Attaining economic growth through financial development and foreign direct investment

Rudra Pradhan
Indian Institute of Technology Kharagpur, Kharagpur, India

Mak B. Arvin
Department of Economics, Trent University, Oshawa, Canada

Sahar Bahmani
University of Wisconsin-Parkside, Kenosha, Wisconsin, USA, and

John H. Hall
University of Pretoria, Pretoria, South Africa

Abstract

Purpose – The purpose of this paper is to consider the heterogeneous relationship among financial development, foreign direct investment (FDI) and economic growth, examining the possible directions of causality among them in both the short and long runs.

Design/methodology/approach – A sample of the G-20 countries over the period 1970–2016 is utilized. A vector error-correction model is used to consider the possible directions of causality among financial development, FDI and economic growth.

Findings – Results suggest a cointegrating relationship among the three series. Although short-run links among the variables are mostly non-uniform, both financial development and FDI matter in the determination of long-run economic growth.

Practical implications – Attention must be paid to policies that promote financial development. This, in turn, calls for fostering incentives to guarantee continued support to liberalize the economy and promoting capital openness. Additionally, financial infrastructure should be improved to improve financial innovation. The establishment of a well-developed financial market, including well-functioning banks and other financial institutions, can facilitate further investment and an easier means of raising capital to support the activities of FDI. Economic growth can ultimately be elevated through both financial development and FDI.

Originality/value – The study considers a sample of the G-20 countries, which have received relatively little attention in the existing literature. In addition, the study concurrently analyses the trivariate causal relationship among financial development, FDI and economic growth, a topic on which there has been a dearth of research.

Keywords Financial development, Economic growth, Foreign direct investment, The G-20 countries

Paper type Research paper

1. Introduction

Financial development is one of the driving factors behind economic growth. The connection between the two has been the major focus of a significant corpus of both theoretical and empirical research since the seminal work of Schumpeter (1911). Several studies have examined the effect of financial development and economic growth using an array of techniques, such as cross-sectional, time series and panel data (see, *inter alia*, Levine, 2003; Beck and Levine, 2004; Herwartz and Walle, 2014; Jedidia *et al.*, 2014; Ngare *et al.*, 2014).

Empirical evidence from previous studies has established the presence of a positive long-run relationship between various indicators of financial development and economic growth. Specifically, most of these papers suggest that a well-developed financial system is

growth-enhancing, and therefore, consistent with the proposition of "more finance, more growth" (see, *inter alia*, Law and Singh, 2014; Pradhan, Arvin, Bahmani, Hall and Norman, 2017; Pradhan, Arvin, Norman and Hall, 2014). At the same time, the focus on causality between financial development and economic growth has gained considerable interest amongst economists and policy makers. Subsequently, there have been numerous 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 (see, *inter alia*, Pradhan, Arvin and Hall, 2018; Pradhan, Arvin, Bennett, Nair and Hall, 2016; Hassan *et al.*, 2011), a number of studies have failed to find evidence of causality from financial development to economic growth. Hence, the existing empirical studies on the relationship between financial development and economic growth do not provide conclusive evidence on the nature and direction of this relationship and there is no consensus among economists about the nature of this relationship either.

Similar to the finance-growth nexus, the link between foreign direct investment (FDI) and economic growth has garnered much attention in the finance literature. This debate mostly focuses on the channels through which FDI may contribute to economic growth and development of recipient countries. In particular, it has been discussed to what extent FDI may augment technological change through spillover effects of knowledge and new capital goods, that is, the process of technological diffusion. It has been further argued that the contribution that FDI makes to economic growth and technology is strongly dependent on the circumstances in the recipient countries (see, *inter alia*, Barro and Sala-i-Martin, 1995; Hermes and Lensink, 2003).

The literature suggests that the development of the financial system of a recipient country is an important pre-condition in order for the FDI to have a positive impact on economic growth (see, *inter alia*, Adeinyi *et al.*, 2012; Alfaro *et al.*, 2004). A country's financial system can enhance the efficient allocation of resources and hence, can improve the absorptive capacity of a country with respect to FDI inflows. More specifically, a well-developed financial system may contribute to the process of technological diffusion associated with FDI. This implies the possibility of a link among financial development, FDI and economic growth. Therefore, the present paper makes an attempt to integrate FDI with the finance-growth nexus.

The contribution of the present study is sixfold. First, the findings of this study can shed additional light on the relationship among variables in the dynamics between financial development and economic growth, between FDI and economic growth, and between financial development and FDI, as prior empirical results on these variables are mixed. Second, the study analyses the trivariate causal relationship among financial development, FDI and economic growth. To the best of our knowledge, there is a dearth of research on the probable concurrent causal relationship among these three variables. Third, a multivariate panel data estimation procedure that can offer more robust estimates by applying variations between countries, as well as variations over time, is deployed. Fourth, a novelty of the study lies in its treatment of disaggregated financial development. Fifth, the study considers a sample (the G-20 countries) which have received relatively little attention in the existing literature. Sixth, more advanced econometric techniques than those previously used in the literature to establish whether there are causal links between the three sets of variables are utilized.

The rest of this paper is structured as follows: Section 2 presents the theoretical framework; Section 3 presents a literature review and provides a rationale for the analysis; Section 4 describes the econometric methodology used in the study; Section 5 discusses the empirical results; and finally, the main findings and conclusions are provided in Section 6.

2. Theoretical framework

The motives and drivers of both financial development and FDI inflow change over time, but the priority toward growth and development remains the same for both developed and

developing countries. This section presents the theoretical framework linking financial development and economic growth, FDI and economic growth, and financial development and FDI.

2.1 Financial development and economic growth

Historically, the financial system is considered as the nerve center of a country's economic development. It is true that an efficient provision of financial services determines the economic growth and prosperity of a country (see, *inter alia,* Freytag and Frickea, 2017; Freckleton *et al.*, 2012; Ahmed and Wahid, 2011; Seetanah and Ramessur, 2009; Pradhan, Arvin and Bahmani, 2015). Usually, financial development contributes toward economic growth by the following means: ensuring financial stability; supporting trade and commerce; mobilizing domestic savings; allowing different risks to be managed efficiently by encouraging the accumulation of new capital; increasing a more efficient allocation of domestic capital; and assisting to reduce or mitigate losses. In addition, there are three elementary features of financial systems that capture the impact of the above functions on economic growth, namely, the level, efficiency and composition of financial intermediation (Alfaro *et al.*, 2009; Bianchi, 2010; Pradhan, Arvin and Hall, 2018; Pradhan, Arvin, Bahmani, Hall and Norman, 2018).

The role of financial development in fostering economic growth has received a considerable attention since the emergence of the endogenous growth theory. The theoretical contributions in this area can be divided into five strands. First, financial systems can allocate resources more efficiently as per the developmental requirement (Wu *et al.*, 2010). Second, financial markets allow firms to diversify portfolios, increase liquidity, reduce risks and hence stimulate growth. Third, financial development provides an exit mechanism for agents and improves the efficiency of financial intermediation (see, *inter alia,* Rousseau and Wachtel, 2000; Arestis *et al.*, 2001). Fourth, financial markets also foster specialization in entrepreneurship and the adoption of new technologies (Greenwood and Smith, 1997). Fifth, financial markets impact economic growth through changes in incentives for corporate control (Choong *et al.*, 2004; Pradhan, Arvin, Nair, Hall and Gupta, 2017).

2.2 Foreign direct investment and economic growth

The literature identifies several channels through which FDI contributes to economic growth. FDI encourages the incorporation of new inputs and technologies in the production systems of host countries. FDI could also stimulate economic growth endogenously if it generates productivity, positive externalities and spillover effects. Since FDI is considered as an important source of know-how, human capital and technological diffusion, these factors can be initiated to promote economic growth through FDI inflows (Xiaohui *et al.*, 2002; De Vita and Kyaw, 2008; Saini and Singhania, 2018).

The theoretical contributions in this area can be divided into three strands. First, the neoclassical theory, which is the notion that FDI contributes positively toward the economic development of the host country by increasing its well-being status. FDI leads to capital formation in the host country, thereby influencing the reinvestment of profits and further inflows of capital therein. The infusion of foreign capital could result in a lower balance of payments and provides higher-order techniques of production by replacing unproductive methods. It adds value to host countries with respect to technology spillover, higher managerial skills and improved marketing information skills (see, for instance, Dwivedi, 2012). Second, the dependency theory, which is the notion that developing countries are well endowed with natural resources and they need innovative techniques to maximize their output. The dependency theory tries to bridge this technological gap. During the 1970s, many East Asian and Latin American countries followed this approach. However, these

countries later had to shift from the dependency principle of stringent strategies to liberal policies for more capital inflows, as this theory proved unhealthy for the development of emerging countries, leading to the shift from a closed economy to an open economy. Third, the industrialization theory and spillover effects. This theory considers FDI as the transfer of the "package" including capital, management, new technology, and is characterized as an international extension of the industrial organization theory. According to this theory, FDI infuses a contagion effect in the host country through the adoption of management practices and advanced technology principles. It is a channel that promotes growth by technology transmission from the parent firm of a multinational corporation (MNC) to its subsidiary abroad (see, *inter alia,* Zhao *et al.*, 2017; Saini and Singhania, 2018).

2.3 Financial development and foreign direct investment

Many policy makers in developing countries believe that FDI has several positive effects, especially on economic growth. With the onset of absorptive capacities, research on whether the level of development of the domestic financial system could also partly determine the positive effects of FDI on economic growth gave an affirmative answer (see, *inter alia,* Tsagkanos *et al.*, 2018; Hermes and Lensink, 2003; Alfaro *et al.*, 2004; Kholdy and Sohrabian, 2008). This opened a new debate to be explored, i.e. if having a minimum threshold level of financial development is a pre-requisite for the positive impact of FDI on growth, is it not reasonable and logical to ask whether FDI itself could contribute to financial development, and hence enhancing its chances for stimulating economic growth? The financial system of a country includes its banking sector, other financial institutions, the stock market and the bond market. In this regard, it is imperative to understand the link between FDI and an efficient financial system and to identify those variables that contribute to FDI inflows (Desbordes and Wei, 2017).

