singapore, Thailand, and Vietnam. The second broad sample consists of the nine countries among the ARF-26 that are recognized as ARF-Dialogue Partner Countries (ADC)[4] which includes Australia, Canada, China, India, Japan, New Zealand, the Korean Republic, the Russian Federation, and the United States. The third broad sample consists of the six countries among the ARF-26 that are recognized as ARF-Observer Countries (AOC), which includes Papua New Guinea, Mongolia, Pakistan, East Timor, Bangladesh, and Sri Lanka. The fourth sample consists of all 26 countries (ATC) that were included in AMC, ADC, and AOC.

The variables used in the study are banking sector development (BSD), stock market development (SMD), per capita economic growth (GDP), and a set of four other macroeconomic variables (MED), namely foreign direct investment (FDI), trade openness (OPE), inflation rate (INF), and government consumption expenditure (GCE).

Banking sector development 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 (Abu-Bader & Abu-Qarn, 2008; Banos, Crouzille, Nys, & Sauviat, 2011; Beck & Levine, 2004; Gregorio & Guidotti, 1995; Gries et al., 2009; Levine & Zervos, 1998; Liang & Teng, 2006; Naceur & Ghazouani, 2007; Pradhan, Dasgupta et al., 2013; Rousseau & Wachtel, 1998). Accordingly, the present study employs four commonly-used measures of banking sector development, namely broad money supply (BRM), claims on private sector (CLM), domestic credit provided by the banking sector (DCB), and domestic credit to the private sector (DCP).

Similarly, stock market development is defined as a process of improvements in the quantity, quality and efficiency of stock market services. It also involves the interaction of many activities and cannot be captured by a single measure (Caporale et al., 2004; Cheng, 2012; Cooray, 2010; Darrat et al., 2006; Hou & Cheng, 2010; Kar et al., 2011; Kolapo & Adaramola, 2012; Pradhan, Arvin et al., 2013; Rousseau, 2009; Rousseau & Wachtel, 1998; Rousseau & Xiao, 2007; Wongbangpo & Sharma, 2002; Zhu et al., 2004). The present study deploys four commonly-used measures of stock market development, namely market capitalization (MAC), traded stocks (TRA), turnover ratio (TUR), and the number of listed companies (NLC).

We use the composite indicators for both BSD and SMD by using the financial indicators above and through principal component analysis (see Appendix A for a detailed discussion). These variables are summarized in Tables 3–5.

The descriptive statistics of the panel data used in this study and the correlation between the variables are summarized in Tables 6 and 7, respectively.

5. Analytical framework and estimation procedure

The following empirical model describes the relationship between economic growth, banking sector development, stock market development, and the four other macroeconomic variables:

$$GDP = f\{BSD,\ SMD,\ FDI,\ OPE,\ INF,\ GCE\}. \quad (1)$$

Of course, GDP is not always the dependent variable. The structural framework of all possible causal relationships is shown in Fig. 2, which entertains the possibility that the direction of causation between the

Table 4
Definition of variables used in defining stock market development.

Variable	Definition
SMD	*Composite index of stock market development*: This utilizes four stock market indicators: MAC, TRA, TUR, and NLC.
MAC	*Market capitalization*: Percentage change in the market capitalization of the listed companies.
TRA	*Traded stocks*: Percentage change in the total value of traded stocks.
TUR	*Turnover ratio*: Percentage change in the turnover ratio in the stock market.
NLC	*Number of listed companies*: It is an additional measure of stock market size and is measured as a percentage of gross domestic product.

Note 1: All monetary measures are in real US dollars.
Note 2: All variables above are defined in the *World Development Indicators* and published by the World Bank.
Note 3: We use the natural log of these variables in our estimation.

[3] The 26 ARF (ASEAN Regional Forum) countries include 25 member nations plus the European Union, which is represented by the President of the European Council and by the European Central Bank. The member countries are: Brunei, Burma, Cambodia, Indonesia, Laos, Malaysia, Philippines, Singapore, Thailand, Vietnam, Australia, Canada, China, the European Union, India, Japan, New Zealand, the Korean Republic, the Russian Federation, the United Sates, Papua New Guinea, Mongolia, Pakistan, East Timor, Bangladesh and Sri Lanka.

[4] We observe only nine countries, which are used for our analysis. The European Union, the tenth member of this group, is excluded since it is not a country.

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Table 5
Definition of economic growth and our other four macroeconomic variables.

Variable	Definition
GDP	*Per capita economic growth rate*: The percentage change in per capita gross domestic product, used as our indicator of economic growth.
FDI	*Foreign Direct Investment (FDI) inflows*: This is expressed as a percentage of gross domestic product.
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.
INF	*Inflation rate*: Measured in percentage change by using the Consumer Price Index.
GCE	*Government final consumption expenditure*: Measured as a percentage of gross domestic product to capture the degree of government involvement in the economy.

Note 1: All monetary measures are in real US dollars.
Note 2: All variables above are defined in the *World Development Indicators* and published by the World Bank.
Note 3: We use the natural log of these variables in our estimation.
Note 4: The set of macroeconomic variables above (other than GDP) is denoted by MED in the text and in Figs. 1 and 2.

variables may proceed in one direction, or in both directions simultaneously.

Following the Holtz-Eakin, Newey, and Rosen (1988) and Arellano and Bond (1991) estimation procedure, we can establish the causal nexus between the variables by employing a vector error-correction model (VECM) of the form:

$$\begin{bmatrix} \Delta \ln GDP_{it} \\ \Delta \ln BSD_{it} \\ \Delta \ln SMD_{it} \\ \Delta \ln FDI_{it} \\ \Delta \ln OPE_{it} \\ \Delta \ln INF_{it} \\ \Delta \ln GCE_{it} \end{bmatrix} = \begin{bmatrix} \alpha_{1j} \\ \alpha_{2j} \\ \alpha_{3j} \\ \alpha_{4j} \\ \alpha_{5j} \\ \alpha_{6j} \\ \alpha_{7j} \end{bmatrix} + \sum_{k=1}^{q} \begin{bmatrix} \beta_{11ik}(L)\beta_{12ik}(L)\beta_{13ik}(L)\beta_{14ik}(L)\beta_{15ik}(L)\beta_{16ik}(L)\beta_{17ik}(L) \\ \beta_{21ik}(L)\beta_{22ik}(L)\beta_{23ik}(L)\beta_{24ik}(L)\beta_{25ik}(L)\beta_{26ik}(L)\beta_{27ik}(L) \\ \beta_{31ik}(L)\beta_{32ik}(L)\beta_{33ik}(L)\beta_{34ik}(L)\beta_{35ik}(L)\beta_{36ik}(L)\beta_{37ik}(L) \\ \beta_{41ik}(L)\beta_{42ik}(L)\beta_{43ik}(L)\beta_{44ik}(L)\beta_{45ik}(L)\beta_{46ik}(L)\beta_{47ik}(L) \\ \beta_{51ik}(L)\beta_{52ik}(L)\beta_{53ik}(L)\beta_{54ik}(L)\beta_{55ik}(L)\beta_{56ik}(L)\beta_{57ik}(L) \\ \beta_{61ik}(L)\beta_{62ik}(L)\beta_{63ik}(L)\beta_{64ik}(L)\beta_{65ik}(L)\beta_{66ik}(L)\beta_{67ik}(L) \\ \beta_{71ik}(L)\beta_{72ik}(L)\beta_{73ik}(L)\beta_{74ik}(L)\beta_{75ik}(L)\beta_{76ik}(L)\beta_{77ik}(L) \end{bmatrix} \begin{bmatrix} \Delta \ln GDP_{it-k} \\ \Delta \ln BSD_{it-k} \\ \Delta \ln SMD_{it-k} \\ \Delta \ln FDI_{it-k} \\ \Delta \ln OPE_{it-k} \\ \Delta \ln INF_{it-k} \\ \Delta \ln GCE_{it-k} \end{bmatrix} + \begin{bmatrix} \gamma_{1i} ECT_{it-1} \\ \gamma_{2i} ECT_{it-1} \\ \gamma_{3i} ECT_{it-1} \\ \gamma_{4i} ECT_{it-1} \\ \gamma_{5i} ECT_{it-1} \\ \gamma_{6i} ECT_{it-1} \\ \gamma_{7i} ECT_{it-1} \end{bmatrix} + \begin{bmatrix} \varepsilon_{1it} \\ \varepsilon_{2it} \\ \varepsilon_{3it} \\ \varepsilon_{4it} \\ \varepsilon_{5it} \\ \varepsilon_{6it} \\ \varepsilon_{7it} \end{bmatrix} \quad (2)$$

Table 6
Summary statistics on the variables.

