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The Link between Financial Development and Knowledge-Based Economy - Evidence from Emerging Markets[1]

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This paper examines the role of financial development in shaping knowledge-based economy in emerging countries using panel data approach from 1995 to 2011. On overall financial development, we find that larger financial sector and financial system that is more bank-based are associated with higher knowledge economy status. On banking development, our results show that a well-developed banking sector contributes positively to a country's standing in the knowledge economy index. Interestingly, we find no evidence that stock market influences the state of knowledge economy. The findings suggest that bank-based financial system is the key financial structure that best supports knowledge-based development in emerging countries.

1. Introduction

A key feature of economies in the 21st century is that accelerated economic growth rests upon innovation and knowledge-intensive activities. Unlike the traditional production-based economy that intensively utilizes tangible production factors such as capital, labour, and raw material inputs, a knowledge-based economy derives its growth factor from intensive applications of knowledge anchored on nation's innovative and creative capacities. To remain relevant in a globally

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competitive economy, many emerging countries have shifted, or are in the process of shifting their economies to become more knowledge-intensive and such transformation is essential for a nation to achieve high-income status. With the importance of knowledge as prime driver of economic growth, initiatives and strategies are being crafted to speed up and enhance a nation's knowledge capacity. In most cases, efforts are targeted to strengthen the real knowledge-drivers and social dimensions of the economy as key determinants for successful transition to knowledge economy. Among others, inputs to knowledge-activities are mostly constrained to scientific and technological capability, quality of human capital, and hard knowledge-infrastructure. This study adds to the literature by examining the role of finance in shaping the knowledge-intensive economy.

With the changing features of the real sector and foundation of economic growth, and given the rising importance of knowledge-capacity in mapping growth potentials of emerging nations, unlocking the possible link between financial development vis-à-vis knowledge-based economies is highly critical in preparing the transition path. In the knowledge economy transformation process, the status of a country's financial development can have profound influence on its pace of transition. A financial sector that is under-developed would severely constrain many of the efforts made during the transition and the longer an economy is trapped in the middle of the transition, the slower it can benefit from the positive outcomes of knowledge revolution. Financial development may contribute to making major advances in the critical component of knowledge economy eco-system. In knowledge-oriented economies, many of the productive assets are now intangible in nature, and financial development by enabling these assets to be financed, acts as an important growth catalyst. As such, financial development deserves similar emphasis of equal importance as other scientific and technological capabilities that are currently being prioritized.

The idea that finance exerts real effects on the economy is widely established. Studies on finance-growth nexus have highlighted the important link between finance and growth in a traditional production-based economy. Theoretical explanations on finance-growth link are largely grounded on the ability of financial sector to resolve various real market-friction type problems that hinders real activities. Financial sector is proposed, among others, to act as efficient monitoring agent

(Diamond, 1984; Ramakrisnan and Thakor, 1984; Boyd and Prescott, 1986); foster corporate governance (Jensen and Meckling, 1976; Jensen and Murphy, 1990); efficiently smoothed risk intertemporally (Allen and Gale, 1997); reduce information acquisition costs, stimulate information production and provide research function (Grossman and Stiglitz, 1980; Merton, 1987; Holmstrom and Tirole, 1993); all of which facilitate the flow of capital to its highest value use. Levine (2005) provides a comprehensive review on the important link between finance and growth.

Core to the knowledge economy, the increasing utilization of intangible assets will naturally exacerbates the degree of market-frictions particularly those of asymmetry information type that are pronounce in screening and monitoring activities. Limited studies explore the role of finance in influencing knowledge-based development. Past studies show that frictions in the capital markets contribute to significant differences in the level of adoption and in the speed of diffusion of new technologies across countries, and constrain the growth and innovativeness of firms (Comin and Nanda, 2009; Correa et al., 2010; Hyytinen and Toivanen, 2005). As financial functions are aimed at ameliorating market frictions, this could possibly suggest an important role of financial sector in affecting the overall readiness of a country for knowledge economy. Financial development may affect a country's ability to successfully transform into knowledge economy and as such, knowledge-oriented economy demands further examination of the finance-growth link. In the present study, we build on the idea that finance does matter for knowledge-based growth and we examine the potential role of finance in influencing the state of knowledge economy in emerging nations. Panel data regression analysis is employed to examine the impact of overall financial development as well as the separate impacts of banks and stock market on the states of knowledge economy in emerging countries. The findings of this study expand existing literature on the working of knowledge-intensive economy and provide valuable insights for policy makers to sharpen knowledge-related policies and strategies required for a sustainable knowledge-led development. The remainder of the paper is organized as follows. Section 2 reviews the literature and Section 3 presents the data and methodology. Section 4 reports the empirical results and Section 5 concludes the study.

2. Literature Review

The increasing knowledge intensity at all levels of the society calls for profound structural and qualitative changes in the operation of economy and transforms the basis of competitive advantage (Houghton and Sheehan, 2000; David and Foray, 2002) which is important for a nation to achieve high-income status. According to a report jointly published by the Korea Development Institute and the World Bank Institute in 2006, the pivotal role of government in a country's successful transition to knowledge-intensive economy is to engage private sector to take the lead in driving knowledge-based development where companies and business community are the key engines of growth. As highlighted in the report, a country's policy framework for knowledge-based economy typically involves ingredients such as making investments in education system, building innovation capability, upgrading information infrastructure, and having an economic environment that is conducive to market transactions. While these elements are essential for knowledge-based development, a supportive regulatory framework is one of the most important requirements for encouraging private sector participation.