It is plausible that in doing its multinational capital budgeting, and in analyzing country risk, a foreign enterprise will prefer to invest in a country where the financial system is more developed with the resultant relative easy access to funds if needed. In contrast, an inefficient and under-developed financial system will have a high cost of operation which will be passed on to clients, resulting in a higher cost of capital for the foreign enterprise. In addition, an under-developed financial system may not be able to provide the foreign enterprise with the level of services that it requires for doing international business. An under-developed banking system may, for example, not have advanced payment systems, letters of credit may take too long to clear and the under-developed banking system may not have the capacity to meet the loan requirements of the foreign enterprise. Also, if the foreign enterprise needs funds to finance working capital, or for other needs, it may decide to borrow from its local bankers based on its expectations of interest rates and currency movements. If the foreign enterprise is set up to produce domestically and then export its products, it may need to rely on a local bank for its international business (i.e. letters of credit). Foreign enterprises will, therefore, prefer to invest in a country that has a more advanced banking system, assuming that the project has a positive net present value, all other things being constant (Agbloyor *et al.*, 2012).

Foreign enterprises may also seek to raise extra funds in the form of equity in order to maintain a certain capital structure once they have entered the host country. The key decision for them, therefore, will be how efficient the local stock market is. If the market is inefficient, they will not be enthusiastic enough to list on it because the value of their investment will not be fairly priced. This also implies that the enterprise may not be able to raise new equity because they may think that the market has under-priced the value of their shares, resulting in a value lesser than the intrinsic value of the equity that they issued. Therefore, a country with a relatively better-developed stock market should attract more FDI (Agbloyor *et al.*, 2012).

In investigating the theoretical framework for the directional relationship from FDI to financial development, Desai *et al.* (2006) argue that any increase in net inflows of FDI increases the funds available in the economy and stimulates financial intermediation through financial markets or the banking system. Agbloyor *et al.* (2012) give some insight as to how inflows of FDI can play an active role in promoting both the domestic banking sector and the domestic stock market. They correctly assert that when foreign firms enter into a domestic economy, they make use of the domestic financial markets. Firms are most likely to open a local bank account to manage their local transactions. As these enterprises are lucrative clients for banks, funds are made available to the banking sector to enhance its lending potential. These enterprises are also more likely to demand higher quality and internationally comparable banking services. Therefore, the inflows of FDI may facilitate ways to promote domestic banking sector development.

Regarding FDI being a stimulus for stock market growth, Agbloyor *et al.* (2012) find that some foreign enterprises decide to list on local stock exchanges. Being MNCs, such enterprises are usually so large that they can significantly increase the market capitalization and liquidity of the stock exchanges concerned. The listing of such companies may also attract non-resident foreign investors to the local stock exchange. Further, some investments in the local stock market can come under realms of FDI if the equity holding acquired exceeds 10 percent of the voting equity of the company invested in. Such investments have been known to promote domestic stock market development. Therefore, FDI is an important driver for the development of the domestic stock market.

3. Literature review

This section discusses three strands of literature on the causal relationship among financial development, FDI, and economic growth.

The first strand of literature considers the nexus between financial development and economic growth. There are four different ways we can classify the results of existing studies on the relationship between financial development and economic growth. These comprise of SLH^A – the supply-leading hypothesis of financial development and economic growth, DFH^A – the demand-following hypothesis of financial development and economic growth, FBH^A – the feedback hypothesis between financial development and economic growth, and NEH^A – the neutrality hypothesis between financial development and economic growth.

SLH^A proposes a unidirectional Granger causality from financial development to economic growth. There are at least four ways in which financial development can increase economic growth (see, *inter alia*, Pradhan, Arvin and Hall, 2018), namely through increasing the efficiency in intermediation between borrowers and lenders, improving the allocation of resources (via fund pooling, risk diversification, liquidity management, screening and monitoring), increasing saving rates, and promoting the development of markets and instruments that enable risk sharing and facilitate economic growth. The studies supporting this hypothesis are those of Pradhan, Arvin, Bahmani, Hall and Norman (2018), Wu *et al.* (2010), Ayyagari *et al.* (2007), Beck *et al.* (2000) and Levine (1998).

DFH^A proposes a unidirectional causality from economic growth to financial development. In this case, financial development plays only a minor role in economic growth and is merely a by-product or an outcome of economic growth in the real side of the economy (see, *inter alia*, Pradhan, Arvin, Bahmani, Hall and Norman, 2018; Liang and Teng, 2006). The idea is that as an economy grows, additional financial institutions and financial products and services emerge in the market in response to a higher demand for financial services. Hence, a lack of financial institutions in developing countries indicates a lack of demand for financial services. Accordingly, as the real side of the economy grows, the financial system develops further, thereby increasing opportunities for funding investment and the diversifying of risk (see, *inter alia,* Quartey and Prah, 2008).

Studies supporting the DFH^A include those of Pradhan *et al.*, Odhiambo (2010) and Liang and Teng (2006).

FBH^A suggests that financial development and economic growth complement each other, lending credence to both the supply-leading and the demand-following hypotheses. The studies supporting this hypothesis are Pradhan, Arvin, Norman and Hall (2014), Pradhan, Arvin, Norman and Nishigaki (2014) and Craigwell *et al.* (2001).

NEH^A suggests that there is no causal connection between financial development and economic growth. In this case, financial development is either too marginal or too saturated and hence, it may not contribute to economic growth. Studies supporting this hypothesis are Pradhan, Arvin, Norman and Hall (2014) and Al-Yousif (2002).

The second strand of literature examines the causal nexus between FDI and economic growth. Analogously to the first strand, four different hypotheses can be considered, namely SLH^B – the supply-leading hypothesis of FDI and economic growth, DFH^B – the demand-following hypothesis of FDI and economic growth, FBH^B – the feedback hypotheses between FDI and economic growth, and NEH^B – the neutrality hypotheses between FDI and economic growth.

SLH^B suggests a unidirectional Granger causality from FDI to economic growth. In this case, FDI can promote long-run economic growth by augmenting the existing stock of knowledge in the host economy through labor training and skill acquisition, on the one hand, and through the introduction of alternative management practices and organizational arrangements on the other hand (see, *inter alia*, Herzer *et al.*, 2008). The studies supporting SLH^B are those of Sunde (2017), Lean and Tan (2011) and Zhang (2001).

DFH^B suggests a unidirectional causality from economic growth to FDI. In this case, the pre-condition is that economic growth has a positive impact on FDI. One can argue that the higher growth rates of an economy stimulate the growth in demand, which implies greater profitability opportunities for inflowing capital. Hence, FDI sources may prefer faster-growing countries. On the other hand, opponents argue that slower-growing economies may imply higher profitability opportunities for capital, given that these economies are capital scarce and labor abundant. The studies supporting this hypothesis are those of Pradhan, Arvin, Bahmani, Hall and Norman (2018), Lean and Tan (2011), Choe (2003), Alguacil *et al.* (2002), Zhang (2001) and Liu *et al.* (2001).

FBH^B proposes that FDI and economic growth complement each other. Here, the line of reasoning is that economies that experience faster economic growth not only generate more demand for FDI inflows, but also provide better opportunities for generating profits, and hence attracting more FDI inflows. In addition to this, FDI would cause faster economic growth and support the economic development of the host economy via direct effects as well as indirect spillover effects. This implies that both FDI and economic growth, in such a case, are positively interdependent, leading to a bidirectional causality linkage or a "virtuous circle" (see, *inter alia,* Zhang, 2001). The studies supporting the FBH^B are those of Chan *et al.* (2014), Liu *et al.* (2001) and Duasa (2007).

The NEH^B suggests that there is no causal connection between FDI and economic growth and there are at least two ways we can justify the lack of connection. First, FDI might simply be too marginal to have a serious economic growth impact. Second, it could very well be that the growth-limiting effects of FDI often limit the growth-enhancing effects leading to small or no net effects. The studies supporting this hypothesis are those of Yalta (2013) and Herzer *et al.* (2008).

The third strand of literature concerns the causal nexus between financial development and FDI. Similar to the previous two strands of literature, the relationship between financial development and FDI can be four types, namely a SLH^C, where financial development leads to FDI; a DFH^C, where FDI leads to financial development; a FBH^C,

where both financial development and FDI cause each other; and a NEH^C, claiming that there is no causal relationship between financial development and FDI. The studies supporting these hypotheses are those of Adeinyi *et al.* (2012), Hermes and Lensink (2003) and Otchere *et al.* (2016).

Table I provides a brief summary of the three strands of the literature.

Based on the results of studies in Table I, it is evident that the direction of causality among the three variables is not uniform and therefore still open to question. In the present study, we make an attempt to examine the simultaneous causal relationship among financial development, FDI and economic growth. Clearly, the present analysis melds the three strands of the literature.