Variable	Mean	Med	Max	Min	Std	Skew	Kur	JB	Pr
Panel 1: Member countries (AMC)									
BSD	0.28	0.32	0.57	−0.22	0.20	−0.48	1.99	9.90	0.01
SMD	0.04	0.06	0.58	−0.71	0.27	−0.34	2.60	3.16	0.21
GDP	1.25	1.28	1.44	−0.15	0.17	−5.34	40.0	76.0	0.00
FDI	0.95	0.90	1.52	0.35	0.21	0.68	3.76	12.3	0.00
OPE	2.11	2.10	2.66	1.66	0.29	0.27	2.00	6.69	0.04
INF	0.80	0.82	1.78	0.06	0.26	0.21	4.39	10.8	0.00
GCE	0.99	0.99	1.15	0.76	0.09	−0.67	2.98	9.18	0.01
Panel 2: Dialogue Partner Countries (ADC)									
BSD	0.16	0.19	0.63	−0.80	0.29	−0.72	3.39	18.1	0.00
SMD	0.01	0.01	0.62	−1.23	0.30	−0.70	4.11	25.6	0.00
GDP	1.25	1.25	1.46	0.86	0.10	−0.85	5.40	69.7	0.00
FDI	0.83	0.81	1.15	0.17	0.11	−0.48	7.56	17.5	0.00
OPE	1.62	1.65	2.04	1.17	0.21	−0.33	2.06	10.5	0.00
INF	0.73	0.69	2.30	−0.23	0.33	0.72	6.43	11.2	0.00
GCE	1.20	1.23	1.38	1.01	0.08	−0.39	2.34	8.46	0.01
Panel 3: Observer countries (AOC)									
BSD	0.40	0.44	0.68	−0.23	0.16	−1.28	5.28	46.3	0.00
SMD	−0.26	−0.33	0.61	−0.87	0.33	0.82	3.44	11.3	0.00
GDP	1.26	1.26	1.49	1.08	0.06	0.02	4.49	8.82	0.01
FDI	0.83	0.78	1.77	0.42	0.18	2.70	13.0	51.0	0.00
OPE	1.75	1.74	2.17	1.28	0.25	0.03	1.75	6.21	0.05
INF	0.99	1.00	1.69	0.46	0.22	0.14	3.97	4.06	0.13
GCE	0.98	1.02	1.25	0.62	0.19	−0.61	2.07	9.31	0.01
Panel 4: Total ARF Countries (ATC)									
BSD	0.08	0.11	0.64	−0.84	0.28	−0.16	2.41	7.80	0.02
SMD	−0.23	−0.17	0.66	−1.60	0.43	−0.56	2.90	21.7	0.00
GDP	1.25	1.25	1.49	−0.15	0.12	−5.01	4.79	36.3	0.00
FDI	0.86	0.82	1.77	0.17	0.17	1.37	7.52	47.9	0.00
OPE	1.80	1.77	2.66	1.17	0.32	0.52	3.00	18.3	0.00
INF	0.81	0.80	2.49	−0.23	0.31	0.57	6.14	22.5	0.00
GCE	1.09	1.10	1.38	0.62	0.16	−0.82	3.45	49.5	0.00

Note 1: Med: median; Max: maximum; Min: minimum; Std: standard deviation; Skew: skewness; Kur: kurtosis; JB: Jarque Bera statistics; Pr: probability.
Note 2: GDP is per capita economic growth rate; BSD is banking sector development index; SMD is stock market development index, FDI is foreign direct investment inflows; OPE is trade openness; INF is inflation rate; GCE is government consumption expenditure. Variables are defined more precisely under Tables 3–5.
Note 3: Values reported here are the natural logs of the variables. We use natural log forms in our estimation.
Note 4: *AMC* involves ten countries, namely Brunei, Burma, Cambodia, Indonesia, Laos, Malaysia, Philippines, Singapore, Thailand, and Vietnam; *ADC* involves nine countries, namely Australia, Canada, China, India, Japan, New Zealand, the Korean Republic, the Russian Federation and the United States; *AOC* involves six countries, namely Papua New Guinea, Mongolia, Pakistan, East Timor, Bangladesh, Sri Lanka; and *ATC* involves a total 25 ARF countries.

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Table 7
The correlation matrix.

Variable	BSD	SMD	GDP	FDI	OPE	INF	GCE
Panel 1: Member countries (AMC)							
BSD	**1.00**	0.67*	−0.05	0.46*	0.63*	−0.49**	0.37
SMD		**1.00**	0.06	0.55*	0.64*	−0.60*	0.50*
GDP			**1.00**	0.15	0.01	−0.25	0.06
FDI				**1.00**	0.81*	−0.42**	0.16
OPE					**1.00**	−0.58*	0.27
INF						**1.00**	−0.58*
GCE							**1.00**
Panel 2: Dialogue Partner Countries (ADC)							
BSD	**1.00**	0.50**	−0.15	0.01	−0.24	−0.77*	0.25
SMD		**1.00**	0.13	−0.06	−0.19	−0.40**	−0.25
GDP			**1.00**	0.19	0.15	0.09	−0.49**
FDI				**1.00**	0.35	0.06	0.17
OPE					**1.00**	0.17	0.21
INF						**1.00**	−0.23
GCE							**1.00**
Panel 3: Observer countries (AOC)							
BSD	**1.00**	0.35	0.36	0.16	−0.12	−0.10	−0.09
SMD		**1.00**	−0.01	0.06	−0.28	0.01	0.09
GDP			**1.00**	0.33	0.23	0.04	−0.02
FDI				**1.00**	0.47	0.15	0.40**
OPE					**1.00**	0.14	0.66*
INF						**1.00**	0.28
GCE							**1.00**
Panel 4: Total ARF Countries (ATC)							
BSD	**1.00**	0.66*	−0.03	0.18	0.02	−0.64*	0.39**
SMD		**1.00**	0.03	0.12	−0.03	−0.46**	0.36**
GDP			**1.00**	0.17	0.07	−0.12	−0.11
FDI				**1.00**	0.63*	−0.10	0.04
OPE					**1.00**	−0.01	−0.12
INF						**1.00**	−0.25
GCE							**1.00**

Note 1: GDP is per capita economic growth rate; BSD is banking sector development index; SMD is stock market development index, FDI is foreign direct investment inflows; OPE is trade openness; INF is inflation rate; GCE is government consumption expenditure. Variables are defined more precisely under Tables 3–5.
* Indicates significance at the 5% level.
** Indicates significance at the 10% level.

where Δ is the first difference filter (I–L); i = 1,...N; t = 1,... T; and ξ_j (j = 1,..., 7) are independently and normally distributed random variables for all i and t, with zero means and finite heterogeneous variances (σ_i^2). The ECTs are error-correction terms that represent the long-run dynamics, while differenced variables represent the short-run dynamics that exist between the variables. The above model is meaningful only if the time series variables are integrated of order one ($I(1)$)[5] and are cointegrated. If the variables are not cointegrated, the ECTs will be removed in the estimation process. We look for both short-run and long-run causal relationships. The short-run causal relationship is measured through F-statistics and the significance of the lagged changes in independent variables, whereas the long-run causal relationship is measured through the significance of the t-test of the lagged ECTs. However, the first procedure under VECM framework is to determine the unit root and the nature of cointegration among these seven variables.

6. Empirical results and discussion

6.1. Results from the panel unit root test

We begin our analysis with unit root test results for all the time series variables together with comments on their stationarity. The estimated results are presented in Table 8. The results reveal that all seven variables in this study [BSD, SMD, GDP, FDI, OPE, INF, and GCE] are non-stationary at their levels. However, all variables become stationary at their first differences. Therefore, we can conclude that the time series for all the variables is integrated of order one over the period 1961–2012. This is true for all four samples that we consider (AMC, ADC, AOC, and ATC).

6.2. Results from the panel co-integration test

After establishing the stationarity of the series by determining the order of integration, we use co-integration testing to determine if there is a long-run equilibrium relationship among these variables. While there are a number of tests available for use, we choose that of Pedroni (1999, 2004). The null hypothesis of no cointegration is examined, based on seven different test statistics (Pedroni, 2004), which includes four individual panel statistics [panel v-statistic, panel ρ-statistic, panel t-statistic (non-parametric) and panel t-statistic (parametric)] and three group statistics [group ρ-statistic, group t-statistic (non-parametric) and group t-statistic (parametric)]. A brief description of these test statistics is available in Appendix B.

Table 9 reports the results of the panel cointegration from the seven test statistics of Pedroni. It can be seen that, of seven test statistics, we found two that are significant at 1–5% levels. Hence, the null hypothesis of no cointegration can be rejected. It can therefore be concluded that these variables are cointegrated, indicating the presence of a long-run equilibrium relationship between banking sector development, stock market development, per capita economic growth, and the other four macroeconomic variables, namely FDI, OPE, INF, and GCE. This finding is true for all the individual regions we examined as well as for Asia as a whole (AMC, ADC, AOC, and ATC) over the period 1961–2012.

[5] That is, if they achieve stationarity after being differenced once.

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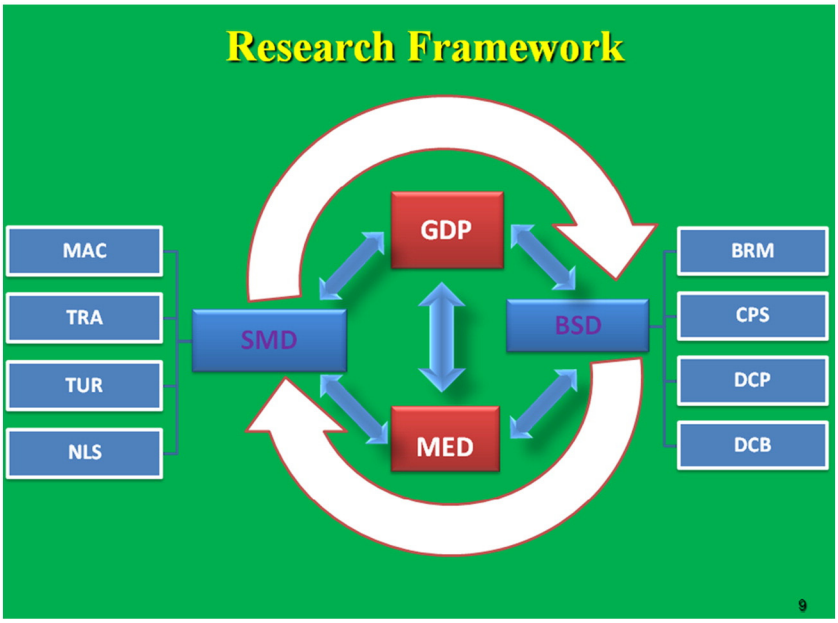

Fig. 2. The structural framework on the possible linkages between banking sector development, stock market development, economic growth, and four other macroeconomic variables. *Note 1*: BSD is the banking sector development index constructed from BRM, CPS, DCP, and DCB; SMD is the stock market development index constructed from MAC, TRA, TUR, and NLC; GDP is per capita economic growth; and MED is a set of four other macroeconomic variables: FDI (foreign direct investment), OPE (trade openness), INF (inflation rate), and GCE (government consumption expenditure). *Note 2*: All variables are defined in Tables 3–5.