The regulatory quality indicator of the World Bank which is available in the Worldwide Governance Indicator (WGI) database, measures the ability of the government to formulate and implement sound policies and regulations that permit and promote private sector development. Regulatory restraints in the credit and labour markets as well as in the overall business environment would hinder a country's ability to respond rapidly to capitalise on the dynamic changes and opportunities brought about by knowledge revolution. The importance of regulatory system in supporting knowledge-based development lies in its role in fostering reciprocal trust and confidence among businesses and consumers given that many of the knowledge-based activities involve intangible ideas, assets, and opportunities. Empirical evidence suggests that regulatory policy of a country needs to be such that market players have the incentives to engage in innovation pursuits and expand technological capability, which are important for knowledge-based development (Ginarte and Park, 1997; Varsakelis, 2001; Chen and Dahlman, 2004; Gust and Marquez, 2004; Varsakelis, 2006; Fu, 2008; Ang, 2010; Ang, 2011; Barbosa and Faria, 2011; among others). Barbosa and Faria (2011) examines the role of institutional environment

on innovation activities and find that stringent regulations in product and labour markets have negative effects on the intensity of innovation. As noted by Barbosa and Faria (2011), while regulations may not cover all aspects of an institution, a country's regulatory structure includes some of the most basic and important elements that shape the institutional environments affecting business activities.

Numerous studies have shown that increased flow of information and knowledge through the usage of information and communication technology (ICT) is crucial for reducing uncertainty and transaction costs, all of which contribute to knowledge-related economic growth (Cette et al., 2005; Chen and Dahlman, 2004; Asian Development Bank, 2007; Vu, 2011; among others). Lee et al. (2005) find that investment in ICT is positively related to productivity growth in developed but not in developing nations. Employing personal computers, internet users, and mobile phones as measures for ICT, Vu (2011) finds that ICT diffusion is significantly and positively related to economic growth. Research has also indicated that technological cooperation, collaboration, and networking expedite knowledge accumulation and contributes positively to innovation process and knowledge development (Becker and Dietz, 2004; Faria et al., 2010; and Zeng et al., 2010).

There is little doubt that education has a crucial role to play in the knowledge economy transformation process. The findings of Salmi (2003) show that tertiary education contributes significantly to the creation of knowledge that is essential for building a well-educated society. Lundvall et al. (2002) emphasize that education is important in bringing forth highly skilled entrepreneurs to create new products and introduce innovative production methods into the competitive marketplace. These findings augment and complement those of Chen and Dahlman (2004), Wang (2010), Youtie and Shapira (2008), and Spielman et al. (2008) that educational quality increases a country's innovative output and thus leading to better growth prospects.

In today's globalized market, a country's openness to international trade determines the extent to which it is able to capitalize on global knowledge network to enhance competitiveness and accelerate knowledge-led economic growth. According to Chen and Dahlman (2004), a "knowledge-conducive" economic regime is one that generally has minimal price distortions, is open to international trade and has

policies that foster healthy competition and promote entrepreneurial efforts. Chen and Dahlman (2004) in their study of the link between knowledge creation and economic growth employed an index of trade openness developed by Sachs and Warner (1995) to proxy for a country's economic regime. As contended by Sachs and Warner (1995), while trade policy represents just one aspect of an overall economic policy, it is considered the most relevant aspect featuring important policy actions that shape and maintain a country's economic development. Numerous empirical studies examine the possible link between international trade and development of technological knowledge. A country's openness can enhance dissemination of global technological knowledge, facilitate technology diffusion, and increase knowledge productivity, all of which contribute to making advancement towards knowledge-based economy. In general, the findings support the notion that international trade plays important role in promoting innovation and technological advancements (Sachs and Warner, 1995; Coe and Helpman, 1995; Eaton and Kortum, 1996; Coe et al., 1997; Chen and Dahlman, 2004; among others). The result of Schneider (2005) suggests that international trade in the form of high technological imports is important in explaining cross-country differences in domestic innovation both in developed and developing countries. Additionally, Okabe (2003), Bhattacharya and Bloch (2004), Matsubara (2005) find evidence that trade openness increases technology diffusion which in turn encourages knowledge-based activities.

Cohen and Levinthal (1990) find that innovation capacity depends on prior knowledge stock accumulation which allows innovation actors to develop new ideas and knowledge, hence suggesting a direct relation between innovation and knowledge creation. Numerous studies provide evidence suggesting that income plays an important role in accelerating the rate of information and knowledge transfer. That is, the pace of innovation increases when consumers have more money to purchase innovative products (Teitel, 1994; Romer, 1994; Barbosa and Faria, 2011; among others). Sullivan and Sheffrin (2004) describe income effect as the change in consumption pattern due to a change in consumer's real income. When consumers get richer, they tend to demand more differentiated products and this encourages firms to create new and innovative ideas that can potentially increase the production of knowledge-based products in the economy.

A huge body of literature finds that a well-functioning financial sector often represents a major element of sustainable economic development. Financial system influences economic growth by easing market frictions and thereby improving resource allocation, risk distribution and management, information acquisitions, corporate governance, and financial exchanges. Linking to the classical views such as Bagehot (1873), Schumpeter (1912), Gurley and Shaw (1955), Goldsmith (1969), McKinnon (1973), and Shaw (1973) provides early modern proponents that suggest finance matters for growth. Other studies include Boyd and Prescott (1986), Greenwood and Jovanovic (1990), King and Levine (1993a, 1993b), Levine (1997), Beck et al. (2000), Demirguc-Kunt (2006), among others.

Prior research on financial sector development provides supportive view that finance potentially has important role in enhancing the ability of a country to shift to knowledge economy. Schumpeter (1912, p.74) highlighted his idea of the role of finance in economic development in ways that foster entrepreneurial growth in the following statement, "*The banker, therefore, is not so much primarily a middleman ... He authorizes people in the name of society...(to innovate)*". According to the author, entrepreneurs act as innovator who is proficient in creating radical changes to the economy in a procedure that he called as "*creative destruction*". King and Levine (1993b), Morales (2003), and Acemoglu et al. (2006) offer support for Schumpeter's (1912) view that banks promote innovation-related activities. They find that banks provide capital to entrepreneurs for executing new innovative technology-based projects that have the highest success rate. This implies that financial sector has a positive influence on knowledge-related growth in ways that foster innovative activities by altering the resource allocation process.