Table I. Summary of studies on the causal connection among financial development, foreign direct investment, and economic growth

Study	Study area	Data period	Hypothesis supported
Case 1: financial development and economic growth			
Hsueh *et al.* (2013)	Ten Asian countries	1980–2007	SLH^A
Menyah *et al.* (2014)	21 African countries	1965–2008	SLH^A, DFH^A
Pradhan, Arvin, Norman and Hall (2014)	ASEAN countries	1961–2012	FBH^A
Pradhan, Arvin, Hall and Nair (2016)	Eurozone countries	1988–2013	FBH^A
Pradhan, Arvin, Bahmani, Hall and Norman (2018)	49 European countries	1961–2014	FBH^A, SLH^A, DFH^A
Case 2: foreign direct investment and economic growth			
Ahmed *et al.* (2011)	Sub-Sahara African countries	1991–2001	FBH^B
Lean and Tan (2011)	Malaysia	1970–2009	SLH^B, DFH^B
Lee (2009)	Malaysia	1970–2000	DFH^B
Lee (2010)	Japan and World	1977–2006	SLH^B, FBH^B
Liu *et al.* (2001)	China	1984–1998	DFH^B
Pradhan, Arvin, Hall and Nair (2016)	Eurozone countries	1988–2003	FBH^B
Tang and Wong (2011)	Cambodia	1994–2006	SLH^B
Sunde (2017)	South Africa		SLH^B
Case 3: financial development and foreign direct investment			
Adeinyi *et al.* (2012)	SODE countries	1970–2012	NEH^C
Kholdy and Sohrabian (2005)	25 countries	1975–2002	FBH^C
Lee and Chang (2009)	37 countries	1970–2002	DFH^C, NEH^C
Pradhan, Arvin, Hall and Nair (2016)	Eurozone countries	1988–2003	NEH^C

Notes: SLH^A is the supply-leading hypothesis, indicating Granger causality from financial development to economic growth; DFH^A is the demand-following hypothesis, indicating Granger causality from economic growth to financial development; FBH^A is the feedback hypothesis, indicating bidirectional Granger causality between economic growth and financial development; NEH^A is the neutrality hypothesis, indicating no Granger causality between financial development and economic growth; SLH^B is the supply-leading hypothesis, indicating Granger causality from foreign direct investment to economic growth; DFH^B is the demand-following hypothesis, indicating Granger causality from economic growth to foreign direct investment; FBH^B is the feedback hypothesis, indicating bidirectional Granger causality between foreign direct investment and economic growth; NEH^B is the neutrality hypothesis, indicating no Granger causality between foreign direct investment and economic growth; SLH^C is the supply-leading hypothesis, indicating Granger causality from financial development to foreign direct investment; DFH^C is the demand-following hypothesis, indicating Granger causality from foreign direct investment to financial development; FBH^C is the feedback hypothesis, indicating bidirectional Granger causality between financial development and foreign direct investment; NEH^C is the neutrality hypothesis, indicating no Granger causality between financial development and foreign direct investment. MENA is the Middle East and North Africa; ARF is ASEAN Regional Forum; SODE is small open developing economies

Source: Authors' compilation from papers cited

4. Econometric methodology

We use the following vector error-correction model (VECM) to consider the possible directions of causality among financial development, FDI and economic growth:

$$\begin{bmatrix} \Delta \mathrm{PEG}_{it} \\ \Delta \mathrm{FDI}_{it} \\ \Delta \mathrm{FIN}_{it} \end{bmatrix} = \begin{bmatrix} \alpha_{1j} \\ \alpha_{2j} \\ \alpha_{3j} \end{bmatrix} + \sum_{k=1}^{n} \begin{bmatrix} \beta_{11ik}(L)\beta_{12ik}(L)\beta_{13ik}(L) \\ \beta_{21ik}(L)\beta_{22ik}(L)\beta_{23ik}(L) \\ \beta_{31ik}(L)\beta_{32ik}(L)\beta_{33ik}(L) \end{bmatrix} \begin{bmatrix} \Delta \mathrm{PEG}_{it-k} \\ \Delta \mathrm{FDI}_{it-k} \\ \Delta \mathrm{FIN}_{it-k} \end{bmatrix} + \begin{bmatrix} \eta_{1i}\mathrm{ECT}_{it-1} \\ \eta_{2i}\mathrm{ECT}_{it-1} \\ \eta_{3i}\mathrm{ECT}_{it-1} \end{bmatrix} + \begin{bmatrix} \zeta_{1it} \\ \zeta_{2it} \\ \zeta_{3it} \end{bmatrix}, \quad (1)$$

where Δ is the first difference operator; i is country specification in the panel; t is year; and ζ is the random error term.

The ECT_{t-1}s are the lagged error-correction terms. Statistical significance of the coefficients on these terms would indicate the presence of a long-run relationship among financial development, FDI and economic growth. The VECM[1] provides robust results if the variables are integrated of order one and cointegrated. The ECTs are removed in the estimation process if the variables used in the study are not cointegrated.

The null hypotheses are to test the following:

$$H_{1A}^{0} : \beta_{12ik} = 0; \text{ and } \eta_{1i} = 0, \quad \text{for } k = 1,\ 2,\ \ldots,\ n,$$

$$H_{1B}^{0} : \beta_{21ik} = 0; \text{ and } \eta_{2i} = 0, \quad \text{for } k = 1,\ 2,\ \ldots,\ n,$$

$$H_{2A}^{0} : \beta_{13ik} = 0; \text{ and } \eta_{1i} = 0, \quad \text{for } k = 1,\ 2,\ \ldots,\ n,$$

$$H_{2B}^{0} : \beta_{31ik} = 0; \text{ and } \eta_{3i} = 0, \quad \text{for } k = 1,\ 2,\ \ldots,\ n,$$

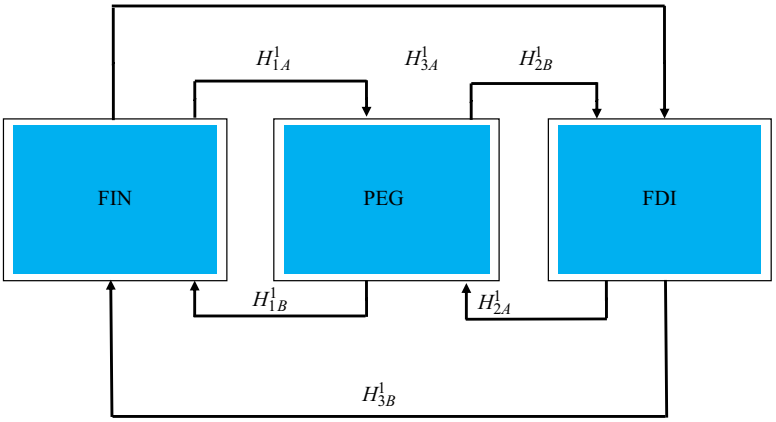
$$H_{3A}^{0} : \beta_{32ik} = 0; \text{ and } \eta_{3i} = 0, \quad \text{for } k = 1,\ 2,\ \ldots,\ n,$$

$$H_{3B}^{0} : \beta_{23ik} = 0; \text{ and } \eta_{2i} = 0, \quad \text{for } k = 1,\ 2,\ \ldots,\ n.$$

There are different possibilities with respect to the direction of causality among financial development, FDI and economic growth. For instance, if neither β_{12ik}, β_{13ik}, β_{21ik}, nor β_{31ik} is significantly different from 0, we can infer that financial development, FDI and economic growth do not cause each other. If only β_{12ik} is statistically different from 0, then only financial development Granger-causes economic growth. If only β_{13ik} is statistically different from 0, then only FDI Granger-causes economic growth. If all β_{12ik}, β_{13ik}, β_{21ik} and β_{31ik} are statistically different from 0, then there is a feedback association among the variables. Figure 1 depicts the hypotheses that are tested in this empirical process.

We use annual time series data[2] from the World Development Indicators for the G-20 countries over the period 1970–2016. The G-20 consists of 19-member countries plus the European Union[3]. These are countries with different development strategies; they are advanced, developing and emerging countries. These countries together represent around 90 percent of the global domestic product, 80 percent of global trade and two-thirds of the world's population. The G-20 is a dynamic group of countries to study, one that has not received much attention before on the topic addressed in the present study.

Our study deploys per capita economic growth (PEG), FDI and 12 different indicators for financial development (FIN), the latter broadly grouped under three headings, namely, banking sector development (BAD), stock market development (STM) and bond market development (BOM). Within each group, we consider four different financial indicators.



Notes: FIN is financial development; PEG is per capita economic growth and FDI is foreign direct investment. FIN is used for BAD, STM and BOM. BAD is banking sector development, STM is stock market development and BOM is bond market development. The null hypotheses are stated below. Superscript 1 on H in this figure gives the alternative, with the direction of causality indicated by an arrow: H^0_{1A}: Financial development does not Granger-cause economic growth; H^0_{1B}: Economic growth does not Granger-cause financial development; H^0_{2A}: Foreign direct investment does not Granger-cause economic growth; H^0_{2B}: Economic growth does not Granger-cause foreign direct investment; H^0_{3A}: Financial development does not Granger-cause foreign direct investment; H^0_{3B}: Foreign direct investment does not Granger-cause financial development

Figure 1. A summary of the hypotheses

For BAD, the four financial indicators are domestic credit to the private sector (DCP), private credit by deposit money banks and other financial institutions (PCO), domestic credit provided by the financial sector (DCF) and domestic credit to the private sector by banks (DCB). For STM, the four indicators are stock market capitalization (SMC), stock market value traded stocks (SVT), stock turnover ratio (STR) and the number of listed companies in the stock market (SNL). For BOM, the four financial indicators are domestic private bonds (DPR), domestic public bonds (DPU), international private bonds (IPR) and international public bonds (IPU). These proxies for financial development have previously been used, for example, by Hassan *et al.* (2011) and Pradhan, Arvin and Ghoshray (2015). All the monetary variables are measured in constant US dollars.

We also construct[4] three composite indices of financial development, one for banking sector development (denoted by BSD[5]), one for stock market development (denoted by SMD[6]) and one for bond market development (denoted by BMD[7]), using principal component analysis.

A detailed description of all the variables is presented in Table II.

We deploy three different specifications, depending on the inclusion of banking sector development, stock market development or bond market development. In each specification, we have five cases, depending on the choice of different financial indicators that are described in Table II. The sample size varies[8] from specification to specification, depending on available data for each financial development indicator. It can be noted that the estimation of the VECM framework requires the status of unit root and cointegration among financial development, FDI and economic growth. Panel unit root and panel cointegration tests are deployed for the same. A brief description of these two tests is available in Appendix 2.

