Financial sector competition and knowledge economy: evidence from SSA and MENA countries

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Abstract

The goal of this paper is to assess how financial sector competition plays out in the development of knowledge economy (KE). It contributes at the same time to the macroeconomic literature on measuring financial development and response to the growing field of KE by means of informal sector promotion, micro finance and mobile banking. It suggests a practicable way to disentangle the effects of various financial sectors on different components of KE. The variables identified under the World Bank's four knowledge economy index (KEI) are employed. Three hypotheses based on seven propositions are tested. Results show: (1) the informal financial sector, a previously missing component in the definition of the financial system by the IMF significantly affects KE dimensions; (2) disentangling different components of the existing measurement of the financial system improves dynamics in the KE-finance nexus and; (3) introduction of measures of sector importance provides relevant new insights into how financial sector competition affects KE.

JEL Classification: G21; O10; O34; P00; P48

Keywords: Financial development; Knowledge Economy

1. Introduction

Since the turn of the 1990's, the imperative of knowledge economy has emerged as a key in the OECD and World Bank reports (World Bank, 2007; Peter, 2008; Weber, 2011). It is now well documented that knowledge created through innovation and technological progress is the long-term driver of economic growth. The challenge of employment creation in Africa has been the focus of high-level political attention in the recent past (Economic Commission for Africa, 2007)[1]. Thus, in line with this high level attention on employment issues, the Committee for Development Information (CODI-V) has centered its theme on: employment and knowledge economy.

Financial intermediation has been well documented as indispensible in channeling mobilized resources to economic operators who represent an important source of employment. The goal of this paper is to assess how financial sector competition play-outs in the development of knowledge economy (KE). Understanding how the growth of different financial sectors play-out in the growth of KE dimensions is crucial in developing economies because, unlike the developed world, the informal and semi-formal financial sectors play an important role in economic development (Demetriades & Hussein, 1996; Khumbhakar & Mavrotas, 2005; Ang & McKibbin, 2007; Abu-Bader & Abu-Qarn; 2008; Asongu, 2011)[2]. Therefore, this study contributes at the same time to the macroeconomic literature on measuring financial development and response to the growing field of knowledge economy by means of informal sector promotion, micro finance and mobile banking. It suggests a practicable way to disentangle the effects of various financial sectors on different components

[1]For instance, the African Union Extraordinary Assembly of Heads of States and Governments adopted the Ouagadougou Declaration on Employment and Poverty Alleviation in 2004. More recently, in May 2006, the Economic Commission for Africa's (ECA) 39th Conference on African Ministers of Finance Planning and Economic Development, was convened on the subject: The Challenge of Employment and Poverty Alleviation in Africa.

[2]Unlike developed countries, a great chunk of the monetary base (M0) in developing countries does not transit through the banking sector.

of KE[3]. Understanding this nexus is crucial because information about the impact of finance on economic growth will influence the priority that policy makers and advisors attach to reforming financial sector policies.

Specifically, the paper's contribution to the literature is fivefold. Firstly, it investigates if the equation of financial depth (in the perspective of money supply) to liquid liabilities in the financial development literature represents a substantial empirical hollow that could undermine the finance-KE nexus. Secondly, it deviates from previous research that does not incorporate all dimensions of KE and provides an exhaustive assessment with six KE dynamics. Thus, in contrast to mainstream approach to the phenomenon (which is premised for the most part on one or two dimensions of KE), this paper employs all of the four components in the World Bank's Knowledge Economy Index (KEI): economic incentive, innovation, education and information infrastructure. Thirdly, a great chunk of research on KE focuses on developed and the emerging economies of Latin America and East Asia. Thus, the scanty evidence of the nexus in SSA and MENA countries is a missing strand motivating this paper. Fourthly, while some aspects of KE might have been investigated prior to the availability of data on information and communication technology (ICT) for developing countries, the use of much recent data by this paper provides an updated account of the KE-finance nexus with more focused policy implications. Fifthly, a motivation of this work also draws from the debate on the 'East Asian miracle'. Therefore, examining how new financial dynamics could ease the path of SSA and MENA countries towards KE economies is interesting.

The rest of the paper is organized as follows. Section 2 examines existing literature in the lights of a conceptual framework and rethinking of financial development indicators. Data

[3]The proposition and employment of new financial development indicators draws from recent findings which have established that the burgeoning phenomenon of mobile banking cannot be effectiveness assessed by traditional financial development measures (Asongu, 2012ab). Hence, assessing the KE dimensions in the context of these findings could lead to interesting policy measures on how financial sector competition plays-out in enhancing KE.

and methodology are presented and outlined respectively in Section 3. Empirical analysis and corresponding discussion are covered in Section 4. Section 5 concludes.