6.3. Results from the panel Granger causality test

After establishing the status of unit root and cointegration, the next step is to check the direction of causality between them. The panel Granger causality test, based on panel VECM, is used to conduct the test. The above tests are performed via the Wald test. The results of the Granger causality tests for all the samples, are summarized in Table 10 and are presented below.

6.3.1. Long-run Granger causality results

The long-run results are ascertained through the statistical significance of the lagged error-correction term. From Table 10 one can see that when ΔGDP serves as the dependent variable, the lagged error-correction terms (ECTs) are statistically significant at the 1–5% levels. This implies that economic growth tends to converge to its long-run equilibrium path in response to changes in its regressors. The significance of the ECT_{-1} coefficient in the ΔGDP equation in each of the four panels confirm the existence of a long-run equilibrium between GDP and its determinants, namely banking sector development, stock market development, foreign direct investment, openness to trade, inflation rate, and government consumption expenditure. In other words, we can generally conclude that banking sector development, stock market development, foreign direct investment, openness to trade, inflation rate and government consumption expenditure Granger-cause economic growth in the long run. This is true for all four samples that we consider (AMC, ADC, AOC, and ATC) over the period 1961–2012. Therefore, the overall conclusion is that economic growth is key in ARF countries and largely influenced by financial development, both stock market and banking sector development, and the other four macroeconomic variables we consider. In addition to this, we also have other long-run Granger causal relationships between these variables. For ARF Member Countries (AMC), when ΔBSD serves as the dependent variable, the lagged error-correction term is statistically significant at the 1% level. This indicates that economic growth, stock market development, foreign direct investment, openness to trade, inflation rate and government consumption expenditure Granger-cause banking sector development in the long run. The long-run Granger causal relationships also exist in other cases when ΔFDI, ΔOPE, and ΔGCF take turns to serve as the dependent variable.

For the ARF Dialogue Partner Countries (ADC), when ΔOPE and ΔINF serve as the dependent variables, the lagged ECTs are statistically significant at the 1–5% levels. This indicates that there are long-run Granger causal relationships when openness to trade or inflation serves as the dependent variable.

For ARF Observer Countries (AOC), when ΔFDI serves as the dependent variable, the lagged error-correction term is statistically significant at the 1% level. This indicates that economic growth, stock market development, banking sector development, openness to trade, inflation rate, and government consumption expenditure Granger-cause foreign direct investment in the long run.

For Total ARF Countries (ATC), when ΔOPE serves as the dependent variable, ECT_{-1} is statistically significant at the 5% level. This indicates that economic growth, stock market development, banking sector development, foreign direct investment, inflation rate, and government consumption expenditure Granger-cause openness to trade in the long-run.

6.3.2. Short-run Granger causality results

In contrast to the long-run Granger causality results, our study reveals a larger spectrum of short-run causality results between our sets of variables. These results are summarized in Table 11 and are presented below.

For ARF Member Countries (AMC), we find the existence of bidirectional causality between economic growth and trade openness [GDP <=> OPE], economic growth and foreign direct investment [GDP <=> FDI], and between economic growth and government consumption expenditure [GDP <=> GCE]. Moreover, we find unidirectional causality from banking sector development to stock market development [BSD => SMD], banking sector development to government consumption expenditure [BSD => GCE], stock market development to government consumption expenditure [SMD => GCE], economic growth to trade openness [GDP => OPE], foreign direct investment to trade openness [FDI => OPE], inflation to foreign direct

Table 8
Results from panel unit root test.

Variable	BSD	SMD	GDP	FDI	OPE	INF	GCE
Panel 1: Member countries (AMC)							
Case 1: Level data							
LLC	1.07	−1.83	−0.96	−0.38	1.42	−1.20	1.45
ADF	11.1	21.7	8.04	5.70	2.87	8.80	4.09
PP	12.7	24.1	10.4	4.59	1.96	8.36	4.17
Case 2: First differenced data							
LLC	−8.56*	−8.51*	−12.9*	−9.01*	−7.68*	−13.5*	−6.27*
ADF	77.3*	75.5*	122*	85.2*	71.1*	126*	50.2**
PP	121*	134*	132*	138*	104*	172*	92.5*
Panel 2: Dialogue Partner Countries (ADC)							
Case 1: Level data							
LLC	1.75	−2.34	−0.63	−0.05	2.72	−1.68	0.98
ADF	12.0	36.9	9.22	9.27	2.91	27.1	8.24
PP	14.9	31.1	12.4	7.20	2.11	27.9	8.10
Case 2: First differenced data							
LLC	−5.58*	−9.59*	−14.0*	−11.1	−7.26*	−12.4*	−8.48*
ADF	60.8**	110*	171*	133.2	82.3*	147*	93.9*
PP	107*	179*	232*	173.6	144*	219*	102*
Panel 3: Observer countries (AOC)							
Case 1: Level data							
LLC	0.87	−1.39	1.93	0.80	0.52	−0.87	−0.24
ADF	2.83	14.9	1.94	4.61	5.00	8.87	13.3
PP	2.84	19.3	1.14	3.54	3.69	8.12	22.6
Case 2: First differenced data							
LLC	−6.14*	−5.91*	−9.30*	−6.20*	−5.33*	−9.77*	−5.99*
ADF	48.7*	44.1*	79.1*	51.9**	41.1**	81.5*	45.5**
PP	78.9*	74.6*	105*	82.3*	64.5**	115*	77.8*
Panel 4: Total ARF Countries (ATC)							
Case 1: Level data							
LLC	1.54	0.29	0.81	0.31	2.91	−1.88	1.37
ADF	46.2	40.0	19.2	19.6	10.8	44.7	25.6
PP	35.2	41.9	23.9	15.3	7.76	44.4	34.9
Case 2: First differenced data							
LLC	−12.2*	−7.64*	−21.0*	−15.5*	−11.6*	−20.1*	−11.9*
ADF	202*	127*	372*	270*	194*	354*	190*
PP	327*	300*	469*	393*	312*	506*	273*

Note 1: GDP is per capita economic growth rate; BSD is banking sector development index; SMD is stock market development index, FDI is foreign direct investment inflows; OPE is trade openness; INF is inflation rate; GCE is gross consumption expenditure. Variables are defined more precisely under Tables 3–5.
Note 2: LLC: Levine–Lin–Chu statistics; ADF: Augmented Dickey Fuller statistics; PP: Phillips Perron statistics.
Note 3: The null hypothesis is that the variable follows a unit root process.
Note 4: Methods used: Levine et al. (2002); Maddala and Wu (1999).
** Indicates significance at the 1% level.
* Indicates significance at the 5% level.

investment [INF => FDI], government consumption expenditure to foreign direct investment [GCE => FDI], inflation to trade openness [INF => OPE], government consumption expenditure to trade openness [GCE => OPE], and from inflation to government consumption expenditure [INF => GCE].

For ARF Dialogue Partner Countries (ADC), we uncover bidirectional causality between banking sector development and government consumption expenditure [BSD <=> GCE], stock market development and economic growth [SMD <=> GDP], trade openness and stock market development [OPE <=> SMD], inflation and stock market development [INF <=> SMD], and between trade openness and government consumption expenditure [OPE <=> GCE]. In addition, we find unidirectional causality from banking sector development to foreign direct investment [BSD => FDI], banking sector development to inflation [BSD => INF], stock market development to government consumption expenditure [SMD => GCE], foreign direct investment to economic growth [FDI => GDP], economic growth to both trade openness and inflation [GDP => OPE; GDP => INF], government consumption expenditure to both economic growth and inflation [GCE => GDP; GCE => INF], trade openness to foreign direct investment [OPE => FDI], and inflation to trade openness [INF => OPE].

For ARF Observer Countries (AOC), we find the existence of bidirectional causality between economic growth and trade openness [GDP <=> OPE], banking sector development and inflation [BSD <=> INF], and stock market development and foreign direct investment [SMD <=> FDI]. Moreover, we find unidirectional causality from banking sector development to stock market development [BSD => SMD], banking sector development to economic growth [BSD => GDP], foreign direct investment to banking sector development [FDI => BSD], banking sector development to government consumption expenditure [BSD => GCE], stock market development to economic growth [SMD => GDP], trade openness to stock market development [OPE => SMD], stock market development to government consumption expenditure [SMD => GCE], government consumption expenditure to economic growth, trade openness, and inflation [GCE => GDP; GCE => OPE; GCE => INF], trade openness to foreign direct investment [OPE => FDI], and foreign direct investment to government consumption expenditure [FDI => GCE].