The advocates of bank-based view such as Diamond (1984), Ramakrisnan and Thakor (1984), Allen and Gale (1999), Boot and Thakor (1997), and among others highlight the advantages of well-functioning banks in fostering entrepreneurship and economic growth. In addition to banks, stock markets also act as unique agents that resolve various market imperfections-type problems that prohibit efficient allocation of resources. Market-based financial systems are favoured by Levine (1991), Jensen and Murphy (1990), Holmstrom and Tirole (1993), among others. Larger banks and more liquid stock markets facilitate firms that rely heavily on external capital to grow successfully

(Levine, 1997). Prior research finds that stock market has a special role of enhancing market liquidity, without which investments will be restricted to low risk-short maturity project. Trading facilities offered by stock markets, where shares are bought and sold at competitive prices, permit premature liquidation of financial assets that channels more resources into longer-term investments (Levine, 1991; Bencivenga et al., 1995). Several studies show that well-functioning stock market that offers profitable trading activities promote research activities on firms and increase the speed of information flow that are critical in the allocation of scarce resources (Holmstrom and Tirole, 1993; Boot and Thakor, 1997). Threat of takeovers promotes application of good governance and effective decisions that lead to greater efficiency among existing firms (Jensen and Murphy, 1990). Research also indicate that an active venture capital industry combined with a liquid stock market are important for a successful development of high technology sector due to the sector's unique financing feature of evolving pattern of control by different investor groups (Mayer, 2002).

Numerous studies present evidence suggesting that financial development provides advantages to industries and firms that are dependent on external finance, and have substantial amount of intangible assets for instance, hi-technology, innovation, and research and development intensive sectors and industries with highly skilled workforce (Rajan and Zingales, 2001; Mayer, 2002; Carlin and Mayer, 2003). In an influential study, Rajan and Zingales (1998) show that industries that rely heavily on external financing perform better if they operate in countries with well-developed banks and stock markets. That is, industries that are highly dependent on external finance should benefit more from higher level of financial development than industries that use little external finance. In the context of knowledge economy, firms engaging in knowledge intensive activities such as research and development or other knowledge-related investments are essentially heavy users of external finance. It follows that such firms should benefit greatly from greater financial development. Similarly, Pang and Wu (2009) finds that countries with better developed financial market invest more in growing industries and this pattern is more prominent for industries that are more dependent on external finance. Hyytinen and Toivanen (2005) find that capital market imperfections constrain the growth and innovativeness of firms, thus reinforcing the important role finance plays in resolving market frictions. The studies of Aghion et al.

(2005), Aghion and Howitt (2009), Ang (2011), Barbosa and Faria (2011), and Maskus et al. (2012) complement earlier findings that financial development plays a key role in supporting innovation-related activities. In a recent study, Tee et al. (2014) highlight the importance of adopting sound policies for enhancing banking sector development in promoting innovative activities. Yartey (2008) finds that credit and stock markets are essential for increasing information and communication technology penetration. That is, a well-functioning financial sector is needed for the accumulation and diffusion of knowledge in bridging information gap across countries. According to Aghion et al. (2005) and Aghion and Howitt (2009), financial market imperfections make fraud an affordable option because firms have incentives to deceive creditors by covering up rewarding innovative inventions in order to avoid loan repayments. For this reason, creditors are reluctant to provide financing for innovative activities and consequently this can hold back the development of innovation-related knowledge.

Estrada et al. (2010) highlight the importance of financial development in supporting the transition of developing countries toward knowledge-based economies. They argue that the lack of access to finance constraints new and inventive firms from entering the market as these firms are unable of self-financing. Thus, sound and efficient banking sectors and stock markets promote the development of knowledge-based industries in emerging countries by providing various forms of financial services. Similarly, Ang (2010) documents that financial deepening spurs credit provision to innovative firms and therefore enhances knowledge accumulation in an emerging market. According to Asian Development Bank (2014), the effective allocation of capital to entrepreneurial firms encourages them to create new products and services which would be important in accelerating knowledge-based economic development in developing countries of Asia.

In this study, we build on the idea that finance matters for knowledge-based development. We examine the extent to which the status of knowledge economy of a country is affected by financial sector development. Specifically, we examine whether countries that are more financially developed have higher scores on their knowledge economy indices. A country with higher value of knowledge economy index suggests faster pace of transformation into knowledge-intensive

economy. The findings offer valuable insights to facilitate emerging nations' continued transition to the knowledge-based economy.

3. Data and Methodology

This study covers 17 emerging countries with relevant annual data that spans over a 17-year period from 1995 to 2011. The sample countries are Brazil, Chile, Colombia, Czech Republic, Hungary, India, Indonesia, Malaysia, Mexico, Peru, Philippines, Poland, Russia, South Africa, South Korea, Thailand, and Turkey.

We employ panel data analysis to examine the role of finance in influencing a country's transition towards knowledge-intensive economy as measured by a country's knowledge economy index. We employ Hausman specification tests to confirm the appropriateness of random effect models under the null hypothesis that individual specific effects are distributed independently of the regressors. That is, $\text{Cov}(\alpha_i, X_{it}) = 0$, $t = 1,2,\ldots,T$. Failing to reject the null hypothesis suggests that random effect model is more efficient than the fixed effect model. We conduct heteroskedasticity test and the results reject the null hypothesis of homoskedasticity. Therefore, we estimate the heteroskedastic robust standard error to eliminate potential biases in the estimated standard errors. The panel regression specification is shown as follows:

$$KEI_{it} = \beta_0 + \beta_1 FINDEV_{it-1} + \beta_2 TRADE_{it} + \beta_3 RGDP_{it} + \beta_4 CONSUMPTION_{it} + \beta_5 REGULATORY_{it} + \beta_6 EDUCATION_{it} + \beta_7 PATENT_{it} + \beta_8 COMPUTER_{it} + \beta_9 TECHCOOP_{it} + \alpha_i + \varepsilon_{it} \quad [1]$$

$t = 1,...,T;\ i = 1,...,N$

where subscript i refers to country and t refers to time period; α_i is individual specific effects and ε_{it} is the error term. FINDEV is financial development measures. To address the potential endogeneity issue between financial development indicators and knowledge economy index, a one-year lag on all financial development measures is imposed.[6] TRADE is international trade to GDP; RGDP is real Gross Domestic

[6] We are grateful to the anonymous reviewer for raising this issue which improved and strengthened our results.