Table II. Definition of variables

Variable	Code definition
DCP	Domestic credit to the private sector: the financial resources provided to the private sector by financial corporations, expressed as a percentage of the gross domestic product
PCO	Private credit by deposit money banks and other financial institutions: expressed as a percentage of the gross domestic product
DCF	Domestic credit provided by financial sector: all the credit to the various sectors on a gross basis, expressed as a percentage of the gross domestic product
DCB	Domestic credit to the private sector by banks: financial resources provided by banks to the private sector, expressed as a percentage of the gross domestic product
BSD	Composite index of banking sector development: the weighted average of the four banking sector development indicators, namely DCP, PCO, DCF and DCB
SMC	Stock market capitalization of listed companies: expressed as a percentage of the gross domestic product
SVT	Stocks traded (total value): expressed as the percentage of the gross domestic product
STR	Stocks traded (turnover ratio): expressed as a percentage change in the turnover ratio in the stock market
NLC	Number of listed companies in the stock market: expressed per 10,000 population
SMD	Composite index of stock market development: the weighted average of the four stock market development indicators, namely SMC, SVT, STR and NLC
DPR	Domestic private debt securities: expressed as a percentage of the gross domestic product
DPU	Domestic public debt securities: expressed as a percentage of the gross domestic product
IPR	International private debt securities: expressed as a percentage of the gross domestic product
IPU	International public debt securities: expressed as a percentage of the gross domestic product
BMD	Composite index of bond market development: the weighted average of the four bond market development indicators, namely DPR, DPU, IPR, and IPU
FDI	Foreign direct investment: total foreign direct investment inflows as a percentage of the gross domestic product
PEG	Economic growth: percentage change in per capita gross domestic product

Notes: The variables above are all defined in the World Development Indicators, published by the World Bank. All monetary variables are in real US dollars

It can be further noted that the VECM estimation and its essentials, such as unit root and cointegration among the variables, depend crucially upon the choice of lag lengths. We deploy both the Akaike information criterion (AIC) and the Schwarz–Bayesian information criterion (SBC) to determine the optimum lag length. Appendix 3 provides the detailed results of our estimation with AIC and SBC statistics.

5. Results and discussion

The VECM framework is used to examine the possible Granger causal relationships among financial development, FDI and economic growth. The econometric analysis begins with a panel unit root test[9] and a panel cointegration test among PEG, FDI and FIN, depending upon the above-mentioned specification (Equation (1)) and the cases (1–5). The panel unit root test is to examine the order of integration of each variable (PEG, FDI, DCP, PCO, DCF, DCB, BSD, SMC, SVT, STR, NLC, SMD, DPR, DPU, IPR, IPU and BMD). For robustness, three types of panel unit root tests were utilized, namely the Levin–Lin–Chu "*t*-stat" (Levin *et al.*, 2002), the augmented Dickey–Fuller–Fisher "χ^2" and the Phillips Perron–Fisher "χ^2" panel unit root tests. These panel unit root tests work under the null hypothesis of a panel unit root (non-stationary variables) and the alternative hypothesis of no unit root (stationary variables). The test results are reported in Table III. The results specify that the null hypothesis of a panel unit root at level data is not rejected by any of these three test statistics. This indicates that the variables are not stationary at level data. However, the null hypothesis of the panel unit root is rejected at the first difference because all the variables are significant at the first difference level. This ensures that all variables are integrated of order one [I (1)].

Table III. Results of the panel unit root test

	Level data			First difference			
	LLC	ADF	PP	LLC	ADF	PP	Inference
Specification 1: PEG, FDI and BAS							
DCP	−0.134	38.95	54.12	−14.91*	320.5*	450.7*	I[1]
PCO	−0.152	37.28	46.96	−12.10*	238.0*	25.6**	I[1]
DCF	−0.492	29.75	48.82	−13.51*	315.9*	521.9*	I[1]
DCB	−1.143	27.08	31.28	−14.04*	310.3*	487.3*	I[1]
BSD	−1.011	23.76	49.09	−10.87*	354.6*	561.4*	I[1]
FDI	−1.156	39.20	49.66	−12.96*	350.0*	532.8*	I[1]
PEG	−1.056	24.87	43.14	−20.89*	668.6*	444.6*	I[1]
Specification 2: PEG, FDI and STM							
SMC	1.381	13.5	11.41	−16.67*	278.4*	238.5*	I[1]
SVT	0.49	16.73	12.59	−12.49*	198.2*	203.7*	I[1]
STR	1.627	15.14	22.86	−15.36*	260.7*	378.9*	I[1]
NLC	1.34	22.27	33.88	−16.77*	274.8*	370.9*	I[1]
SMD	−0.957	42.56	59.5	−8.613*	117.7*	256.3*	I[1]
FDI	2.28	42.4	55.65	−5.01*	133.3*	330.3*	I[1]
PEG	−0.642	18.67	29.47	−17.55*	298.5*	538.2*	I[1]
Specification 3: PEG, FDI and BOM							
DPR	2.365	20.16	20.59	−10.87*	176.4*	179.1*	I[1]
DPU	4.98	14.44	14.71	−12.13*	193.8*	195.7*	I[1]
IPR	8.23	6.325	8.686	−6.387*	105.4*	106.1*	I[1]
IPU	−1.989	52.59	51.7	−1.55***	156.4*	156.5*	I[1]
BMD	−0.267	55.89	43.84	−8.526*	124.9*	256.4*	I[1]
FDI	−0.142	32.67	55.49	−12.44*	182.6*	384.6*	I[1]
PEG	−0.198	17.17	22.1	−16.77*	287.3*	481.3*	I[1]

Notes: Variables are defined in Table II. LD is level data, and FD is first difference data. LLC, ADF and PP are test statistics; I[1] denotes integration of order one. Optimum lag length in each of the test is two. *,**, ***Significant at 1, 5 and 10 percent, respectively
Source: Authors' calculations

The next step is to determine whether a long-run relationship among the variables exists. We deployed the Pedroni (1999) panel cointegration test, which is based on the Engle and Granger (1987) framework, to examine the existence of long-run relationships among PEG, FDI and FIN. This panel cointegration test depends on the null hypothesis of no cointegration and the alternative hypothesis of cointegration among the three variables.

The results from this test validate the existence of a long-run equilibrium relationship among these variables (PEG, FDI and FIN) in each of the three specifications and the five cases under each specification in our empirical model (see Table IV).

The above findings support our VECM approach to ascertain the Granger causal relationships among financial development, FDI and economic growth. The results of the VECM estimation are presented in Table V.

We first analyze the long-run Granger causality test results by examining the statistical significance of the ECT_{t-1} coefficients. We find that when ΔPEG is the dependent variable; the coefficients are statistically significant. This implies that economic growth tends to converge to its long-run equilibrium path in response to changes in both financial development and FDI. This is true for all five cases and the three specifications that we have considered. Consequently, we can conclude that economic growth in the G-20 countries is significantly influenced by both financial development and FDI. Therefore, to stimulate long-run economic growth, it is important to enhance both financial development and FDI in these countries.

Table IV. Results of the cointegration test among FDI, financial development and economic growth

Specifications	Cases				
Specification 1: PEG, FDI and BAS					
	DCP	PCO	DCF	DCB	BSD
Panel v-statistics	3.941*	4.331*	2.269*	3.480*	4.636*
Panel ρ-statistics	−11.51*	−10.05*	−12.23*	−11.48*	−12.26*
Panel PP-statistics	−11.73*	−10.75*	−14.97*	−11.91*	−12.55*
Panel ADF-statistics	−8.411*	−7.67*	−9.93*	−8.54*	−9.011*
Group ρ-statistics	−10.23*	−9.26*	−9.25*	−9.80*	−10.29
Group PP-statistics	−15.96*	−15.37*	−16.22*	−17.64*	−17.80
Group ADF-statistics	−11.19*	−11.02*	−11.53*	−11.56*	−11.92*
Specification 2: PEG, FDI and STM					
	SMC	SVT	STR	NLC	SMD
Panel v-statistics	−0.436	−0.886	−0.545	2.125**	1.554***
Panel ρ-statistics	−6.414*	−5.601*	−4.991*	−5.025*	−5.206*
Panel PP-statistics	−10.05	−9.658*	−9.606*	−9.153*	−9.319
Panel ADF-statistics	−6.384*	−6.334*	−6.705*	−6.496*	−6.866*
Group ρ-statistics	−3.089*	−2.417*	−1.147	−2.654*	−2.041*
Group PP-statistics	−9.467*	−10.25*	−9.411*	−11.06*	−9.591*
Group ADF-statistics	−6.601*	−7.237*	−6.395*	−6.301*	−7.570*
Specification 3: PEG, FDI and BOM					
	DPR	DPU	IPR	IPU	BMD
Panel v-statistics	−1.177	−0.839	−0.647	−1.342	−0.51
Panel ρ-statistics	−3.679*	−5.036*	−4.121*	−3.831*	−6.380*
Panel PP-statistics	−9.364*	−9.209*	−9.307*	−9.759*	−11.02*
Panel ADF-statistics	−5.741*	−5.426*	−5.012*	−6.019*	−6.625*
Group ρ-statistics	−1.923***	−2.088**	−1.451***	−0.587	−2.864*
Group PP-statistics	−12.55*	−11.73*	−11.26*	−10.45*	−12.39*
Group ADF-statistics	−6.847*	−7.568*	−6.131*	−6.203*	−7.01*

Notes: Specification 1 deals with PEG, FDI and BAS (DCP/PCO/DCF/DCB/BSD); Specification 2 deals with PEG, FDI and STM (SMC/SVT/STR/NLC/SMD); and Specification 3 deals with PEG, FDI and BOM (DPR/DPU/IPR/IPU/BMD). BAS is banking sector development and stands for DCP, PCO, DCF, DCB or BSD; STM is stock market development and stands for SMC, SVT, STR, NLC or SMD; BOM is bond market development and stands for DPR, DPU, IPR, IPU or BMD. Variables are defined in Table II. Optimum lag length in each case is two. *,**,***Significant at 1, 5 and 10 percent, respectively
Source: Authors' calculations

In the short run, the results are mostly uniform, with only one exception. The uniform finding is the bidirectional causality between financial development and economic growth (i.e. the support of FBH under each specification and in all cases). Moreover, we find non-uniform short-run Granger causality between FDI and economic growth, and between FDI and financial development. The results, summarized in Table VI, demonstrate that the short-run adjustment dynamics vary across the five cases. In some cases, the existence of unidirectional causality (supply-leading or demand-following) is supported, while bidirectional causality (feedback) and no causality (neutrality) are supported in other cases. These findings are in line with the findings of Adeinyi *et al.* (2012), Lee and Chang, and Pradhan, Arvin, Hall and Nair (2016).