For ARF Total Countries (ATC), we discover the existence of bidirectional causality between inflation and banking sector development [INF <=> BSD], trade openness and stock market development [OPE <=> SMD], economic growth and trade openness [GDP <=> OPE], trade openness and foreign direct investment [OPE <=> FDI], and between trade openness and government consumption expenditure [OPE <=> GCE]. Furthermore, we find unidirectional causality from banking sector development to stock market development [BSD => SMD], banking sector development to government consumption expenditure [BSD => GCE], trade openness to banking

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Table 9
Results of Pedroni panel cointegration test.

Test statistics	No intercept & no trend		Deterministic intercept only		Deterministic intercept & trend	
Panel A: Member countries (AMC)						
Panel v-statistics	−0.30	[0.62]	−0.55	[0.70]	−0.74	[0.77]
Panel ρ-statistics	−0.06	[0.48]	−0.12	[0.45]	1.00	[0.84]
Panel PP-statistics	−4.42*	[0.00]	−4.98*	[0.00]	−3.68*	[0.00]
Panel ADF-statistics	−1.40	[0.08]	−1.11	[0.13]	−0.52	[0.30]
Group ρ-statistics	−1.28	[0.89]	1.17	[0.88]	2.33	[0.99]
Group PP-Statistics	−3.20*	[0.00]	−3.86*	[0.00]	−2.24*	[0.01]
Group ADF-statistics	−0.58	[0.20]	0.18	[0.42]	0.38	[0.64]
Inference: cointegrated						
Panel B: Dialogue Partner Countries (ADC)						
Panel v-statistics	−0.97	[0.83]	−1.41	[0.92]	1.44	[0.07]
Panel ρ-statistics	1.76	[0.96]	2.60	[0.99]	4.29	[1.00]
Panel PP-statistics	−3.30*	[0.00]	−1.87*	[0.01]	−2.80*	[0.00]
Panel ADF-statistics	2.52	[0.99]	3.42	[0.99]	0.97	[0.83]
Group ρ-Statistics	3.42	[0.99]	3.87	[0.99]	5.13	[1.00]
Group PP-statistics	−1.39**	[0.02]	−1.80	[0.01]	−3.26	[0.01]
Group ADF-statistics	3.70	[0.99]	4.34	[1.00]	3.85	[0.99]
Inference: cointegrated						
Panel C: Observer Countries (AOC)						
Panel v-statistics	−0.94	[0.83]	−1.02	[0.84]	0.57	[0.29]
Panel ρ-statistics	0.49	[0.69]	1.12	[0.87]	1.11	[0.87]
Panel PP-statistics	−1.89**	[0.03]	−1.17	[0.12]	−5.52*	[0.00]
Panel ADF-statistics	2.24	[0.99]	3.26	[0.99]	0.14	[0.55]
Group ρ-statistics	1.61	[0.25]	2.43	[0.99]	2.47	[0.99]
Group PP-statistics	−2.83*	[0.00]	−2.34*	[0.00]	−6.71*	[0.00]
Group ADF-statistics	2.42	[0.99]	1.89	[0.97]	−1.03	[0.15]
Inference: cointegrated						
Panel D: Total ARF Countries (ATC)						
Panel v-statistics	−1.97	[0.98]	−2.16	[0.98]	−0.09	[0.53]
Panel ρ-statistics	1.32	[0.91]	2.23	[0.99]	3.24	[0.99]
Panel PP-statistics	−3.16*	[0.00]	−2.23*	[0.01]	−6.55*	[0.00]
Panel ADF-statistics	2.80	[0.99]	3.99	[1.00]	−0.12	[0.45]
Group ρ-statistics	3.85	[0.99]	4.57	[1.00]	5.63	[1.00]
Group PP-statistics	−1.85**	[0.03]	−1.28**	[0.03]	−4.24*	[0.00]
Group ADF-statistics	3.86	[099]	4.24	[1.00]	1.92	[0.97]
Inference: cointegrated						

Note 1: Variables and regions shown above are defined in the text. Natural log forms are used in our estimation.
Note 2: The null hypothesis is that the variables are not cointegrated.
Note 3: Figures in square brackets are probability levels indicating significance.
Note 4: ADF: Augmented Dickey Fuller statistics; PP: Phillips Perron statistics; the other statistics are defined in Pedroni (1999, 2004).
* Indicates significance at the 1% level.
** Indicates significance at the 5% level.

sector development [OPE => BSD], stock market development to economic growth, inflation, and government consumption expenditure [SMD => GDP; SMD => INF; SMD => GCE], foreign direct investment to economic growth [FDI => GDP], government consumption expenditure to both foreign direct investment and inflation [GCE => FDI; GCE => INF], and inflation to trade openness [INF => OPE].

6.3.3. Discussions and insights

It should be clear that unlike much of the earlier literature, we make a clear distinction between the short-run and the long-run causal relationships. The long-run causal results depict the causal link between the variables in the long-run, whereas short-run causal results describe the adjustment dynamics between the variables in the short-run.

We found uniform and robust results for the long-run equilibrium relationship among the variables, when economic growth serves as the dependent variable. Thus, evidently, for the sake of stimulating long-run economic growth, banking sector development, stock market development, foreign direct investment, and openness to trade should be encouraged in the ARF countries.

For short-run causal relationships, we find remarkable variations in results which are nonetheless congruent with earlier work in the different strands of this literature. We highlight some of these short-run results below.

Firstly, our result that banking sector development Granger causes economic growth, lends support to the "*supply-leading hypothesis (SLH)*". This result appears in two of our samples (ADC and AOC) and is consistent with the findings of Menyah et al. (2014), Pradhan, Arvin, Norman and Nishigaki (2014), Pradhan, Arvin et al. (2013), Hsueh et al. (2013), Bojanic (2012), Chaiechi (2012), Akinlo and Akinlo (2009), Nowbutsing (1999), Tsouma (2009), Enisan and Olufisayo (2009), Colombage (2009), Deb and Mukherjee (2008), Shahbaz, Ahmed, and Ali (2008), Nieuwerburgh et al. (2006), and Levine and Zervos (1998).

Secondly, our result that stock market development Granger causes economic growth, lending support to the "*supply-leading hypothesis (SLH)*", appears in all four samples of our study and is consistent with the findings of Pradhan, Arvin et al. (2013), Kolapo and Adaramola (2012), Tsouma (2009), Enisan and Olufisayo (2009), Colombage (2009), Deb and Mukherjee (2008), and Nieuwerburgh et al. (2006).

Thirdly, our findings that macroeconomic determinants (FDI and GCE) Granger cause economic growth, lend support to the "*supply-leading hypothesis (SLH)*" view. These results hold true in all four samples and are consistent with the findings of Pradhan, Arvin, Norman and Hall (2014), Abdelhafidh (2013), Lean and Tan (2011), Tang and Wang (2011), Lee (2010), and Zhang (2001).

Fourthly, we find banking sector development and stock market development Granger cause each other, which supports the prevalence of

Table 10
Granger causality test results.

Dependent variable	Independent variables							Lagged ECT
	ΔBSD	ΔSMD	ΔGDP	ΔFDI	ΔOPE	ΔINF	ΔGCE	ECT_{-1}
Panel 1: Member countries (AMC)								
ΔBSD	————	0.93	1.09	2.53	11.0*	0.85	0.20	−3.21*
ΔSMD	8.98*	————	1.97	0.46	1.55	0.52	1.53	−0.68
ΔGDP	2.25	4.58*	————	3.87**	0.79	0.87	4.10*	−3.38*
ΔFDI	2.43	2.61	3.34*	————	2.65	3.39**	3.87**	−2.47**
ΔOPE	4.41*	1.10	6.57*	3.86**	————	5.72*	4.92*	−2.47**
ΔINF	0.66	0.97	1.55	1.37	0.55	————	4.02*	−1.96
ΔGCE	6.56*	3.49**	11.6*	3.36**	3.39**	12.7*	————	−2.92**
Panel 2: Dialogue Partner Countries (ADC)								
ΔBSD	————	1.26	0.92	3.60**	2.41	1.70	13.3*	0.59
ΔSMD	5.02*	————	5.72*	2.59	14.6*	7.12*	2.12	1.42
ΔGDP	3.53**	6.29*	————	4.38*	2.17	0.22	7.86*	−3.93*
ΔFDI	4.03*	2.77	0.86	————	5.82*	2.36	0.30	1.47
ΔOPE	2.46	7.43*	3.34**	1.51	————	4.64*	14.7*	−2.86**
ΔINF	5.65*	3.20**	18.2*	1.96	1.05	————	3.82**	−3.37*
ΔGCE	6.09*	7.19*	2.78	0.56	6.05*	1.74	————	0.17
Panel 3: Observer countries (AOC)								
ΔBSD	————	0.60	0.73	2.95	2.35	8.63*	0.51	−0.01
ΔSMD	4.75*	————	0.52	10.3*	8.99*	0.65	0.12	2.29
ΔGDP	15.3*	5.39*	————	2.55	6.31*	2.22	8.65*	−2.73**
ΔFDI	1.46	10.1*	2.74	————	10.7*	1.87	0.95	−3.94*
ΔOPE	0.84	0.64	3.72**	1.06	————	4.22*	3.40**	−0.57
ΔINF	5.73*	1.27	2.59	1.84	0.77	————	4.25*	0.56
ΔGCE	3.65**	5.89*	1.75	3.49**	2.50	0.90	————	0.07
Panel 4: Total ARF Countries (ATC)								
ΔBSD	————	2.73	1.06	2.29	6.24*	4.54*	0.45	−1.55
ΔSMD	8.94*	————	2.01	0.02	1.66	0.42	0.82	−0.24
ΔGDP	0.79	10.7*	————	7.26*	3.48**	1.48	1.45	−7.51*
ΔFDI	2.93	2.43	2.76	————	3.78**	0.43	3.48**	−1.19
ΔOPE	7.02*	4.59**	12.4*	1.53	————	22.5*	14.9*	−2.71**
ΔINF	13.2*	4.76**	2.71	2.00	1.81	————	3.38**	−2.01
ΔGCE	6.44*	6.13*	1.77	1.43	3.51**	1.32	————	−0.46