2. Existing literature

2.1 Conceptual framework:

2.1.1 Knowledge economy and finance

In this section, we devote space to spelling-out why finance is necessary in KE. It has been well documented that financial instruments may arise to mitigate the effects of information and transaction costs. Thus in emerging to ameliorate market frictions, financial arrangements change the incentive and constraints facing economic agents. In a nutshell, financial systems have a bearing on the savings rates, investment decisions, technological innovation and long-run growth rates (Levine, 2005, p.3). A natural extension of this thesis will imply, finance significantly influences the World Bank's KEI.

The existing theory and evidence suggest that better developed financial systems ease external financing constraints facing firms, which illuminates one mechanism via which financial development influences economic growth (Levine, 2005) and in the same vein KE. Owing to space constraints we shall not elaborate too much on the finance-growth nexus because it has already been substantially documented in the literature. This assertion is in line with the postulation of Nobel Laureate Merton Miller (1998, p.14) who argues that: "*the idea that financial markets contribute to economic growth is a proposition too obvious for serious discussion*". Drawing a more retrained conclusion, Bagehot (1873), Schumpeter (1912), Gurley & Shaw (1955), Goldsmith (1969) and McKinnon (1973) reject the thesis that the finance-growth nexus can be safely ignored without substantially infringing our understanding of economic growth.

Borrowing from the World Bank (2007, p.73), a KE cannot be built without finance. For small entrepreneurial projects in developing countries, funding needs may be relatively

small and microfinance mechanisms are enough. Hence, the new sector-importance financial indicators we shall use in the empirical section of the paper will incorporate informal financial development that captures these microfinance mechanisms. Spreading rapidly through-out the world following the pioneering initiative of the Bangladesh Grameen Bank, microfinance hinges on the social responsibility of borrowers belonging to a narrow group to ensure repayment. Other entrepreneurial projects require a substantial amount of development capital. Indeed a broad range of financial services is necessary to support growth and entrepreneurship in knowledge-based economies in the developing world, as elsewhere (World Bank, 2007).

2.1.2 Knowledge economy for SSA and MENA: Why? What? How?

The governments of The Newly Industrialized Economies (Hong Kong, Korea, Taiwan & Singapore), Malaysia and China led by Japan are playing a substantial role in their moving towards 'knowledge-based economy' from the 'product economy' in the post-industrialization period (Chandra & Yokoyama, 2011). The main idea is that, the process of creation and diffusion of knowledge depends on financial sectors that are the outcome of financial policies. Therefore, it is important to identify how financial sectors promote the diffusion of knowledge. Reflecting the "East Asian Miracle" in the context of SSA and MENA countries, this section will be elucidated in two strands: the first stressing the imperative of assessing KE in Arab states and the second discussing the need to investigate the phenomenon in SSA.

The current climate and future prospects in education, innovation and technology concludes that insofar as the main cultural underpinnings of KEs are concerned (education, innovation and technology), the Arab countries may be on arid grounds but not in a total dessert. It further asserts there are a few oases with more being planted and much more needed to be done specifically on the KE determinants (Bizri, 2009). The purpose of this

paper is to break new grounds on the KE-finance nexus by employing unexplored financial sector dimensions which could enhanced understanding of KE dynamics and provide the much need policy guidance on how to increases KE oases in the Arab deserts. This need for policy reform draws from the Lightfoot (2011) conclusion that emphasizes the need for deeper reforms as means to fulfilling the policy aspirations rather than speculating over progress through technology enriched futures. More so, the significant bearing poor institutions (financial or otherwise) have on the development of knowledge-societies is not a secret in Arab countries (UNDP[4] Arab Report, 2009). For example, when applying the framework of knowledge economy (KE) to developing nations in the Middle East and North African (MENA) region, a World Bank report discovered that they were not investing in key areas that are fundamental to KEs: "*To date, related investments in education, information infrastructure, research and development (R&D), and innovation have been insufficient or inappropriate in most MENA countries. Moreover, inadequate economic and institutional frameworks prevent these investments from yielding desired results*" (Aubert & Reiffers, 2003, p.1). Hence, this work will contribute to these issues by assessing how financial sector competition plays-out in enhancing various dimensions of KE.