We test for the robustness of our results through several avenues. First, we utilized fully modified ordinary least squares and dynamic ordinary least squares. The estimates from these tests show that both financial development and FDI have a positive impact on economic growth, which is congruent with the findings of Adjasi *et al.* (2012), Alfaro *et al.* (2009), Choong (2011) and Pradhan, Arvin, Bahmani, Hall and Norman (2018). Second, we performed a sensitivity analysis by varying the order of the VECM. The results do not

Table V. Results of panel granger causality test among foreign direct investment, financial development and economic growth

Dependent variable	Independent variables											
Specification 1: PEG, FDI and BAS												
	Case 1: DCP				Case 2: PCO				Case 3: DCF			
	ΔPEG	ΔFDI	ΔDCP	ECT_{-1}	ΔPEG	ΔFDI	ΔPCO	ECT_{-1}	ΔPEG	ΔFDI	ΔDCF	ECT_{-1}
ΔPEG	–	0.284	4.671	−0.94*	–	0.787	5.127*	−0.87*	–	1.343	3.019***	−0.49*
ΔFDI	1.219	–	0.178	−0.69	1.117	–	0.585	−0.94	4.095*	–	1.054	−0.24
ΔBAS	4.339**	1.015	–	−0.24	8.26*	1.373	–	−0.13	10.0*	0.55	–	−0.12
	Case 4: DCB				Case 5: BSD							
	ΔPEG	ΔFDI	ΔDCB	ECT_{-1}	ΔPEG	ΔFDI	ΔBSD	ECT_{-1}				
ΔPEG	–	0.63	5.82*	−0.50*	–	0.538	3.482	−0.49*				
ΔFDI	0.24	–	2.38	−0.72	1.803	–	3.591***	−0.11				
ΔBAS	8.89*	3.49***	–	−0.14	8.821*	2.471	–	−0.19				
Specification 2: PEG, FDI and STM												
	Case 1: SMC				Case 2: SVT				Case 3: STR			
	ΔPEG	ΔFDI	ΔSMC	ECT_{-1}	ΔPEG	ΔFDI	ΔSVT	ECT_{-1}	ΔPEG	ΔFDI	ΔSTR	ECT_{-1}
ΔPEG	–	2.288	8.50*	−0.39*	–	1.901	4.377**	−0.42*	–	0.759	4.81**	−0.55*
ΔFDI	0.752	–	9.046*	−0.43	0.66	–	0.84	−0.13	0.07	–	1.93	−0.74
ΔSTM	5.034*	1.753	–	−0.84	16.7*	3.04	–	−0.21	6.67*	4.84**	–	−0.24
	Case 4: NLC				Case 5: SMD							
	ΔPEG	ΔFDI	ΔNLC	ECT_{-1}	ΔPEG	ΔFDI	ΔSMD	ECT_{-1}				
ΔPEG	–	3.09***	12.98*	−0.55*	–	3.753***	4.801**	−0.36*				
ΔFDI	1.595	–	3.291***	−0.27	5.079*	–	0.149	−0.156				
ΔSTM	5.01*	1.461	–	−0.02	9.458*	8.300*	–	−0.16				
Specification 3: PEG, FDI and BOM												
	Case 1: DPR				Case 2: DPU				Case 3: IPR			
	ΔPEG	ΔFDI	ΔDPR	ECT_{-1}	ΔPEG	ΔFDI	ΔDPU	ECT_{-1}	ΔPEG	ΔFDI	ΔIPR	ECT_{-1}
ΔPEG	–	0.991	13.17*	−0.43*	–	0.738	5.435*	−0.55*	–	3.651***	4.049**	−0.56*
ΔFDI	7.399*	–	0.727	−0.79	5.854*	–	0.162	−0.52	1.516	–	5.156*	−0.21
ΔBOM	4.899**	0.005	–	−0.68	3.970***	0.432	–	−0.21	23.5*	1.67	–	−0.012
	Case 4: IPU				Case 5: BMD							
	ΔPEG	ΔFDI	ΔIPU	ECT_{-1}	ΔPEG	ΔFDI	ΔBMD	ECT_{-1}				
ΔPEG	–	5.35**	5.43**	−0.38*	–	6.06*	18.6**	−0.56*				
ΔFDI	10.8*	–	3.59***	−0.26	1.898	–	3.045***	−0.26				
ΔBOM	4.818**	3.149***	–	−0.01	9.03*	1.157	–	−0.86				

Notes: Specification 1 deals with PEG, FDI and BAS (DCP/PCO/DCF/DCB/BSD); Specification 2 deals with PEG, FDI and STM (SMC/SVT/STR/NLC/SMD); and Specification 3 deals with PEG, FDI and BOM (DPR/DPU/IPR/IPU/BMD). BAS is banking sector development and stands for DCP, PCO, DCF, DCB or BSD (Cases 1–5 in the table); STM is stock market development and stands for SMC, SVT, STR, NLC or SMD (Cases 1–5 in the table); BOM is bond market development and stands for DPR, DPU, IPR, IPU or BMD (Cases 1–5 in the table). Variables are defined in Table II. ECT_{-1} is the lagged error-correction term. Optimum lag lengths in each case are derived on the basis of AIC and SBC statistics (see Appendix 3). *,**,***Significant at 1, 5 and 10 percent, respectively

Source: Authors' calculations

Table VI. Summary of short-run Granger causality results

Cases/ Specifications	Financial development and economic growth	FDI and economic growth	Financial development and FDI
Specification 1: PEG, FDI and BAS			
Case 1	FBH^A	NEH^B	NEH^C
Case 2	FBH^A	NEH^B	NEH^C
Case 3	FBH^A	DFH^B	NEH^C
Case 4	FBH^A	NEH^B	DFH^C
Case 5	FBH^A	NEH^B	SLH^C
Specification 2: PEG, FDI and STM			
Case 1	FBH^B	NEH^B	SLH^B
Case 2	FBH^B	NEH^B	DFH^B
Case 3	FBH^B	NEH^B	DFH^B
Case 4	FBH^B	SLH^B	SLH^B
Case 5	FBH^B	FBH^B	DFH^B
Specification 3: PEG, FDI and BOM			
Case 1	FBH^C	DFH^C	NEH^C
Case 2	FBH^C	DFH^C	NEH^C
Case 3	FBH^C	SLH^C	SLH^C
Case 4	FBH^C	FBH^C	FBH^C
Case 5	FBH^C	SLH^C	SLH^C

Notes: SLH^A is the supply-leading hypothesis, indicating Granger causality from financial development to per capita economic growth; DFH^A is the demand-following hypothesis, indicating Granger causality from per capita economic growth to financial development; FBH^A is the feedback hypothesis, indicating bidirectional Granger causality between financial development and per capita economic growth; SLH^B is the supply-leading hypothesis, indicating Granger causality from foreign direct investment to per capita economic growth; DFH^B is the demand-following hypothesis, indicating Granger causality from per capita economic growth to foreign direct investment; FBH^B is the feedback hypothesis, indicating bidirectional Granger causality between foreign direct investment and per capita economic growth; SLH^C is the supply-leading hypothesis, indicating Granger causality from financial development to foreign direct investment; DFH^C is the demand-following hypothesis, indicating Granger causality from foreign direct investment to financial development; FBH^C is the feedback hypothesis, indicating bidirectional Granger causality between financial development and foreign direct investment; NEH^A is the neutrality hypothesis, indicating no Granger causality between financial development and per capita economic growth; NEH^B is the neutrality hypothesis, indicating no Granger causality between foreign direct investment and per capita economic growth; and NEH^C is the neutrality hypothesis, indicating no Granger causality between foreign direct investment and financial development. Financial development is used to denote all three aspects of financial development, namely BAS (captured by DCP/PCO/DCF/DCB/BSD), STM (captured by SMC/SVT/STR/NLC/SMD) and BOM (captured by DPR/DPU/IPR/IPU/BMD). BAS is banking sector development and stands for DCP, PCO, DCF, DCB or BSD (Cases 1–5 in the table); STM is stock market development and stands for SMC, SVT, STR, NLC or SMD (Cases 1–5 in the table); BOM is bond market development and stands for DPR, DPU, IPR, IPU or BMD (Cases 1–5 in the table). Variables are defined in Table II. The findings are on the basis of the test results in Table V
Source: Authors' calculation

reveal any substantial change to our earlier findings. Third, we used generalized impulse response functions to trace the effect of a one-off shock to an innovation on the current and future values of the endogenous variables. The results provide supplementary insight into our general approach. The results of these additional tests are not provided here for the sake of brevity but are available from the authors upon request.

6. Conclusion

This study examines the causal relationship among financial development, FDI and economic growth in the G-20 countries over the period 1970–2016. The analysis was based on four indicators of banking sector development, four indicators of stock market development and four indicators of bond market development. Since using all of these indicators

simultaneously poses a multicollinearity problem, the study uses them individually along with composite indices.