Note 1: GDP is per capita economic growth rate; BSD is banking sector development index; SMD is stock market development index, FDI is foreign direct investment inflows; OPE is trade openness; INF is inflation rate; GCE is government consumption expenditure; ECT_{-1} is lagged error-correction term.
Note 2: The study uses Akaike information criterion (AIC) and Schwarz information criterion (SIC) to determine the optimum lag length. Like the standard information criteria, a smaller SIC (or AIC) indicates a better fit of the model to data.
Note 3: * and ** indicate that the parameter estimates are significant at the 1% and 5% levels, respectively.

the feedback hypothesis (FBH). This is true for all four samples in our study and is consistent with the earlier findings of Pradhan, Arvin, Norman and Hall (2014), Cheng (2012), Hou and Cheng (2010), Beck and Levine (2004), and Levine and Zervos (1998).

In addition, there are cases where both banking sector development and stock market development Granger cause macroeconomic determinants and vice versa. For instance, in AMC, BSD Granger causes INF in most of our samples (see Table 11). This supports the findings of Rashid (2008), Darrat et al. (2006), Bilson et al. (2001), and Garcia and Liu (1999).

6.3.4. Results from generalized impulse response functions

The Holtz-Eakin et al. (1988) and Arellano and Bond (1991) estimation procedure is one way of checking the Granger causality among the variables used in the present study. However, this estimation procedure does not provide much information on how each variable responds to innovations in other variables, or whether the shock is permanent or not. This shortcoming can be overcome by using the generalized impulse response function (GIRF) as in Koop, Pesaran, and Potter (1996) and Pesaran and Shin (1998). The GIRF has an advantage in that it is insensitive to the ordering of the variables in the VAR system. The GIRF approach overcomes the originality problem inherent in traditional out-of-sample Granger causality tests. The results of the Granger causality test do not suggest that an unexpected change, i.e. shock, does not affect the changes in financial development. Therefore, the GRIF is used to discover which variable takes precedence over the other. That means that the GIRF indicates how persistent and strong these effects are, therefore to trace the effect of a one-off shock to one of the innovations on the current and future values of the endogenous variables. In this context, the mutual impacts of banking sector development, stock market development, a set of macroeconomic variables (FDI, OPE, INF and GCE), and economic growth are presented in Figs. 3–6. The GIRFs[6] are plotted out to 10 periods after the shocks.

While the years after the impulse shocks are shown on the horizontal axis, the vertical axis measures the magnitude of the response, scaled in such a way that 1.0 equals 1 standard deviation. The significance is determined by the use of confidence intervals representing ± 2 standard deviation (Runkle, 1987). A Monte Carlo simulation with 1000 replications is used to obtain the error brands. At points where the confidence brands do not straddle the line at zero, the impulse response is considered to be statistically different from zero at the 5% level of significance or less ($p \leq 0$). Figs. 3–6 reflect that an unexpected positive change (i.e., shock) in economic growth has a positive and significant initial impact effect on own economic growth. This effect then diminishes over the

[6] Before using the results of generalized impulse responses, the procedure is to perform the log-likelihood ratio (LR) test to determine whether the shocks are contemporaneously correlated in the individual equations that make up the VAR. This suggests that the assumption that all off-diagonal elements in the covariance matrix are zero is strongly rejected, and we hence use the GIRFs in our analysis (see, for instance, Lee, Huang, & Yin, 2013).

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Table 11
The summary of short-run Granger causality.

Causal relationships tested in the model	Direction of relationships observed in ARF Member Countries	Direction of relationships observed in ARF Dialogue Partner Countries	Direction of Relationships Observed in ARF Observer Countries	Direction of relationships observed in all ARF Countries
BSD vs. SMD	BSD => SMD	BSD => SMD	BSD => SMD	BSD => SMD
BSD vs. GDP	NA	BSD => GDP	BSD => GDP	NA
BSD vs. FDI	NA	BSD <=> FDI	NA	NA
BSD vs. OPE	BSD <=> OPE	NA	NA	BSD <=> OPE
BSD vs. INF	NA	BSD => INF	BSD <=> INF	BSD <=> INF
BSD vs. GCE	BSD => GCE	BSD <=> GCE	BSD => GCE	BSD => GCE
SMD vs. GDP	SMD => GDP	SMD <=> GDP	SMD => GDP	SMD => GDP
SMD vs. FDI	NA	NA	FDI <=> SMD	NA
SMD vs. OPE	NA	SMD <=> OPE	SMD => OPE	SMD => OPE
SMD vs. INF	NA	SMD <=> INF	NA	SMD => INF
SMD vs. GCE	SMD => GCE	SMD <=> GCE	SMD => GCE	SMD => GCE
GDP vs. FDI	GDP <=> FDI	FDI => GDP	NA	FDI => GDP
GDP vs. OPE	GDP => OPE	GDP => OPE	GDP <=> OPE	GDP <=> OPE
GDP vs. INF	NA	GDP => INF	NA	NA
GDP vs. GCE	GDP <=> GCE	GCE => GDP	GCE => GDP	NA
FDI vs. OPE	FDI => OPE	OPE => FDI	OPE => FDI	OPE => FDI
FDI vs. INF	INF => FDI	NA	NA	NA
FDI vs. GCE	FDI <=> GCE	NA	FDI => GCE	GCE => FDI
OPE vs. INF	INF => OPE	INF => OPE	INF => OPE	INF => OPE
OPE vs. GCE	GCE <=> OPE	GCE <=> OPE	GCE => OPE	GCE <=> OPE
INF vs. GCE	INF <=> GCE	GCE => INF	GCE => INF	GCE => INF

Note 1: GDP is per capita economic growth rate; BSD is banking sector development index; SMD is stock market development index, FDI is foreign direct investment inflows; OPE is trade openness; INF is inflation rate; GCE is government consumption expenditure. Variables are defined under Tables 3–5.
Note 2: X => Y means variable X Granger causes Variable Y; and X <=> Y means both variables Granger cause each other; NA: No causality between the two variables.