Product per capita (constant 2000 USD); CONSUMPTION is household consumption expenditure to GDP; REGULATORY is regulatory quality; EDUCATION is total public education expenditure to GDP; PATENT is the number of patent granted; COMPUTER is the number of personal computers per 100 people; and TECHCOOP is technological cooperation.

The dependent variable is knowledge economy index (KEI), sourced from the World Bank's Knowledge for Development (K4D) Program Database. The World Bank's K4D develops a knowledge economy index that evaluates a country's readiness for the knowledge economy. The knowledge economy index is constructed based on the following four knowledge economy pillars: economic incentive and institutional regime; education and human resources; innovation system; and, information and communication technology. The value of the index suggests that countries with higher scores on the knowledge economy index have greater potential of achieving good level of knowledge development (World Bank Institute, 2010). The KEI has values from 0 to 10 with higher score indicating better knowledge development. However, the data on KEI are not released every year and are only available for three time periods: 1995, 2000, and the most recent year which is 2012. For this reason, we use the relevant KEI for multiple years until the information on the next KEI becomes available. For example, the KEI of 1995 is used for the year 1995 and subsequent years until the next KEI of 2000 becomes available and so on. Similar procedure of handling data that are not available every year is also employed by Gompers et al. (2003) and Core et al. (2006).

To measure financial development, we employ standard indicators of banking and equity market retrieved from the World Bank's Database on Financial Development and Structure. Firstly, we examine the importance of the overall financial development in explaining cross-country differences in the states of knowledge economy. The overall financial development is measured by financial development size and the structure of financial system. Secondly, we investigate the roles of banking sector and stock market in influencing a country's knowledge economy status. All financial development indicators are expressed in logarithm forms.

For overall financial development, since financial sector comprises both the financial intermediary and capital market segments, we use both financial intermediary size and the size of the stock market sector relative to Gross Domestic Product (GDP) for measuring the overall size of financial sector development (OSIZE). The overall size indicator is defined as credit issued to private sector by all financial institutions to GDP plus stock market capitalization to GDP. The structure of the financial system is proxied by the STRUCTURE indicator, defined as credit issued to private sector by deposit money bank to GDP divided by stock market capitalization to GDP. Higher value for this indicator suggests a more bank-based financial system (Levine, 2002; and Beck et al., 2010).

On banking sector development, we employed three commonly used standard banking indicators. The conventional practice of measuring banking sector development has been to use the size of financial intermediary sector relative to economic activity. We call this indicator BSIZE and it captures all credit issued to private sector by all financial institutions (deposit money banks and other financial institutions) as a share to GDP. This size measure of the banking sector that includes all financial intermediaries may not provide indication of the relative importance of specific financial institution. Consequently, we also employ measures that focus on banking institutions and we call these indicators BANK and ASSET. The indicator BANK defined as private sector credit issued by deposit money banks to GDP highlights the role of banks in providing external financing to the private sector. The indicator ASSET is the ratio of deposit money banks asset to GDP.

We employed three indicators to measure equity market development. The indicator MARKET, defined as stock market capitalization divided by GDP captures the value of listed shares to GDP. The indicator VALUE is the total value of shares traded as a share of GDP and it measures the value of stock transactions in relation to the size of the economy. This indicator captures information on both the size and activity of the stock market, and not merely on the value of listed shares. The indicator TURNOVER is the ratio of the total value of shares traded to market capitalization and it measures the value of stock transactions relative to the size of the stock market. These banking and equity market indicators are widely used in the literature as measures of bank and

stock market development (Levine and Zervos, 1998; Levine, 2002; Beck and Levine, 2004; Beck et al., 2010; and Allen et al., 2012).
To assess the independent link between finance and the state of knowledge economy, we control for other knowledge-related drivers and social dimensions of the economy that are important in shaping knowledge-intensive economy. These variables include a country's openness to international trade, consumption expenditure, real gross domestic product, regulatory quality, education expenditure, the number of patent granted, personal computers, and technological cooperation. The indicator TRADE captures a country's openness to trade internationally. The indicator RGDP measures the real Gross Domestic Product per capita and it reflects a country's income status. This variable is log-transformed. Consumption expenditure (CONSUMPTION) proxies for income and socio-economic status of a country (Deaton, 1997; Morris et al., 2000). We sourced the data on international trade and real Gross Domestic Product per capita from World Development Indicators (WDI) database while consumption expenditure was retrieved from IMD World Competitiveness database.

The indicator regulatory quality (REGULATORY) obtained from the World Bank's Worldwide Governance Indicators (WGI) database proxies for a country's institutional framework. The index indicates whether a country's regulatory system is sufficiently effective in encouraging private sector development. As defined in Kaufmann et al. (2010), this index captures "*...the ability of the government to formulate and implement sound policies and regulations that permit and promote private sector development*". It has a value from -2.5 to +2.5, with higher values representing stronger regulatory structure. A strong regulatory system is essential in promoting knowledge-based activities because a country with good regulatory structure provides more incentives and better investment climate for private sector development than one with poor regulatory system with more regulatory restraints in the financial markets, labour market, and in the overall business environment.

The indicator EDUCATION represents expenditure on education as a percentage of GDP and the data were sourced from IMD World Competitiveness database. This variable proxies for a country's educational resource and high percentage of public expenditure on education suggests that great emphasis is placed on increasing peoples'

capacity to learn and to use new knowledge. Given that innovation is an important element that contributes to building a nation's knowledge capacity, we employ natural logarithm of the number of patent granted (PATENT) to proxy for a country's innovation system. The data were sourced from World Intellectual Property Organization (WIPO) database and this measure has been widely used in the literature as a measure of innovative activities (Kortum, 1993; Furman et al., 2002; Varsakelis, 2006; Ang, 2010; Ang, 2011; Barbosa and Faria, 2011; among others). Patent is the most common and reliable indicator of innovative activity which is a major source of knowledge stock (Griliches, 1990; Acs, 2002).