The finance parameter is also very relevant in MENA countries. According to the World Bank (2007, p.74), early efforts to develop Small and Medium Enterprise (SME) financing were limited to encouraging banks to extend existing services to the SME sector (European Commission). Later, a novel form of funds, known as 'general funds' was put in place. They were general in the perspective that, they would consider investing in almost any sector and at almost any stage of financing. However, they faced an uphill battle because company owners unfamiliar with finance had difficulty understanding their potential importance. Also, many owners were reluctant to take advice from relatively young fund

[4] United Nations Development Program.

managers. A second generation of funds shows a tendency toward market segmentation. Funds now target specific-sectors such as agro-food, tourism and information technology. Faced with the specialization of funds in financing enterprises, some governments (in Morocco) for instance have established a regional investment center that carter for the needs of foreign investors as well as those local entrepreneurs and business people who might need access to finance for growth and expansion.

In the second strand, we discuss the need for assessing KE in SSA. Africa remains the world's poorest inhabited continent despite its abundance in minerals and human resources. Presently, the continent is lagging behind in the KEI: a benchmark used to measure the knowledge infusion in an economy. The global knowledge revolution is an opportunity for Africa which has missed the industrial era. Owing the South Korean example, Africa needs the four pillars of KE more than ever for its development: a sound economic incentive and institutional regime; an educated and creative population; a dynamic information infrastructure and; an efficient innovation system.

An example of the benefits in KE in SSA is the burgeoning phenomenon of mobile banking which has facilitated financial services for mobile users living in informal and/or cash economies without access to financial services. Buoyed by prepay cards and inexpensive handset, hundreds of millions of first-time telephone owners have made voice calls and text messages an essential component of their livelihoods. Much recent findings have shown that the phenomenon of mobile-banking (which is an aspect of KE) can only be effectively assessed with financial development indicators that integrate the informal financial sector into the definition of the financial system[5]. These new trends show that novel ideas and approaches are required for policy makers and leaders in order to evolve and sustain a KE in Africa; which is fundamental to economic growth. Hence, the need to incorporate other

[5]In the first empirical assessment of the incidence of finance on KE, we use two definitions of the financial system: the traditional IFS (2008) and Asongu (2011, 2012ab) measures of financial sector importance.

dimensions of KE into the analysis and examine how financial sector competition indicators affect the KE-finance nexus.

2.2 Rethinking financial indicators and propositions

2.2.1 Rethinking financial development indicators

In accordance with Asongu (2011, 2012ab), financial development indicators have been universally employed without due regard to regional/country specific financial development realities (contexts). The application of some indicators for example hinges on the presumption that they are generally valid (Gries et al., 2009)[6]. As far as we have searched, but for Beck et al. (1999) and Asongu (2011, 2012ab), the absence of studies that underline the quality of financial development indicators with respect to contextual development concerns begs the search for the missing link.

It has been well documented that the financial depth indicator as applied to developing countries is very misleading as it does not integrate the realities and challenges of financial intermediary development (Demetriades & Hussein, 1996; Khumbhakar & Mavrotas, 2005; Ang & McKibbin, 2007; Abu-Bader & Abu-Qarn; 2008; Asongu, 2011). Thus, a motivation of this work hinges on an existing debate over the contextual quality of financial development indicators. Recent findings have shown that traditional financial indicators based on the IFS (2008) definition of the financial system do not capture certain dimensions of KE (e.g mobile banking)[7].

[6]Gries et al. (2009) state: "*In the related literature several proxies for financial deepening have been suggested, for example, monetary aggregates such as Money Supply (M2) on GDP. To date there is no consensus on the on the superiority of any indicator*" (Gries et al., 2009, p.1851).

[7]A bias in the definition of 'financial system deposits' (aka liquid liabilities) by the International Monetary Fund (IMF) best illustrate this point. According to the IFS, the financial system is made-up of the formal and semi-formal sectors; that is deposit money banks and other financial institutions (see lines 24, 25 and 45 of IFS, October 2008). Whereas, this conception and definition could be quasi-true for developed countries, it fails to take account of the informal financial sector in developing and undeveloped countries.

2.2.2 Existing empirical solutions

Money supply (M2/GDP) which represents the money stock has been widely employed as a standard measure of liquid liabilities in many studies (World Bank, 1989; King & Levine, 1993). Whereas, this proxy maybe quasi-true in the developed world, its application to developing countries has faced substantial criticisms. Critics stress that in less developed countries; an improvement in M2 may reflect an extensive use of currency rather than an increase in bank deposits. In a bid to address this problem in empirical literature, a number of solutions have been suggested.