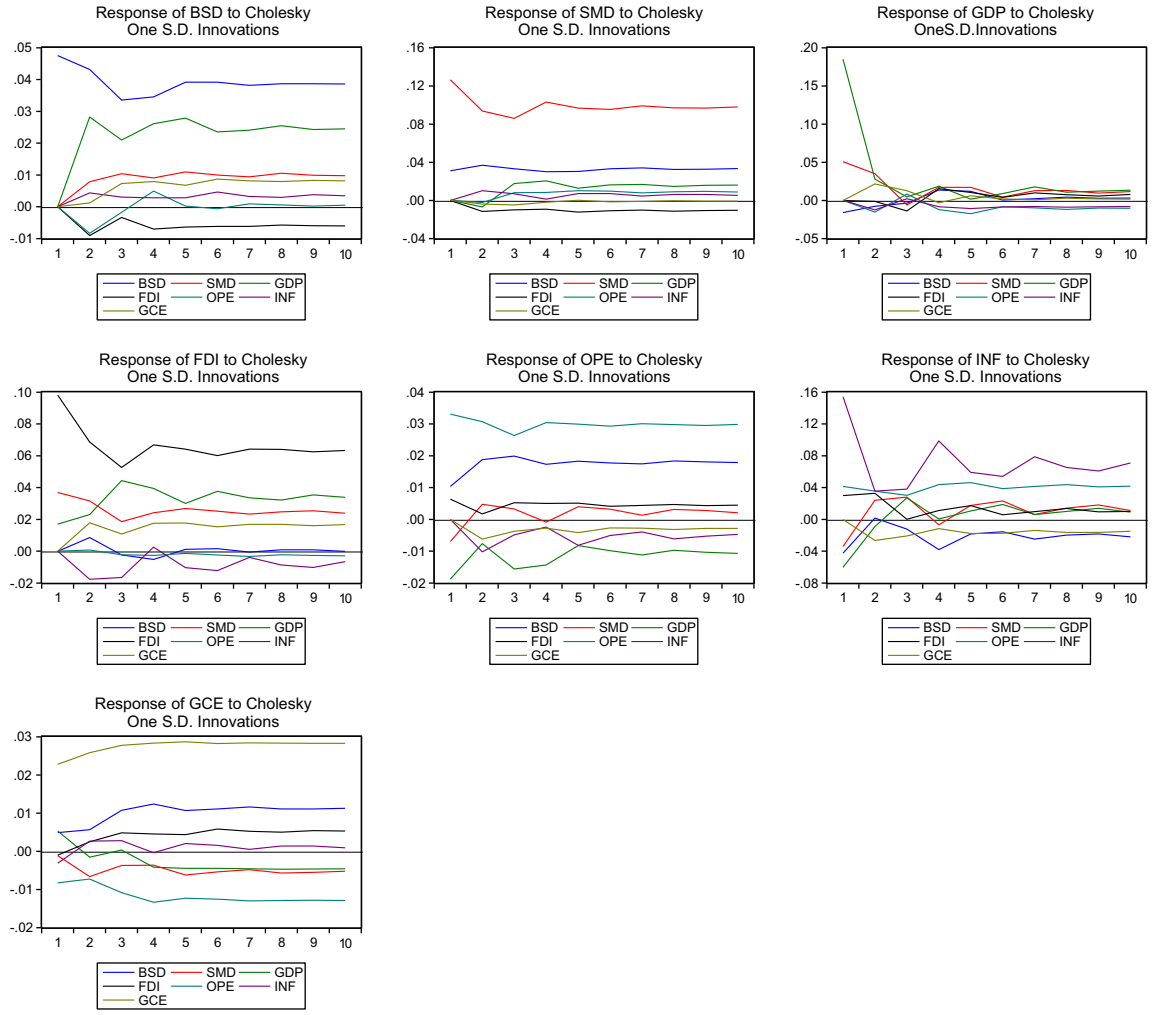

Fig. 3. Granger causal relations between the variables in ARF Member Countries. *Note 1*: GDP is per capita economic growth rate; BSD is banking sector development index; SMD is stock market development index, FDI is foreign direct investment inflows; OPE is trade openness; INF is inflation rate; and GCE is government consumption expenditure. *Note 2*: ARF Member Countries comprise the pool of ten countries, namely Brunei, Burma, Cambodia, Indonesia, Laos, Malaysia, Philippines, Singapore, Thailand, and Vietnam.

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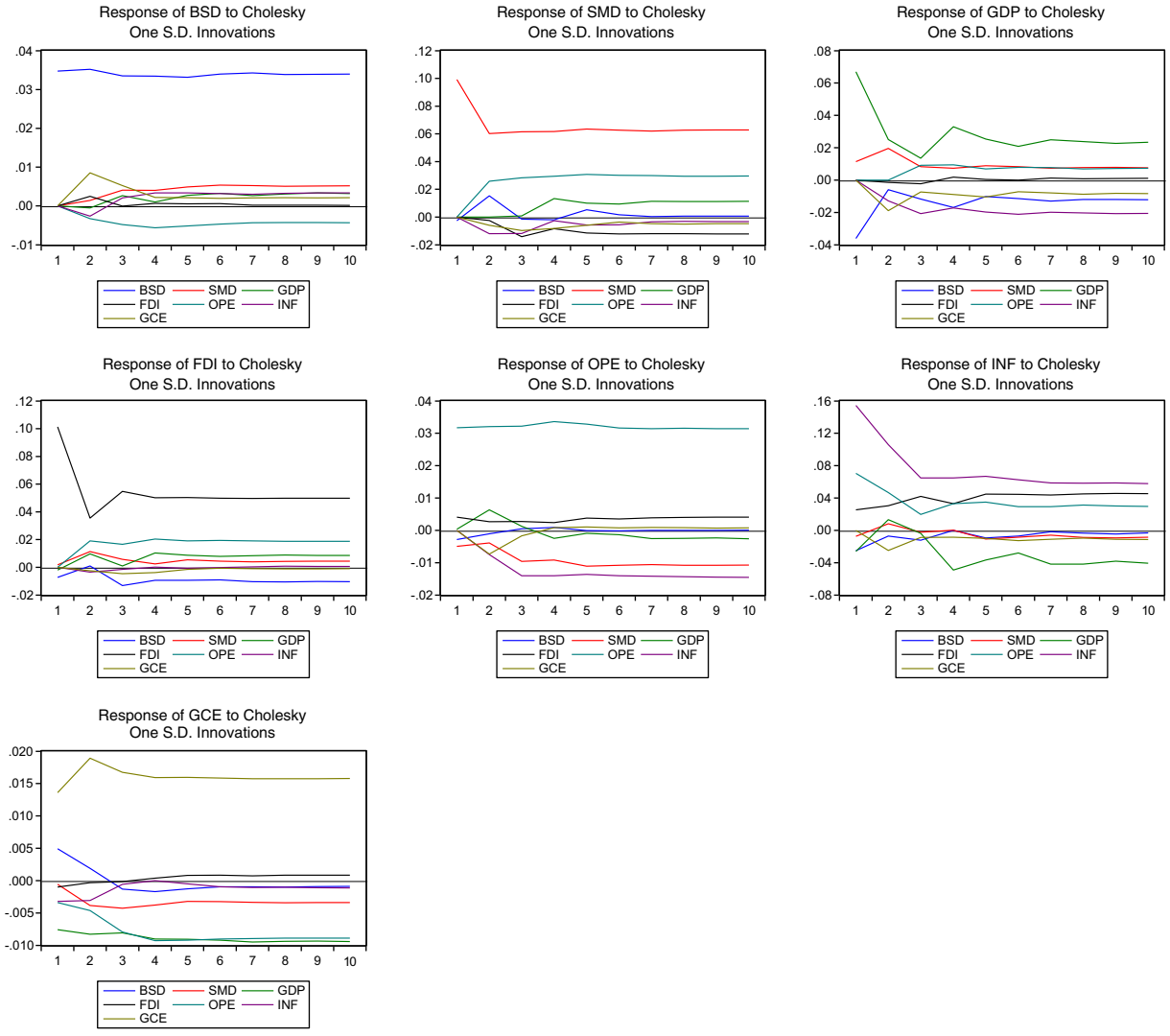

Fig. 4. Granger causal relations between the variables in ARF Dialogue Partner Countries. *Note 1*: GDP is per capita economic growth rate; BSD is banking sector development index; SMD is stock market development index, FDI is foreign direct investment inflows; OPE is trade openness; INF is inflation rate; and GCE is government consumption expenditure. *Note 2*: ARF Dialogue Partner Countries comprise of the pool of nine countries, namely Australia, Canada, China, India, Japan, New Zealand, the Korean Republic, the Russian Federation, and the United States.

next period and becomes negative over a horizon of the next two periods after the shock at which economic growth returns to steady state or equilibrium. This 'own' effect to a shock is consistent with the cycling process often found in banking sector development, stock market development, and other macroeconomic determinants. In fact, a shock to both banking sector development and stock market development are positive and significant after two periods before the effects of the shock completely wear off. Therefore, both banking sector development and stock market development exhibit cycling behaviour and persistence to shocks.

An advantage of utilizing the impulse response analysis within a vector autoregressive framework is that it allows for the treatment of the responses to shocks, known as a 'cross effect'. Hence, GIRFs offer an additional support into how shocks to banking sector development and stock market development can affect and be affected by economic growth and other macroeconomic variables.

Meaningful GIRFs are considered as an out-of-sample Granger causality test, and hence, the discussions on the long-run Granger causality could be applied in this part as well. Since the shocks are both negative and positive events, the economic application for the planners are to rebalance their financial flows and macroeconomic determinants. For instance, if the government brings a sudden change to financial markets (say through money supply, market capitalization of traded stocks, or turnover ratio), based on our empirical results, then the change affects the economy in terms of banking sector development, stock market development, economic growth, and the other macroeconomic variables we consider, both in the short-run and long-run.

7. Conclusion and policy implications

Understanding the policy implications of the nexus between banking sector development, stock market development, economic growth, and other macroeconomic variables is of great importance in the field of development economics (Boulila & Trabelsi, 2004; Cheng, 2012). Still, much needs to be learned about the various connections among these four sets of variables. Earlier studies examine the causal link between two variables. In contrast, our study looks at the causal relationship between *all* the variables. That is, the causal link between two variables is considered *in the presence of the remaining variables*.

This study finds that banking sector development, stock market development, economic growth, and four key macroeconomic variables are cointegrated in the ARF countries. Importantly, we find that banking sector development and stock market development, as well as other macroeconomic variables, matter in the determination of long-run