Following Yartey (2008) and Vu (2011), we employ natural logarithm of the indicator personal computers (COMPUTER) to capture the extent to which diffusion of information and communication technology contributes to enhancing a country's knowledge capacity. In addition, the indicator technological cooperation (TECHCOOP) is also used to proxy for a country's information and communication technology infrastructure and it is constructed based on a scale of from 0 to 10, with higher scores signifying better technological cooperation between firms. Technological cooperation is essential in order for technologies to be acquired and adapted more easily and thus enhancing a country's capacity to transform to knowledge-intensive economy. Past studies have pointed out that countries with a large number of personal computers and technological cooperation tend to facilitate knowledge-related economy growth (Yartey, 2008; Vu, 2011; Becker and Dietz, 2004; Faria et al., 2010; Zeng et al., 2010). The data for personal computers and technological cooperation were sourced from the World Development Indicators (WDI) and IMD World Competitiveness databases respectively.

4. Empirical Findings and Discussion

Table 1 presents descriptive statistics for variables employed from 1995 to 2011. The knowledge economy index (KEI) has an average value of 5.79 out of 10, suggesting that the state of knowledge economy in emerging market countries is moderate at best. That is, on average, emerging nations have yet to reach a level where a country's economic development hinges on the creation and effective use of knowledge. The lowest index value is 3.02 while the highest value is 8.42. The

STRUCTURE indicator is averaged at about 1.08. Since this measure is defined as bank credit to GDP divided by stock market capitalization to GDP, a ratio of greater than 1 suggests that on average, financial structures in emerging market countries are bank-based systems. The overall financial development size indicator (OSIZE) has an average value of about 1.16 suggesting that the size of a country's financial sector outpaces the size of its economy since the measure is scaled by a country's GDP. On banking development, the BANK indicator defined as private sector credit to GDP has an average value of 0.47 and this indicator highlights the important role of banks in providing financing to the private sector. The indicator BSIZE defined as all credit issued to private sector by all financial institutions (deposit money banks and other financial institutions) to GDP, has an average value of about 0.54 while the percentage of banks asset to GDP (ASSET) is averaged at 0.58. Stock market development indicators have average values ranging from 0.36-0.62 and large standard deviations that range from about 0.49-0.69.

On average, the percentage of international trade to GDP of 76.48 percent suggests that emerging countries are fairly open to international trade. The governance indicator, a proxy for regulatory quality observes an average score of 0.41 out of 2.5, suggesting a relatively poor regulatory framework in emerging countries. A country's total expenditure on education reflects its emphasis on education and on average, the total public expenditure on education to GDP is 4.06 percent and the highest value is 7.81 percent.

In Table 2, the correlation coefficients show positive relationships between knowledge economy index and financial development indicators. The correlation coefficients of bank development indicators are higher than those of stock market development. These suggest that banks possibly assume a more important role than the stock market in affecting the state of knowledge economy in emerging countries. With the exception of the stock market turnover indicator, the correlation results show that financial indicators are positively and highly correlated with each other. The Pearson correlation coefficients range between 0.49 and 0.97. The control variables generally have positive correlations with the knowledge economy index with real GDP per capita indicator having the highest correlation coefficient of 0.84.

Tables 3 to 5 report the results of fixed effect panel regression analyses for the relationship between financial development and the state of knowledge economy in emerging countries. The fixed effect model is the finest model compared to the random effect model for all models since the statistics of Hausman test suggest that individual specific effects are correlated with the regressors, i.e., $Cov(\alpha_i, X_{it}) \neq 0$, and thus confirming the suitability of fixed effect model against the random effect model in all models.

Table 3 presents results for the impacts of overall financial sector development in terms of size and financial system structure on the state of knowledge economy. As shown, both size and the structure of the financial sector have important influences on the state of knowledge economy in emerging market countries. The coefficient of the overall financial sector size (OSIZE) is positively and significantly related to a country's state of progression towards knowledge-based economy. That is, the size of financial sector matters for promoting knowledge-based development and larger financial sector is shown to be associated with higher knowledge economy status. Additionally, the positive and significant coefficient of the structure indicator (STRUCTURE) suggests that a country's financial system structure importantly influences its knowledge economy status. Since the structure indicator is defined as bank credit to GDP divided by stock market capitalization to GDP, the positive coefficient suggests that financial structure geared towards bank-based system contributes positively to a country's standing in the knowledge economy index. This result is somewhat consistent with prior findings that bank-based structure tends to dominate the financial systems of emerging market countries where banks remain an important financing channel. (Demirguc-Kunt and Levine, 1999; and Allen et al., 2012). This finding also offers support for the proponents of bank-based view such as Diamond (1984), Ramakrisnan and Thakor (1984), Allen and Gale (1999), Boot and Thakor (1997), among others that services provided by financial intermediaries are essential for economic development. Several of the coefficients for control variables maintain their significance in the presence of financial development indicators. A country's openness to international trade, its regulatory quality, and the fraction of resources spent on education are all positively related to the state of knowledge economy.

Table 4 presents results of the relation between banking development and a country's standing in the knowledge economy index. We employed three standard measures of banking development as shown in models 1 through 3 respectively. In all three models the coefficients of banking indicators are positively and significantly related to the knowledge economy index after controlling for factors known to affect knowledge-related development. Model 1 employs the indicator BSIZE which is a broad measure of banking sector development that captures the size of the financial intermediary sector relative to economic activity. We find that financial intermediary sector exerts positive and significant effects on knowledge economy index. This result is supportive of Schumpeter's (1911) view raised 100 years ago that emphasizes on the importance of financial institutions in evaluating and financing entrepreneurs' innovative activity. While the indicator BSIZE in model 1 includes all financial institutions without distinguishing financial institutions that perform intermediation functions, the indicators employed in models 2 and 3 focus on the importance of banking institutions as proxied by BANK and ASSET indicators respectively. As reported, the coefficients of BANK and ASSET are positive and highly significant, suggesting important link between banks and the states of knowledge economy. Countries with higher levels of banking sector development tend to achieve higher scores in the knowledge economy index. The reported results in models 1 through 3 suggest that banks are important for knowledge-based development. Banks spur knowledge-related growth by resolving various market imperfections with positive ramifications on the knowledge-based economy. Such findings are supportive of the view that financial intermediaries stimulate knowledge-related activity through the financing of tangible and intangible investments that lead to technological innovation (King and Levine, 1993a, and King and Levine, 1993b).