Our key findings are that financial development, FDI and economic growth are integrated of order one and cointegrated. Most importantly, there is clear evidence that both financial development and FDI matter in the determination of long-run economic growth. In the short run, the causal connection between the variables is bidirectional, unidirectional or neutral, depending on the type of financial indicators that we incorporate in the estimation process.

One drawback of our analysis is that the period under consideration includes a set of crises (the Brazilian crisis, the September 11 terror attacks, and the worldwide financial crisis, including the debt crisis) that cause significant asymmetries. The classical VECM cannot capture these asymmetries. This implies that the causality among financial development, FDI and economic growth may be time-varying. Further investigation of this issue is an open area for future research[10].

Our present study carries the following policy implications.

6.1 With respect to the financial development and economic growth nexus

In order to promote economic growth, attention must be paid to policies that promote financial development. This, in turn, calls for fostering incentives to guarantee continued support to liberalize the economy, promote capital openness and focus on developing a country's infrastructure. Additionally, the level of financial infrastructure should be improved in order to have more financial innovation and application in the economy (see, *inter alia*, Beck and Levine, 2004; Herwartz and Walle, 2014). Furthermore, given the possibility of bidirectional causality, policies that increase economic growth would be desirable in order to bring about further financial development.

6.2 With respect to the foreign direct investment and economic growth nexus

To promote economic growth, a well-developed market for FDI is needed for the G-20 countries. This requires the development of a strategy by which FDI can adjust to the macroeconomic changes in order to enhance long-run economic growth. This can also include the relaxation of FDI restrictive policies wherever they exist. Policy makers ought to ensure that the FDI ecosystem is robust and supports knowledge spillover in the host economy to nurture entrepreneurship and next-generation enterprises that can contribute to economic growth. Countries without a sound institutional setup to improve the human capital will not be able to sustain viable FDI (see, *inter alia*, Borensztein *et al.*, 1998). This may hinder the development of start-up enterprises that have the potential to develop next-generation technologies and innovation that contribute to economic growth. Conversely, economic growth is likely to attract further FDIs.

6.3 With regard to the foreign direct investment and financial development nexus

In order to facilitate better financial development, a greater degree of FDI is desirable in the G-20 countries, and vice versa. The establishment of a well-developed financial market, including well-functioning banks and other financial institutions, can facilitate further investment and an easier means of raising capital to support the activities of FDI, which in turn could lead to better outcomes in the economy. On the flip side, improvements in FDI can support further development of the financial activities through increased organizational and operational efficiencies (see, *inter alia*, Agbloyor *et al.*, 2013).

Summing up, to stimulate long-term economic growth in the G-20 countries, policy makers should give priority to financial sector reforms, particularly with reference to banking sector development, stock market development and bond market development.

Additionally, sustainable economic growth ought to be a goal in these countries, since it would generate additional opportunities for banking sector development, stock market development and bond market development, as well as FDI, at least in the short run.

Notes

1. The estimation of the VECM is very sensitive to the choice of lag length, as the causality test results depend on the lag specification. The study uses the Akaike information criterion and the Schwarz–Bayesian information criterion to determine the optimum lag length for each specification and each case (see below for further discussion).
2. We have an unbalanced panel as dictated by data availability on the countries over the period 1970–2016.
3. The countries are Argentina, Brazil, China, India, Indonesia, Mexico, the Russian Federation, Saudi Arabia, South Africa, Turkey, Australia, Canada, France, Germany, Italy, Japan, the Korean Republic, the UK and the USA. The European Union is excluded to avoid double counting countries.
4. The procedural details are discussed in Pradhan, Arvin, Norman and Hall (2014) and Pradhan *et al.*
5. BSD is the weighted average of the four banking sector development indicators, namely, DCP, PCO, DCF and DCB. The weights of this index are derived by PCA. Appendix 1 provides a brief description of these weights and the index construction (see Table A1).
6. SMD is the weighted average of the four stock market development indicators, namely, SMC, SVT, STR and SNL. The weights of this index are derived by PCA (for details see Table A2).
7. BMD is the weighted average of the four bond market development indicators, namely, DPR, DPU, IPR and IPU. The weights of this index are derived by PCA (for details see Table A3).
8. Variation is with respect to time series only, while country inclusion (19) remains the same under each specification.
9. This is to determine whether a time series variable is non-stationary and possesses a unit root (Bierens, 2001).
10. The techniques like two-regime vector error-correction model (see, for instance, Hansen and Seo, 2002) can be additionally used to trace the effects of these crises on the causality among financial development, foreign direct investment and economic growth in the G-20 countries.

References

Adeinyi, O., Omisakin, O., Egwaikh, F.O. and Oyinlola, A. (2012), "Foreign direct investment, economic growth and financial sector development in small open developing economies", *Economic Analysis and Policy*, Vol. 42 No. 1, pp. 105-127.

Adjasi, C.K.D., Abor, J., Osei, K.A. and Nyavor-Foli, E.E. (2012), "FDI and economic activity in Africa: the role of local financial markets", *Thunderbird International Business Review*, Vol. 54 No. 4, pp. 429-439.

Agbloyor, E.K., Abor, J. and Adjasi, C.K.D. (2013), "Exploring the causality links between financial markets and foreign direct investment in Africa", *Research in International Business and Finance*, Vol. 28 No. 2013, pp. 118-134.

Agbloyor, E.K., Abor, J., Adjasi, C.K. and Yawson, A. (2012), "Domestic banking sector development and cross border mergers and acquisitions in Africa", *Review of Development Finance*, Vol. 2 No. 1, pp. 32-42.

Ahmed, A.D. and Wahid, A.N.M. (2011), "Financial structure and economic growth link in African countries: a panel cointegration analysis", *Journal of Economic Studies*, Vol. 38 No. 3, pp. 331-357.

Ahmed, A.D., Cheng, E. and Messinis, G. (2011), "The role of exports, FDI and imports in development: evidence from Sub-Saharan African Countries", *Applied Economics*, Vol. 43 No. 26, pp. 3719-3731.

Alfaro, L., Kalemli-Ozcan, S. and Sayek, S. (2009), "FDI, productivity and financial development", *The World Economy*, Vol. 32 No. 1, pp. 111-135.

Alfaro, L., Chanda, A., Ozcan, S.K. and Sayek, S. (2004), "FDI and economic growth: the role of local financial markets", *Journal of International Economics*, Vol. 64 No. 1, pp. 89-112.

Alguacil, M.T., Cuadros, A. and Orts, V. (2002), "Foreign direct investment, exports and domestic performance in Mexico: a causality analysis", *Economic Letters*, Vol. 77 No. 3, pp. 371-376.

Al-Yousif, Y.K. (2002), "Financial development and economic growth: another look at the evidence from developing countries", *Review of Financial Economics*, Vol. 11 No. 2, pp. 131-150.

Arestis, P., Demetriades, P.O. and Luintel, K.B. (2001), "Financial development and economic growth: the role of stock markets", *Journal of Money, Credit and Banking*, Vol. 33 No. 1, pp. 16-41.

Ayyagari, M., Demirgüç-Kunt, A. and Maksimovic, V. (2007), "Formal versus informal finance: evidence from China", *Review of Financial Studies*, Vol. 23 No. 8, pp. 3048-3097.

Barro, R.J. and Sala-i-Martin, X. (1995), *Economic Growth*, McGraw Hill, New York, NY.

Beck, T. and Levine, R. (2004), "Stock markets, banks, and growth: panel evidence", *Journal of Banking and Finance*, Vol. 28 No. 3, pp. 423-442.

Beck, T., Levine, R. and Loayza, N. (2000), "Finance and the sources of growth", *Journal of Financial Economics*, Vol. 58 No. 1, pp. 261-300.

Bianchi, J. (2010), "Credit externalities: macroeconomic effects and policy implications", *American Economic Review*, Vol. 100 No. 2, pp. 398-402.

Bierens, H.J. (2001), "Unit roots", Chapter 29 in Baltagi, B. (Ed.), *A Companion to Econometric Theory*, Blackwell Publishers, Oxford, pp. 610-633.

Borensztein, E., Gregorio, J.D. and Lee, J.W. (1998), "How does foreign direct investment affect economic growth?", *Journal of International Economics*, Vol. 45 No. 1, pp. 115-135.

Chan, M.W., Hou, K., Li, X. and Mountain, D.C. (2014), "Foreign direct investment and its determinants: a regional panel causality analysis", *Quarterly Review of Economics and Finance*, Vol. 54 No. 4, pp. 579-589.

Choe, J.I. (2003), "Do foreign direct investment and gross domestic investment promote economic growth?", *Review of Development Economics*, Vol. 7 No. 1, pp. 44-57.

Choong, C. (2011), "Does domestic financial development enhance the linkages between foreign direct investment and economic growth?", *Empirical Economics*, Vol. 42 No. 3, pp. 819-834.

Choong, C.K., Yusop, Z. and Soo, S.C. (2004), "Foreign direct investment, economic growth, and financial sector development: a comparative analysis", *ASEAN Economic Bulletin*, Vol. 21 No. 3, pp. 278-289.

Craigwell, R., Downes, D. and Howard, M. (2001), "The finance-growth nexus: a multivariate VAR analysis of a small open economy", *Savings and Development*, Vol. 25 No. 2, pp. 209-223.

De Vita, G. and Kyaw, K.S. (2008), "Determinants of FDI and portfolio flows to developing countries: a panel cointegration analysis", *European Journal of Economics, Finance and Administrative Sciences*, Vol. 13 No. 13, pp. 161-168.

Desai, M.A., Foley, C.F. and Hines, J.R. Jr (2006), "Capital controls, liberalizations, and foreign direct investment", *The Review of Financial Studies*, Vol. 19 No. 4, pp. 1433-1464.

Desbordes, R. and Wei, S. (2017), "The effects of financial development on foreign direct investment", *Journal of Development Economics*, Vol. 127, pp. 153-168.