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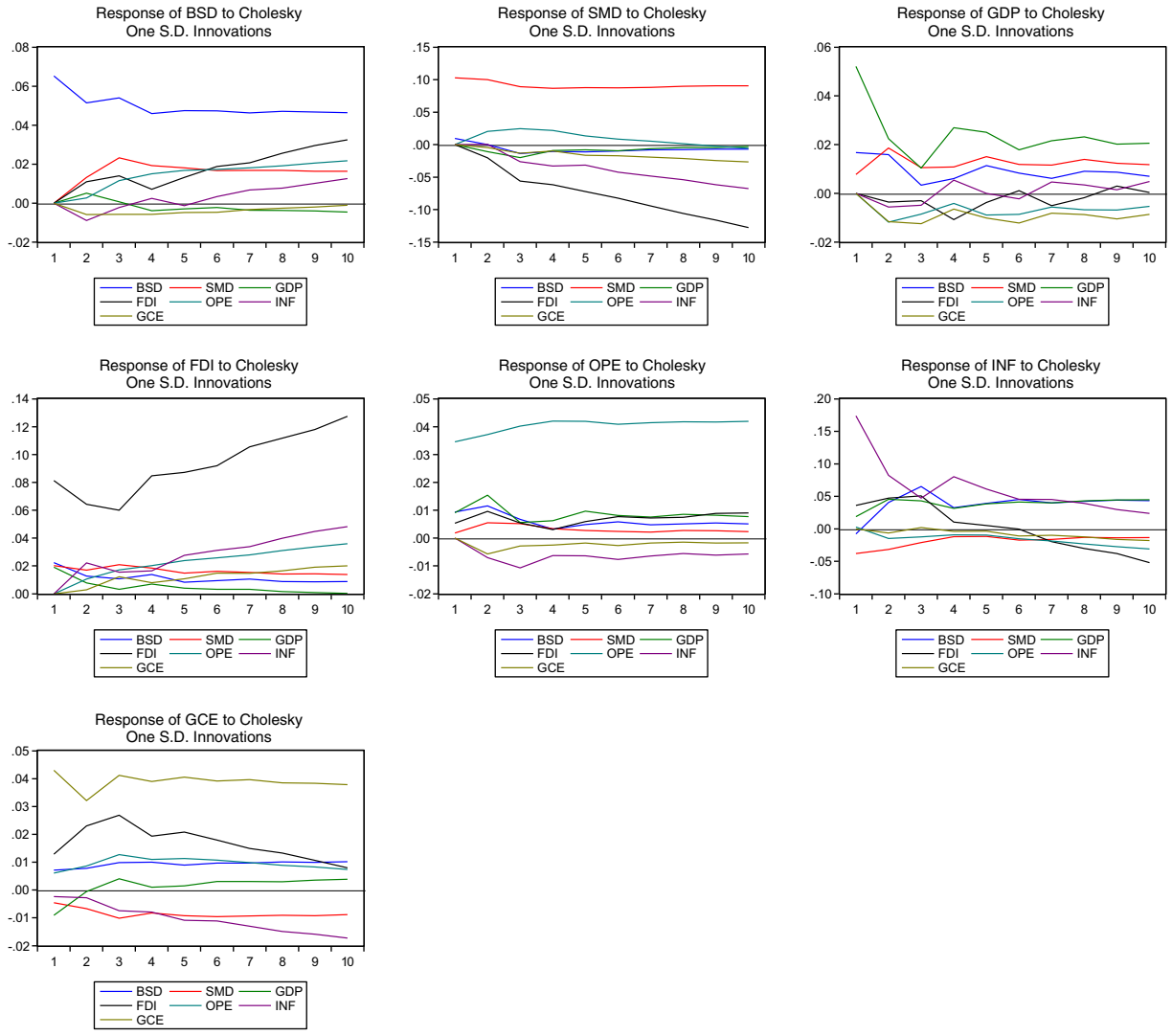

Fig. 5. Granger causal relations between the variables in ARF Observer Countries. *Note 1*: GDP is per capita economic growth rate; BSD is banking sector development index; SMD is stock market development index, FDI is foreign direct investment inflows; OPE is trade openness; INF is inflation rate; and GCE is government consumption expenditure. *Note 2*: ARF Observer Countries comprise of the pool of six countries, namely Papua New Guinea, Mongolia, Pakistan, East Timor, Bangladesh, and Sri Lanka.

economic growth — although the set of statistically significant independent variables varies by sample due to heterogeneity of the countries within each panel. Our results carry three policy implications:

i) With regard to the banking sector development-economic growth nexus: In order to promote economic growth, attention must be paid to policies that promote banking sector development. This, in turn, calls for an efficient allocation of financial resources combined with sound regulation of the banking system. A sound banking system instills confidence among the savers so that resources can be effectively mobilized to increase productivity in the economy. The banking system should be simplified and banking fees should be reduced for qualifying clients, so that the barriers to entry of the banking sector is lowered, making banking activities more accessible to that part of a country's population that are currently excluded from engaging in banking and financial transactions. In addition, the products of the banking system should be diversified in such a way that non-banking financial companies and non-financial institutions can enter the banking sector (as advocated in Mercelin & Mathur, 2014).

ii) With regard to the stock market development-economic growth nexus: To promote economic growth, a well-developed stock market will likely be necessary for these ARF countries, including the future provision of stock market development. A credible and reliable stock market system is indispensable to ensure the smooth-functioning of the financial system and to increase the productivity of the economy, congruent with the arguments presented in Yartey (2008) and Levine (1991). A well-developed stock market will facilitate the raising of debt and equity capital for investment by firms, thereby further enhancing economic growth and attracting foreign direct investment by multi-national corporations.

iii) With regard to the MED-economic growth nexus: In order to facilitate economic growth, macroeconomic development is solely desirable in these ARF countries. For instance, attracting foreign direct investment and promoting trade openness can facilitate further investment and easier means of raising capital to support the activities of stock markets and banks, which will lead to increased economic activity (as also argued in Herwartz & Walle, 2014).

Appendix A. Principal component analysis

Modelling various indicators of banking sector development and stock market development in the same equation would lead to multicollinearity. Thus, we combine these indicators together to create

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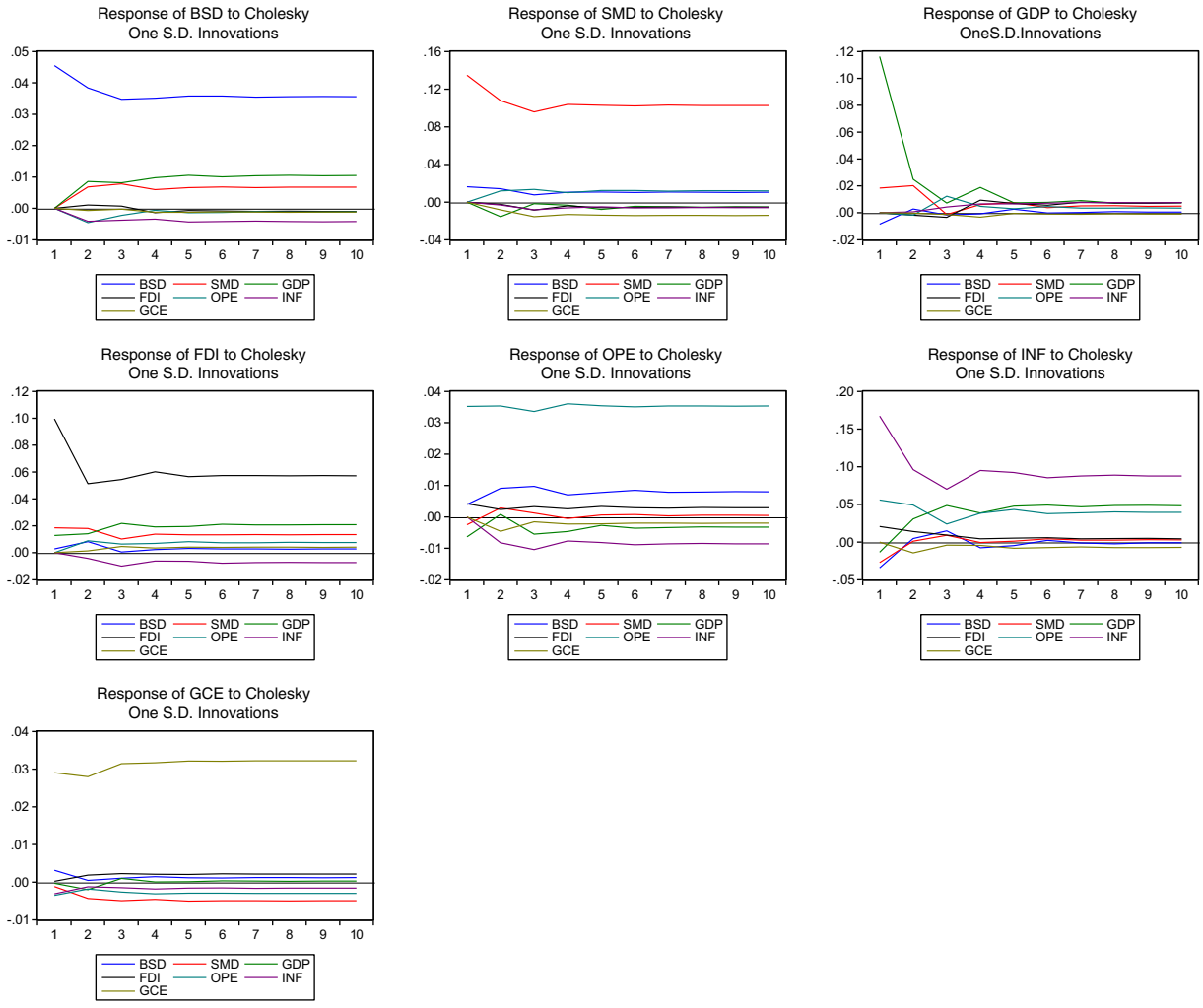

Fig. 6. Granger causal relations between the variables in ARF Total Countries. *Note 1*: GDP is per capita economic growth rate; BSD is banking sector development index; SMD is stock market development index, FDI is foreign direct investment inflows; OPE is trade openness; INF is inflation rate; and GCE is government consumption expenditure. *Note 2*: ARF Total Countries comprise of the pool of 25 countries, namely Brunei, Burma, Cambodia, Indonesia, Laos, Malaysia, Philippines, Singapore, Thailand, Vietnam, Australia, Canada, China, India, Japan, New Zealand, the Korean Republic, the Russian Federation, the United States, Papua New Guinea, Mongolia, Pakistan, East Timor, Bangladesh, and Sri Lanka.

an index of banking sector development and stock market development. We use principal component analysis (PCA), which is based on a linear transformation of the variables so that they are orthogonal to each other (Lewis-Beck, 1994). It is ideally suited because it maximizes the variance, rather than minimizing the least square distance. In brief, PCA transforms the data into new variables (i.e., the principal components) that are not correlated.