In Table 5, the results for the impacts of stock market development on the state of knowledge economy are reported in models 4 through 6 using the following 3 indicators respectively: stock market capitalization to GDP (MARKET); stock market value traded to GDP (VALUE); and total value of shares traded to market capitalization (TURNOVER). Interestingly, in all the 3 models, we find no evidence that stock market development influences the status of knowledge economy in emerging market countries. None of the stock market indicators is significant in

explaining the cross-country differences in the values of knowledge economy index. These results imply that the relationship between stock market development and the state of knowledge economy differs from the one observed between banking development and knowledge economy. Given that financial systems in emerging market countries are generally bank-based systems, the observed results imply that banks remain essential for fostering knowledge-related activity and that stock market has yet to play significant role in influencing the states of knowledge economy of emerging market countries.

In all models of banking and stock market development as reported in Tables 4 and 5, the coefficients of several control variables such as openness to international trade (TRADE), regulatory quality (REGULATORY), and the fraction of resources spent on education (EDUCATION) are all positively and significantly related to the knowledge economy index. Openness to international trade affects the degree to which a country is able to capitalise on global technological know-how in enhancing and supporting its knowledge capacity. This result parallel those of past studies that highlight the important role of international trade in promoting technological progress (Coe and Helpman, 1995; Sachs et al., 1995; Eaton and Kortum, 1996; Coe et al., 1997; Okabe, 2003; Bhattacharya and Bloch, 2004; Chen and Dahlman, 2004; Matsubara, 2005; and Schneider, 2005). Additionally, a good regulatory framework with minimal regulatory restraints in the financial and labour markets and the overall business environment is also essential for promoting knowledge-based activity. The importance of good regulatory quality is highlighted in the studies of Ginarte and Park (1997), Varsakelis (2001), Furman et al. (2002), Chen and Dahlman (2004), Varsakelis (2006), Fu (2008), and Barbosa and Faria (2011). Education is almost always recognized as a key element for economic development and the results show that higher levels of education expenditure lead to higher rankings in the knowledge economy index. This is broadly consistent with the findings of Lundvall et al. (2002), Salmi (2003), Chen and Dahlman (2004), Spielman et al. (2008), Youtie and Shapira (2008), and Wang (2010) that highlight the important role of education in promoting knowledge-led economic growth.

On the whole, the findings that banks are important in influencing the states of knowledge economy support the view that banks provide important screening and monitoring services. These services are

particularly important for financing knowledge-related activities that are characterised by high risk endeavours and involves assets that represent intangible ideas and project opportunities. The findings imply that the implementation of knowledge economy strategies calls for inclusion of the financial domain, i.e., the banking sector in addition to the currently emphasized scientific and social dimensions. These findings provide the much needed policy directions for the governments of emerging countries in driving the transition to knowledge-based economy.

5. Conclusions

In this paper, we examine whether higher levels of financial sector development are positively associated with higher levels of knowledge economy status in 17 emerging market countries from 1995 to 2011. Specifically, we investigate the impact of overall financial sector development on a country's knowledge economy status and the separate effects of banks and stock market development on the state of progression towards knowledge-based economy. On overall financial development, we find that larger financial sector and financial system that leans toward bank-based structure are associated with higher values in the knowledge economy index. On the relation between banking development and a country's standing in the knowledge economy index, our findings suggest that banks play important roles in shaping knowledge-based development and the results hold true across all three banking indicators. However, on stock market development, we find no evidence that stock market influences a country's knowledge economy status. The results also indicate that a country's openness to international trade, its regulatory quality, and the fraction of resources spent on education are important in explaining cross-country differences in the knowledge economy index. Taken as a whole, our findings suggest that banking sector plays crucial role in promoting knowledge-based development. By mitigating the effects of market frictions, banks contribute positively to a country's state of progression towards knowledge-based economy. While existing policies and strategies generally place emphasis on core knowledge drivers and social dimensions, it must be emphasized that policies that hold back banking sector development can have detrimental effects on knowledge-based development in emerging countries. As such, a country's policy framework for knowledge-based economy should embrace banking sector development as one of its key policy areas. For academics, the

findings expand existing literature on finance-growth nexus, enhance understanding on the working of knowledge-intensive economy that incorporates the important role of finance, and provide a basis for future research that focuses on firm and industry-level analyses.

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Appendix 1
List of countries

Brazil	Chile	Czech Republic	Colombia
Hungary	India	Indonesia	Malaysia
Mexico	Peru	Philippines	Poland
Russia	South Africa	South Korea	Thailand
Turkey			

Appendix 2
Data sources and description of variables

Variable	**Description**	**Source**
KEI	Knowledge economy index (in scale ranges from 0 to 10)	World Bank's Knowledge for Development Program (K4D) Database
TRADE	International trade (% of GDP)	World Development Indicators (WDI)
RGDP	Real gross domestic product per capita (constant 2000 USD) (in logarithm scale)	World Development Indicators (WDI)
CONSUMPTION	Household consumption expenditure (% of GDP)	IMD World Competitiveness Database
REGULATORY	Regulatory quality (in value ranges from -2.5 to +2.5)	World Bank's Worldwide Governance Indicators (WGI) Database
EDUCATION	Total public expenditure on education (% of GDP)	IMD World Competitiveness Database
PATENT	The number of patent granted (in logarithm scale)	World Intellectual Property Organization (WIPO)
COMPUTER	The number of personal computers (per 100 people) (in logarithm scale)	World Development Indicators (WDI)