Duasa, J. (2007), "Malaysian foreign direct investment and growth: does stability matter?", *Journal of Economic Cooperation*, Vol. 28 No. 2, pp. 83-98.

Dwivedi, A. (2012), "Effect of FDI and trade on productivity in Indian electronics firms", *Economic Journal*, Vol. 60 No. 3, pp. 76-90.

Engle, R.F. and Granger, C.W.J. (1987), "Cointegration and error correction: representation, estimation and testing", *Econometrica*, Vol. 55 No. 2, pp. 251-276.

Freckleton, M., Wright, A. and Craigwell, R. (2012), "Economic growth, foreign direct investment and corruption in developed and developing countries", *Journal of Economic Studies*, Vol. 39 No. 6, pp. 630-652.

Freytag, A. and Frickea, S. (2017), "Sectoral linkages of financial services as channels of economic development- an input-output analysis of the Nigerian and Kenyan economies", *Review of Development Finance*, Vol. 7 No. 2017, pp. 36-44.

Greenwood, J. and Smith, B. (1997), "Financial markets in development, and the development of financial markets", *Journal of Economic Dynamics and Control*, Vol. 21 No. 1, pp. 145-181.

Hansen, B. and Seo, B. (2002), "Testing for two-regime threshold cointegration in vector error-correction models", *Journal of Econometrics*, Vol. 110 No. 2, pp. 293-318.

Hassan, K.M., Sanchez, B. and Yu, J. (2011), "Financial development and economic growth: new evidence from panel data", *Quarterly Review of Economics and Finance*, Vol. 51 No. 1, pp. 88-104.

Hermes, N. and Lensink, R. (2003), "Foreign direct investment, financial development and economic growth", *Journal of Development Studies*, Vol. 40 No. 1, pp. 142-163.

Herwartz, H. and Walle, Y.M. (2014), "Determinants of the link between financial and economic development: evidence from a functional coefficient model", *Economic Modelling*, Vol. 37 No. 2, pp. 417-427.

Herzer, D., Klasen, S. and Nowak-Lehmann, F.D. (2008), "In search of FDI-led growth in developing countries: the way forward", *Economic Modelling*, Vol. 25 No. 5, pp. 793-810.

Hsueh, S., Hu, Y. and Tu, C. (2013), "Economic growth and financial development in Asian countries: a bootstrap panel Granger causality analysis", *Economic Modelling*, Vol. 32 No. 3, pp. 294-301.

Jedidia, K.B., Boujelbene, T. and Helali, K. (2014), "Financial development and economic growth: new evidence from Tunisia", *Journal of Policy Modelling*, Vol. 36 No. 5, pp. 883-898.

Kholdy, S. and Sohrabian, A. (2008), "Foreign direct investment, financial markets, and political corruption", *Journal of Economic Studies*, Vol. 35 No. 6, pp. 486-500.

Law, S.H. and Singh, N. (2014), "Does too much finance harm economic growth?", *Journal of Banking and Finance*, Vol. 41 No. 3, pp. 36-44.

Lean, H.H. and Tan, B.W. (2011), "Linkages between foreign direct investment, domestic investment and economic growth in Malaysia", *Journal of Economic Cooperation and Development*, Vol. 32 No. 4, pp. 75-96.

Levin, A., Lin, C.F. and Chu, C.S.J. (2002), "Unit root tests in panel data: asymptotic and finite-sample properties", *Journal of Econometrics*, Vol. 108 No. 1, pp. 1-24.

Levine, R. (1998), "The legal environment, banks, and long-run economic growth", *Journal of Money, Credit and Banking*, Vol. 30 No. 3, pp. 596-613.

Levine, R. (2003), "More on finance and growth: more finance, more growth?", *Federal Reserve Bank of St Louis Review*, Vol. 85 No. 6, pp. 31-46.

Liang, Q. and Teng, Z. (2006), "Financial development and economic growth: evidence from China", *China Economic Review*, Vol. 17 No. 2, pp. 395-411.

Liu, X., Wang, C. and Wei, Y. (2001), "Casuals link between foreign direct investment and trade in China", *China Economic Review*, Vol. 12 No. 2, pp. 190-202.

Menyah, K., Nazlioglu, S. and Wolde-Rufael, Y. (2014), "Financial development, trade openness and economic growth in African countries: new insights from a panel causality approach", *Economic Modelling,*, Vol. 37 No. 2, pp. 386-394.

Ngare, E., Nyamongo, E.M. and Misati, R.N. (2014), "Stock market development and economic growth in Africa", *Journal of Economics and Business*, Vol. 74 No. 1, pp. 24-39.

Odhiambo, N.M. (2010), "Finance-investment-growth nexus in South Africa: an ARDL bounds testing procedure", *Economic Change Restructuring*, Vol. 43 No. 3, pp. 205-219.

Otchere, I., Soumaré, I. and Yourougou, P. (2016), "FDI and financial market development in Africa", *The World Economy*, Vol. 39 No. 5, pp. 651-678.

Pedroni, P. (1999), "Critical values for cointegration tests in heterogeneous panels with multiple regressors", *Oxford Bulletin of Economics and Statistics*, Vol. 61 No. S1, pp. 653-670.

Pradhan, R.P., Arvin, M.B. and Bahmani, S. (2015), "Causal nexus between economic growth, inflation, and stock market development: the case of OECD countries", *Global Finance Journal*, Vol. 27, July, pp. 98-111.

Pradhan, R.P., Arvin, M.B. and Ghoshray, A. (2015), "The dynamics of economic growth, oil prices, stock market depth, and other macroeconomic variables: evidence from the G-20 countries", *International Review of Financial Analysis*, Vol. 39, pp. 89-95, available at: https://doi.org/10.1016/j.irfa.2015.03.006

Pradhan, R.P., Arvin, M.B. and Hall, J.H. (2018), "The nexus between economic growth, stock market depth, trade openness, and foreign direct investment: the case of ASEAN countries", *Singapore Economic Review*, Vol. 63 No. 1, pp. 1-33.

Pradhan, R.P., Arvin, M.B., Hall, J.H. and Nair, M. (2016), "Trade openness, foreign direct investment, and finance-growth nexus in the Eurozone countries", *Journal of International Trade and Economic Development*, Vol. 26 No. 3, pp. 336-360.

Pradhan, R.P., Arvin, M.B., Norman, N.R. and Hall, J.H. (2014), "The dynamics of banking sector and stock market maturity and the performance of Asian economies", *Journal of Economic and Administrative Sciences*, Vol. 30 No. 1, pp. 16-44.

Pradhan, R.P., Arvin, M.B., Norman, N.R. and Nishigaki, Y. (2014), "Does banking sector development affect economic growth and inflation? A panel cointegration and causality approach", *Applied Financial Economics*, Vol. 24 No. 7, pp. 465-480.

Pradhan, R.P., Arvin, M.B., Bahmani, S., Hall, J.H. and Norman, N.R. (2017), "Finance and growth: evidence from the ARF countries", *Quarterly Review of Economics and Finance*, Vol. 66 No. 4, pp. 136-148.

Pradhan, R.P., Arvin, M.B., Bahmani, S., Hall, J.H. and Norman, N.R. (2018), "Are innovation and financial development causative factors in economic growth? Evidence from a panel Granger causality test", *Technological Forecasting & Social Change*, Vol. 132, July, pp. 130-142.

Pradhan, R.P., Arvin, M.B., Bennett, S.E., Nair, M. and Hall, J.H. (2016), "Bond market development, economic growth and other macroeconomic determinants: panel VAR evidence", *Asia-Pacific Financial Markets*, Vol. 23 No. 2, pp. 175-201.

Pradhan, R.P., Arvin, M.B., Nair, M., Hall, J.H. and Gupta, A. (2017), "Is there a link between economic growth and insurance and banking sector activities in the G-20 countries?", *Review of Financial Economics*, Vol. 33 No. 1, pp. 12-28.

Quartey, P. and Prah, F. (2008), "Financial development and economic growth in Ghana: is there a causal link?", *African Finance Journal*, Vol. 10 No. 1, pp. 28-54.

Rousseau, P.L. and Wachtel, P. (2000), "Banks, stock markets and China's great leap forward", *Emerging Markets Review*, Vol. 8 No. 3, pp. 206-217.

Saini, N. and Singhania, M. (2018), "Determinants of FDI in developed and developing countries: a quantitative analysis using GMM", *Journal of Economic Studies*, Vol. 45 No. 2, pp. 348-382.

Schumpeter, J.A. (1911), *The Theory of Economic Development*, Harvard University Press, Cambridge, MA.

Seetanah, B. and Ramessur, S.T. (2009), "Financial development and economic growth: new evidence from a sample of Island economies", *Journal of Economic Studies*, Vol. 36 No. 2, pp. 124-134.

Sunde, T. (2017), "Foreign direct investment, exports and economic growth: ADRL and causality analysis for South Africa", *Research in International Business and Finance*, Vol. 41 No. C, pp. 434-444.

Tang, T.C. and Wong, K.N. (2011), "Foreign direct investment, merchandise and services trade in a transition economy: the case of Cambodia", *International Economic Journal*, Vol. 25 No. 2, pp. 251-267.

Tsagkanos, A., Siriopoulos, C. and Vartholomatou, K. (2018), "Foreign direct investment and stock market development: evidence from a 'new' emerging market", *Journal of Economic Studies*, Vol. 46, pp. 55-70, available at: https://doi.org/10.1108/JES-06-2017-0154

Wu, J., Hou, H. and Cheng, S. (2010), "The dynamic impacts of financial institutions on economic growth: evidence from the European union", *Journal of Macroeconomics*, Vol. 32 No. 3, pp. 879-891.

Xiaohui, L., Burridge, P. and Sinclair, P.J.N. (2002), "Relationships between economic growth, foreign direct investment and trade: evidence from China", *Applied Economics*, Vol. 34 No. 11, pp. 1433-1440.