The concept of PCA is to construct indexes similar to ours is well-documented in several papers (for example, Ang & McKibbin, 2007; Coban & Topcu, 2013; Fritz, 1984; Gries et al., 2009; Herwartz & Walle, 2014; Huang et al., 2000; Menyah et al., 2014; Murthy & Kalsie, 2013; Pradhan, Mukhopadhyay et al., 2013; Saci & Holden, 2008; Shih, Zhng, & Liu, 2007).[7] To be clear, PCA is a special case of the more general method of factor analysis. The PCA entails a few structured steps, including the construction of a data matrix, creation of standardized variables, calculation of a correlation matrix, determination of eigenvalues (to rank principal components) and eigenvectors, selection of PCs (based on stopping rules), and the interpretation of results (Hosseini & Kaneko, 2011, 2012). The intent behind 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 is to construct from a set of variables, X_j's ($j = 1, 2, \ldots, n$) that are new variables (P_i) called 'principal components', which are linear combinations of the X's. Representing it mathematically,

$$\begin{aligned} P_1 &= a_{11}X_1 + \quad + a_{1n}X_n \\ &\cdot \qquad\qquad\quad \cdot \\ P_m &= a_{m1}X_1 + \quad + a_{mn}X_n \end{aligned} \tag{6}$$

which can be re-written as

$$P = \sum_{i=1}^{n} a_{ij}X_i \quad for(j = 1, 2, \ldots m) \tag{7}$$

where $P = [P_1, P_2, \ldots, P_m]$ are principal components; $A = [a_{ij}]$ for $i = (1, 2, \ldots, m)$; and $j = (1, 2, \ldots, n)$ are component loadings; and $X = [X_1, X_2, \ldots, X_n]$ are original variables. The 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.

[7] Manly (1994), Sharma (1996), Joliffe (2002), OECD (2008), Hosseini and Kaneko (2011, 2012), and Pradhan, Dasgupta, et al. (2013) provide the procedural details on the use of PCA.

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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 at a maximum. The second principal component (P_2), independent from the first principal component, is determined so as to provide a maximum contribution to the total variance left after the variance explained by the first principal component. Analogously, the third and the other principal components are determined as to provide the maximum contribution to the remaining variance and are 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 here that the method of principal components could be applied by using the original values of the X_j's, by their deviations from their means, or by the standardized variables. The present study, however, adopts the latter procedure, as it is assumed to be more general and can be applied to variables measured in different units. It is important to note that the values of the principal components will be different 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 constructed principal components satisfy two conditions: (a) principal components are uncorrelated (orthogonal), and (b) the first principal component P_1 absorbs and accounts for the maximum possible proportion of total variation in the set of all X's. Furthermore, the 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. Here, variance explained criteria are implemented based on the rule of keeping enough principal components to account for 90% of the variation (see, for instance, Hosseini & Kaneko, 2011, 2012; Murthy & Kalsie, 2013; Jackson, 1991; Joliffe, 2002; Wold, 1978).

Thus, PCA examines the statistical correlations across the different variables, and assigns the largest weights to the indicators of banking sector development and stock market development, most correlated with the other indicators in the dataset (Creane, Goyal, Mobarak, & Sab, 2004). Intuitively, PCA tries to uncover the common statistical characteristics across the various indicators in order to combine them into a composite index of banking sector development and a composite index of stock market development.

The following equation is used to construct BSD, our composite index for banking sector development:

$$BSD = \sum_{i=1}^{4} w_{ij} \frac{X_{ij}}{Sd(X_i)} \tag{8}$$

where BSD is our composite index for banking sector development, *Sd* is standard deviation, X_{ij} is the *i*th variable in the *j*th year; and w_{ij} is factor loading, as derived by PCA. Thus, BSD captures the four indicators we mentioned earlier, which are summarized under Table 3. The index is calculated for each country and for each year of our study.

An analogous equation may be used to create SMD, our composite index for stock market development, using the four indicators that are summarized under Table 4.

Appendix B. Panel unit root test and panel cointegration test

B.1. Unit root test for the panel data

One of the primary reasons for the utilization of a panel of cross section units for unit root tests is to increase the statistical power of their univariate counterparts. The traditional Augmented Dickey–Fuller (ADF) test of unit root is characterized by having a low power in rejecting the null hypothesis of no stationarity of the series, especially for short-spanned data. On the contrary, recent developments in the econometrics literature suggest that panel based unit root tests have higher power than the unit root tests based on individual time series analysis. Panel data techniques are also preferable because of their weak restrictions; indeed, they capture both country-specific effects and heterogeneity in the direction and magnitude of the parameters across the panel. Furthermore, these techniques allow the model to be selected with a high degree of flexibility, proposing a relatively wide range of alternative specifications, from models with no constant and no trends to models with a constant and deterministic trend. Within each model, there is the possibility of testing for common time effects.

The unit root test examines the order of integration, where the time series variable attains stationarity. We deploy the Levine–Lin–Chu (LLC: Levine, Lin, & Chu, 2002) test for determining the order of integration. The test is based on the principles of the conventional ADF test. The LLC test allows for heterogeneity of the intercepts across members of the panel. It is applied by averaging the individual ADF t-statistics across cross-section units. The test proceeds with the estimation of the following equation:

$$\Delta Y_t = \mu_i + \tau_i Y_{it-1} + \sum_{j=1}^{p_i} \beta_{ij} \Delta Y_{it-j} + \lambda_i t + \varepsilon_{it} \tag{3}$$

where

i	1, 2, 3,..., N; t = 1, 2, 3,..., T;
Y_{it}	is the series for country i in the panel over period t;
p_i	is the number of lags selected for the ADF regression;
Δ	is the first difference filter (I–L);

and ε_{it} are independently and normally distributed random variables for all i and t with zero means and finite heterogeneous variances (σ_i^2).

The LLC test considers the coefficients of the autoregressive term as homogenous across all individuals, i.e., $\tau_i = \tau$ for all i. It tests the null hypothesis that each individual in the panel has integrated time series, i.e.,

H0. $\tau_i = \tau = 0$ for all i against an alternative H_A: $\tau_i = \tau < 0$ for all i.

Furthermore, the test considers pooling the cross-section time series data. It is based on the following t-statistics:

$$t_y^* = \frac{\hat{\tau}}{s.e.(\hat{\tau})}. \tag{4}$$

Here, in the LLC test, τ is restricted by being kept identical across regions under both the null and alternative hypotheses.

B.2. Cointegration test for the panel data

The technique 'cointegration', introduced by Granger (1988), is relevant to the problem of the determination of a long-run relationship between variables. The basic idea behind cointegration is simple. If the difference between two non-stationary series is itself stationary, then the two series are said to be 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. On the other hand, the lack of cointegration, suggests that the variables have no long-run relationship; i.e., 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 may have linear combinations that are stationary without differencing. Such collections of series are known to be cointegrated (Granger, 1988). If the variables are integrated of 'order one' (i.e. I (1)), we can employ cointegration technique in order to establish whether there is any long-run equilibrium relationship among the set of such possibly 'integrated' variables. The Pedroni's panel cointegration method

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(Pedroni, 2000) is used to determine the existence of cointegration among these three series. The technique starts with the following regression equation.

$$GDP_{it} = \beta_{0i} + \beta_{1i}t + \beta_{2i}BSD_{it} + \beta_{3i}SMD_{it} + \beta_{4i}MED_{it} + \varepsilon_{it}\varepsilon_{it} = \eta_i\varepsilon_{it-1} + \xi_{it} \quad (5)$$

where

$i = 1, 2, 3,\ldots, N$; and $t = 1, 2, 3,\ldots, T$.

β_{0i} is the member-specific intercept, or fixed-effects parameter, that is allowed to vary across individual cross-sectional units. The $\beta_{1i}t$ is a deterministic time trend specific to individual countries in the panel. The slope coefficients, β_{2i} and β_{3i}, may vary from one individual to another, allowing the cointegrating vectors to be heterogeneous across countries.

There are seven different statistics, as proposed by Pedroni (2000), for the cointegration test in the panel data setting. Of the seven statistics, the first four are known as panel cointegration statistics, which are *within-dimension* statistics, while the last three are known as group mean panel cointegrating statistics, which are *between-dimension* statistics. Their levels are based on the way the autoregressive coefficients are manipulated to arrive at the final statistic. There are basically five steps to obtain these cointegration statistics. The mathematical exposition and the asymptotic distributions of these panel cointegration statistics are contained in Pedroni (1999). Under an appropriate standardization, based on the moments of the vector of Brownian motion function, these statistics are distributed as standard normal. Accordingly, the null of no cointegration is then tested, based on the above description of standard normal distribution. The null hypothesis and alternative hypothesis of no cointegration of the pooled, within-dimension, estimation are as follows:

H0. $\eta_i = 1\ \forall\ i$ against an alternative hypothesis H_A: $\eta_i = \eta < 1\ \forall\ i$.

where the within-dimensional estimation assumes a common value for $\eta_i = \eta$.

On the contrary, the group means panel cointegration statistics (i.e., pooled between-dimension) test the following hypothesis of no cointegration:

H0. $\eta_i = 1\ \forall\ i$ against an alternative hypothesis H_A: $\eta_i < 1\ \forall\ i$.

where, under the alternative hypothesis, the between-dimensional estimation does not presume a common value for $\eta_i = \eta$.

This allows an additional source of possible heterogeneity across individual country members of the panel. These statistics diverge to negative infinity under the alternative hypothesis. As a result, the left tail of the normal distribution is usually employed here to reject the null hypothesis.

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