Cont'd

Variable	Description	Source
TECHCOOP	Technological cooperation (in scale ranges from 0 to 10)	IMD World Competitiveness Database
OSIZE	Private credit by deposit money banks and other financial institutions together with stock market capitalization to GDP (in logarithm scale)	World Bank's Financial Development and Financial Structure Dataset
STRUCTURE	Private credit by deposit money banks to GDP divided by stock market capitalization to GDP (in logarithm scale)	World Bank's Financial Development and Financial Structure Dataset
BSIZE	Private credit by all financial institutions (deposit money banks and other financial institutions) to GDP (in logarithm scale)	World Bank's Financial Development and Financial Structure Dataset
BANK	Private credit by deposit money banks to GDP (in logarithm scale)	World Bank's Financial Development and Financial Structure Dataset
ASSET	Deposit money bank assets to GDP (in logarithm scale)	World Bank's Financial Development and Financial Structure Dataset
MARKET	Stock market capitalization to GDP (in logarithm scale)	World Bank's Financial Development and Financial Structure Dataset
VALUE	Total value of shares traded to GDP (in logarithm scale)	World Bank's Financial Development and Financial Structure Dataset
TURNOVER	Total value of shares traded to market capitalization (in logarithm scale)	World Bank's Financial Development and Financial Structure Dataset

Table 1: Descriptive statistics

Variable	Mean	Standard deviation	Median	Minimum	Maximum
KEI	5.7869	1.3594	5.6300	3.0200	8.4200
TRADE	76.48	45.91	59.45	14.93	220.41
RGDP	5876.79	4316.24	5185.85	469.47	22883.76
CONSUMPTION	60.29	8.97	61.92	4.44	74.30
REGULATORY	0.4078	0.5000	0.3976	-0.7819	1.5871
EDUCATION	4.06	1.36	3.96	0.49	7.81
PATENT	401.12	1547.66	41.00	1.00	13239.00
COMPUTER	8.33	10.21	4.91	0.13	57.55
TECHCOOP	4.5603	0.9604	4.5200	1.9200	7.3600
OSIZE	1.1581	0.9024	0.7912	0.1027	5.1214
STRUCTURE	1.0763	0.8647	0.8020	0.1336	6.3469
BSIZE	0.5447	0.4074	0.3637	0.0770	1.7393
BANK	0.4687	0.3236	0.3501	0.0770	1.6596
ASSET	0.5762	0.3170	0.4941	0.1464	1.7353
MARKET	0.6247	0.5764	0.3806	0.0201	3.3820
VALUE	0.3553	0.4879	0.1877	0.0012	3.7628
TURNOVER	0.6196	0.6862	0.4197	0.0269	6.2242

The dependent variable is KEI, the knowledge economy index. The two measures for overall financial development are: financial development size, OSIZE; the structure of financial system, STRUCTURE. The three banking sector development indicators are: private sector credit issued by all financial institutions, BSIZE; private sector credit issued by banks, BANK; banks' assets, ASSET. The three stock market development indicators are: stock market capitalization, MARKET; stock market value traded, VALUE; total value shares traded to market capitalization, TURNOVER. The control variables are: openness to international trade, TRADE; real GDP per capita (constant 2000 USD), RGDP; household consumption expenditure, CONSUMPTION; regulatory quality, REGULATORY; total public expenditure on education, EDUCATION; the number of patent granted, PATENT; the number of personal computers per 100 people, COMPUTER; technological cooperation, TECHCOOP.

Table 2: Correlation coefficients

	KEI	TRA	RGD	CON	REG	EDU	PAT	COM	TEC	OSI	STR	BSI	BAN	ASS	MAR	VAL	TUR
KEI	1																
TRA	0.43**	1															
RGD	0.84**	0.27**	1														
CON	-0.32**	-0.44**	-0.30**	1													
REG	0.77**	0.37**	0.60**	-0.10	1												
EDU	0.58**	0.32**	0.37**	-0.28**	0.43**	1											
PAT	0.35**	0.04	0.64**	-0.17**	0.13*	0.06	1										
COM	0.62**	0.24**	0.83**	-0.37**	0.36**	0.22**	0.83**	1									
TEC	0.21**	0.45**	0.26**	-0.24**	0.24**	0.23**	0.14*	0.46**	1								
OSI	0.16**	0.33**	0.09	-0.44**	0.16**	0.35**	0.19**	0.27**	0.32**	1							
STR	0.31**	0.15**	0.14*	-0.06	0.17**	0.13*	0.03	0.02	-0.27**	-0.22**	1						
BSI	0.37**	0.44**	0.27**	-0.50**	0.29**	0.37**	0.28**	0.39**	0.26**	0.88**	0.12*	1					
BAN	0.34**	0.62**	0.23**	-0.51**	0.31**	0.32**	0.30**	0.30**	0.33**	0.76**	0.21**	0.89**	1				
ASS	0.29**	0.61**	0.20**	-0.48**	0.24**	0.32**	0.28**	0.27**	0.37**	0.71**	0.20**	0.85**	0.97**	1			
MAR	0.02	0.24**	-0.01	-0.34**	0.08	0.31**	0.10	0.12	0.35**	0.94**	-0.42**	0.66**	0.55**	0.51**	1		
VAL	0.19**	0.14*	0.42**	-0.28**	0.05	0.15**	0.66**	0.59**	0.29**	0.62**	-0.15**	0.55**	0.50**	0.49**	0.58**	1	
TUR	0.21**	0.01	0.40**	-0.06	0.01	-0.03	0.46**	0.41**	0.03	0.06	0.13*	0.22**	0.17**	0.19**	-0.06	0.56	1

The dependent variable is KEI, knowledge economy index. The financial development measures are: OSI, the overall financial development size; STR, financial structure; BSI, private sector credit issued by all financial institutions; BAN, private sector credit issued by banks; AST, banks' assets; MAR, stock market capitalization; VAL, stock market value traded; TUR; stock market turnover. The control variables are: TRA, international trade; RGD, real GDP per capita; CON, consumption expenditure; REG, regulatory quality, EDU, education expenditure; PAT, patent granted; COM, personal computers; TEC, technological cooperation.