Yalta, A.Y. (2013), "Revisiting the FDI-led growth hypothesis: the case of China", *Economic Modelling*, Vol. 31 No. 3, pp. 335-343.

Zhang, K.H. (2001), "Does foreign direct investment promote economic growth? Evidence from East Asia and Latin America", *Contemporary Economic Policy*, Vol. 19 No. 2, pp. 175-185.

Zhao, L., Wei, Z. and Andreosso-O'Callaghan, B. (2017), "FDI outflows, exports and financial development", *Journal of Economic Studies*, Vol. 44 No. 6, pp. 987-1002.

Further reading

Ang, J.B. (2009), "Financial development and the FDI-growth nexus: the Malaysian experience", *Applied Economics*, Vol. 41 No. 13, pp. 1595-1601.

Appendix 1. Formulation of a composite index of banking sector development, stock market development and bond market development using principal component analysis

We construct three composite indices of financial development, namely banking sector development (BSD), stock market development (SMD) and bond market development (BMD), through principal component analysis (PCA). Such an approach is detailed in several sources, including Pradhan, Arvin and Hall (2018) and Pradhan, Arvin, Bahmani, Hall and Norman (2018). Hence, it will not be described here.

The variables included in the construction of "BSD" are domestic credit to private sector (DCP), private credit by deposit money banks and other financial institutions (PCO), domestic credit provided by the financial sector (DCF) and domestic credit to private sector by banks (DCB). We choose only these four banking sector development indicators in our index since they all have a common unit of measurement: all are expressed in percentage. Table AI presents the statistical values from our PCA.

The variables included in the construction of "SMD" are SMC, stock market value traded stocks (SVT), STR and the number of listed companies in the stock market (SNL). We choose only these four stock market development indicators in our index since they all have a common unit of measurement: all are expressed in percentage. Table AII presents the statistical values from our PCA.

The variables included in the construction of "BMD" are domestic private bonds (DPR), domestic public bonds (DPU), international private bonds (IPR) and international public bonds (IPU). We choose only these four bond market development indicators in our index since they all have a common unit of measurement: all are expressed in percentage. Table AIII presents the statistical values from our PCA.

Table AI. Summary of PCA-related information for the composite index of banking sector development (BSD)

Part I: Eigen analysis of correlation matrix				
PCs	Eigen value	Proportion	Cumulative	
1	3.6655	0.9164	0.9164	
2	0.2280	0.0570	0.9734	
3	0.0826	0.0206	0.9940	
4	0.0239	0.0060	1.0000	
Part II: Eigen vectors (component loadings)				
Variables	PC1	PC2	PC3	PC4
DCP	0.515	0.197	0.174	−0.816
PCO	0.508	0.245	0.644	0.517
DCF	0.501	0.375	−0.738	0.250
DCB	0.475	−0.872	−0.098	0.069

Notes: PCs denotes principal components; variables were defined earlier
Source: Authors' calculations

Table AII. Summary of PCA-related information for the composite index of stock market development (SMD)

Part I: Eigen analysis of correlation matrix				
PCs	Eigen value	Proportion	Cumulative	
1	2.2131	0.5533	0.5533	
2	0.9732	0.2433	0.7966	
3	0.6736	0.1684	0.9650	
4	0.1402	0.0350	1.0000	
Part II: Eigen vectors (component loadings)				
Variables	PC1	PC2	PC3	PC4
SMC	0.467	−0.605	0.442	0.471
SVT	0.626	0.109	0.261	−0.726
STR	0.435	0.749	0.033	0.499
SNL	0.448	−0.250	−0.858	0.040

Note: PCs denotes principal components; variables were defined earlier
Source: Authors' calculations

Table AIII. Summary of PCA-related Information for the composite index of bond market development (BMD)

Part I: Eigen analysis of correlation matrix				
PCs	Eigen value	Proportion	Cumulative	
1	1.7510	0.4377	0.4377	
2	0.9197	0.2299	0.6677	
3	0.8735	0.2184	0.8861	
4	0.4558	0.1139	1.0000	
Part II: Eigen vectors (component loadings)				
Variables	PC1	PC2	PC3	PC4
DCP	0.633	0.182	−0.155	−0.736
PCO	0.538	0.595	0.107	0.588
DCF	0.363	−0.493	0.790	0.023
DCB	0.422	0.608	0.583	−0.335

Note: PCs denotes principal components; variables were defined earlier
Source: Authors' calculations

Appendix 2. A note on panel unit root test and panel cointegration test

Panel unit root test

It can be noted that data generating for many economic variables are characterized by stochastic trends that might result in spurious inference if the time series properties are not investigated. A time series is said to be stationary if the mean and autocovariance of the series do not depend on time. Any series that is not stationary has a unit root. The formal method to test the stationarity is the unit root test. The panel unit root test is conducted to determine the stationarity of the series, i.e., to ascertain the degree (or order) of integration for financial development, FDI and economic growth. Three-unit root tests are conducted in this paper. These tests are Levin–Lin–Chu, augmented Dickey–Fuller and Phillips and Perron. We do not present the details of these tests here as they are covered in most time series and/or econometric textbooks.

Panel cointegration test

Cointegration test is deployed to know whether there is a long-run relationship among financial development, FDI and economic growth. The available techniques for panel cointegration tests are, in essence, an application of the Engle and Granger (1987) cointegration analysis. As in the analysis of single time series, these approaches test the residuals from the estimation for stationarity. Pedroni (1999) provide different statistics for this purpose, both of which assume homogenous slope coefficients across the countries. These tests are adequately described in advanced econometric textbooks.

Appendix 3. VECM estimation results and lag specification

Table AIV. Lag specification for VECM estimation

Cases/Items	Dependent variable specifications		
Specification 1: VECM with PEG, FDI and BAS			
	PEG	FDI	BAS
Case 1.1: DCP	−3.18 [−3.10]	0.46 [0.54]	−0.84 [−0.70]
Case 1.2: PCO	−3.18 [−3.08]	0.46 [0.71]	−3.48 [−3.39]
Case 1.3: DCF	−3.20 [−3.11]	0.51 [0.60]	−3.32 [−3.23]
Case 1.4: DCB	−3.18 [−3.10]	0.47 [0.55]	−2.72 [−2.63]
Case 1.5: BSD	−3.20 [−3.12]	−0.49 [−0.57]	−2.03 [−1.95]
Specification 2: VECM with PEG, FDI and STM			
	PEG	FDI	BAS
Case 1.1: SMC	−3.25 [−3.12]	0.36 [0.50]	−1.78 [−1.64]
Case 1.2: SVT	−3.10 [−2.97]	0.26 [0.39]	−1.44 [−1.30]
Case 1.3: STR	−3.11 [−2.98]	0.24 [0.37]	−0.77 [−0.64]
Case 1.4: NLC	−3.29 [−3.21]	0.47 [0.56]	−2.55 [−2.46]
Case 1.5: SMD	−3.21 [−3.12]	0.45 [0.54]	−1.82 [−1.70]
Specification 3: VECM with PEG, FDI and BOM			
	PEG	FDI	BAS
Case 1.1: DPR	−3.30 [−3.20]	0.49 [0.59]	−1.95 [−1.85]
Case 1.2: DPU	−3.23 [−3.14]	0.47 [0.56]	−1.61 [−1.52]
Case 1.3: IPR	−3.17 [−3.06]	0.67 [0.78]	−2.76 [−2.65]
Case 1.4: IPU	−3.12 [−3.01]	0.57 [0.68]	−0.91 [−0.80]
Case 1.5: BMD	−3.25 [−3.16]	0.75 [0.84]	−0.70 [−0.61]

Notes: Variables are defined in Table II. LD is level data, and FD is first difference data. First figures relate to AIC statistics, while bracketed ones relate to SBC statistics. The lag lengths are selected on the basis of both AIC and SBC statistics. Complete estimated results are not reported here due to space constraints and are available upon request

Source: Authors' calculations

About the authors

Rudra Pradhan is SAP Fellow and Associate Professor at Indian institute of Technology Kharagpur, India, where he has been associated with Vinod Gupta School of Management and RCG School of Infrastructure Design and Management. Pradhan is affiliated with various professional journals like *Journal of Economic Development* (*Associate Editor*), *Heliyon (Editorial Board Member)*, *Financial Innovation* (*Editorial Board Member*), *Emerald's Emerging Market Case Studies* (*Editorial Board Member*), *Journal of Corporate Finance*, *International Journal of Sustainable Transportation, IEEE Transactions on Engineering Management, Technology Forecasting and Social Change, Futures, Telecommunications Policy*, *Cities*, *Empirica* and *Neural Computing and Applications*. Dr Pradhan is Visiting Professor at Asian Institute of Technology, Thailand and Visiting Scholar at the University of Pretoria, South Africa. Dr Rudra Pradhan is the corresponding author and can be contacted at: rudrap@vgsom.iitkgp.ernet.in

Mak B. Arvin is Full Professor of Economics at Trent University, Peterborough, Ontario, Canada, where he has been a faculty member for the past 28 years. He is the author of 130 papers and reviews in refereed journals as well as several books on many topics. Arvin is associated with over a dozen professional journals. He is the Editor-in-Chief of the *International Journal of Happiness and Development.* In addition, he is on the editorial board of ten journals and the Associate Editor of three more. He has been a visiting professor to Boston College and a consultant to IFO Institute for Economic Research, Germany.

Sahar Bahmani is Assistant Professor at the Department of Economics, University of Wisconsin at Parkside, Kenosha, Wisconsin, USA. Her area of interest includes ICT infrastructure and technology management. She has published extensively in monetary economics and was named a Wisconsin Teaching Fellow for the 2013–2014 academic year.

John H. Hall is Professor in the Department of Financial Management at the University of Pretoria in the Republic of South Africa. He has published numerous articles in scholarly journals (some of which have received best paper awards) and has presented research papers on a number of conferences both locally and internationally. He has supervised a number of doctoral and Master's students.