** and * indicate significance at the 1 percent and 5 percent levels respectively.

Table 3: Panel regression results of the link between overall financial sector development and knowledge economy index from 1995-2011.

Constant	5.9945
	(1.84)
TRADE	0.0048*
	(2.64)
RGDP	-0.1745
	(-0.41)
CONSUMPTION	0.0125
	(1.86)
REGULATORY	0.3069*
	(2.18)
EDUCATION	0.0700*
	(2.76)
PATENT	-0.0138
	(-0.47)
COMPUTER	-0.0576
	(-0.69)
TECHCOOP	-0.0041
	(-0.14)
OSIZE	0.2841**
	(4.51)
STRUCTURE	0.0810**
	(3.93)
R-squared	0.4749
F-value	19.45
Prob>F-value	[0.00]
Hausman Test	34.36
	[0.00]

The dependent variable is KEI, knowledge economy index. The financial development measures are: OSIZE, the overall size of financial development; STRUCTURE, financial structure. The control variables are: TRADE, international trade; RGDP, real GDP per capita; CONSUMPTION, consumption expenditure; REGULATORY, regulatory quality, EDUCATION, education expenditure; PATENT, patent granted; COMPUTER, personal computers; TECHCOOP, technological cooperation. The financial development indicators, real GDP per capita, patent granted, and personal computers are log-transformed. The model is estimated as fixed effects.

t-statistics are in parentheses and are adjusted for heteroskedasticity in the error terms. *p*-values are in square brackets.

** and * indicate significance at the 1 percent and 5 percent levels respectively.

Table 4: Panel regression results of the link between banking sector development and knowledge economy index from 1995-2011.

	Model 1	**Model 2**	**Model 3**
Constant	4.9337	5.5713	4.9008
	(1.53)	(1.73)	(1.39)
TRADE	0.0051*	0.0050*	0.0052**
	(2.66)	(2.64)	(2.89)
RGDP	-0.0178	-0.0796	0.0190
	(-0.04)	(-0.20)	(0.04)
CONSUMPTION	0.0115	0.0113	0.0103
	(1.63)	(1.63)	(1.47)
REGULATORY	0.3315*	0.3140*	0.3752*
	(2.41)	(2.26)	(2.55)
EDUCATION	0.0687**	0.0600*	0.0594*
	(2.89)	(2.61)	(2.32)
PATENT	-0.0118	-0.0168	-0.0303
	(-0.40)	(-0.57)	(-1.00)
COMPUTER	-0.0805	-0.0689	-0.0809
	(-0.94)	(-0.79)	(-0.91)
TECHCOOP	-0.0144	-0.0180	-0.0358
	(-0.63)	(-0.79)	(-1.58)
BSIZE	0.2134**		
	(3.03)		
BANK		0.2267**	
		(3.71)	
ASSET			0.3023**
			(3.71)
R-squared	0.4523	0.4643	0.4546
F-value	9.45	10.01	8.38
Prob>F-value	[0.00]	[0.00]	[0.00]
Hausman Test	25.34	27.72	26.07
	[0.00]	[0.00]	[0.00]

The dependent variable is KEI, knowledge economy index. The banking sector development measures are: BSIZE, private sector credit issued by all financial institutions; BANK, private sector credit issued by banks; ASSET, banks' assets. The control variables are: TRADE, international trade; RGDP, real GDP per capita; CONSUMPTION, consumption expenditure; REGULATORY, regulatory quality, EDUCATION, education expenditure; PATENT, patent granted; COMPUTER, personal computers; TECHCOOP, technological cooperation. The financial development indicators, real GDP per capita, patent granted, and personal computers are log-transformed. The models are estimated as fixed effects.

t-statistics are in the parentheses are adjusted for heteroskedasticity in the error terms. *p*-values are in square brackets.

** and * indicate significance at the 1 percent and 5 percent levels respectively.

Table 5: Panel regression results of the link between stock market development and knowledge economy index from 1995-2011.

	Model 4	**Model 5**	**Model 6**
Constant	3.2685	2.0950	2.7810
	(1.08)	(0.62)	(0.95)
TRADE	0.0058*	0.0063*	0.0066**
	(2.51)	(2.71)	(2.89)
RGDP	0.1754	0.2992	0.2181
	(0.46)	(0.70)	(0.59)
CONSUMPTION	0.0105	0.0121	0.0115
	(1.27)	(1.40)	(1.34)
REGULATORY	0.4006*	0.4289**	0.4434**
	(2.65)	(2.98)	(3.54)
EDUCATION	0.0738**	0.0646**	0.0643**
	(2.80)	(2.80)	(2.87)
PATENT	-0.0208	-0.0314	-0.0227
	(-0.57)	(-0.93)	(-0.70)
COMPUTER	-0.0848	-0.0851	-0.0832
	(-0.97)	(-0.98)	(-1.03)
TECHCOOP	-0.0406	-0.0400	-0.0486
	(-1.56)	(-1.44)	(-1.91)
MARKET	0.0225		
	(0.81)		
VALUE		-0.0259	
		(-1.49)	
TURNOVER			-0.0513
			(-1.94)
R-squared	0.3973	0.4023	0.4171
F-value	6.17	5.43	8.72
Prob>F-value	[0.00]	[0.00]	[0.00]
Hausman Test	25.01	17.87	27.75
	[0.00]	[0.04]	[0.00]

The dependent variable is KEI, knowledge economy index. The stock market development measures are: MARKET, stock market capitalization; VALUE, stock market value traded; TURNOVER, stock market turnover. The control variables are: TRADE, international trade; RGDP, real GDP per capita; CONSUMPTION, consumption expenditure; REGULATORY, regulatory quality, EDUCATION, education expenditure; PATENT, patent granted; COMPUTER, personal computers; TECHCOOP, technological cooperation. The financial development indicators, real GDP per capita, patent granted, and personal computers are log-transformed. The models are estimated as fixed effects.

t-statistics are in the parentheses are adjusted for heteroskedasticity in the error terms. *p*-values are in square brackets.

** and * indicate significance at the 1 percent and 5 percent levels respectively.