Firstly, in an attempt to curtail this shortcoming, Demetriades & Hussein (1996) have suggested the subtraction of currency outside banks from M2 in the measurement of liquid liabilities in developing countries. Abu-Bader & Abu-Qarn (2008) amongst others have recently followed suit in adjusting M2. However, these adjustments have failed to emphasize financial sector importance; since the informal financial sector is ruled-out as marginal in this adjustment.

Secondly, some authors have sought to address the issue by determining a variable that broadly outlines financial depth. They use the first principal component of money supply and a combination of other financial indicators (Khumbhakar & Mavrotas, 2005; Ang & McKibbin, 2007; Gries et al., 2009). By so doing, they decrease the dimensionality of the set of variables without losing much information from the initial data on the one hand; and on the other hand, decrease problems related to the quality of M2 as a proxy for liquid liabilities. The set-back of this approach is that, for the most part, M2 is mixed with concepts of financial activity (private domestic credit/GDP), financial size (deposit bank assets/central bank assets plus deposit bank assets), financial allocation efficiency (bank credit/bank deposits)…etc.

Thirdly, Asongu (2011, 2012a) has addressed this problem in the finance-growth literature without mixing-up financial concepts. He has provided a practical way of

disentangling the effects of formal, semi-formal and informal financial development sectors contained in M2. In opposition to other solutions highlighted above, the present study best fits into the context of Asongu (2011; 2012a) because it seeks to capture the role of financial sector importance in KE.

2.2.3 Propositions

Financial development could be seen from indirect (financial intermediary development-through the banking sector) and direct (via financial markets) perspectives. The context of this study is limited to the former type. Borrowing from Beck et al. (1999), indirect indicators could further be classified into financial development dimensions of depth (M2), allocation efficiency[8], activity[9] and size[10]. Amongst these indicators, M2 for financial depth is the most widely used in the finance-growth literature. By disentangling M2 into its inherent constituents and relaxing the IFS definition of the financial system, the following propositions inspired by Asongu (2011, 2012a) are derived.

Propositions in Table 1 are based on a rethinking of the IFS (2008) definition of the financial system as elucidated in Section 2.2 above and summarized in Appendix 4. The Asongu (2011, 2012a) definition integrates a previously missing informal financial sector component into the definition of the financial system. Thus, the empirical section of this paper which is based on this new financial system definition will test the following hypotheses.

[8] Bank credit on bank deposits.
[9] Private domestic credit on GDP.
[10] Deposit bank assets / Central bank assets plus deposit bank assets.

Table 1: Summary of propositions

Propositions	Name(s)	Formula	Elucidation
Panel A: GDP-based financial development indicators			
Proposition 1	Formal financial development	Bank deposits/GDP	Bank deposits[11] here refer to demand, time and saving deposits in deposit money banks.
Proposition 2	Semi-formal financial development	(Financial deposits – Bank deposits)/ GDP	Financial deposits[12] are demand, time and saving deposits in deposit money banks and other financial institutions.
Proposition 3	Informal financial development	(Money Supply – Financial deposits)/GDP	
Proposition 4	Informal and semi-formal financial development	(Money Supply – Bank deposits)/GDP	
Panel B: Measures of financial sector importance			
Proposition 5	Financial intermediary formalization	Bank deposits/ Money Supply (M2)	From 'informal and semi-formal' to *formal* financial development (formalization)[13] .
Proposition 6	Financial intermediary 'semi-formalization'	(Financial deposits - Bank deposits)/ Money Supply	From 'informal and formal' to *semi-formal* financial development (Semi-formalization)[14].
Proposition 7	Financial intermediary 'informalization'	(Money Supply – Financial deposits)/ Money Supply	From 'formal and semi-formal' to *informal* financial development (Informalisation)[15].
Proposition 8	Financial intermediary 'semi-formalization and informalization'	(Money Supply – Bank Deposits)/Money Supply	Formal to '*informal and semi-formal'* financial development: (Semi-formalization and informalization) [16]

N.B: Propositions 5, 6, 7 add up to unity (one); arithmetically spelling-out the underlying assumption of sector importance. Hence, when their time series properties are considered in empirical analysis, the evolution of one sector is to the detriment of other sectors and vice-versa.

[11] Lines 24 and 25 of the IFS (October 2008).

[12] Lines 24, 25 and 45 of the IFS (2008).

[13] In undeveloped countries M2 is not equal to liquid liabilities (liquid liabilities equal bank deposits: bd). Whereas, in undeveloped countries bd/M2<1, in developed countries bd/M2 is almost equal to 1. This indicator measures the rate at which money in circulation is absorbed by the banking system. Financial formalization here is defined as the propensity of the formal banking system to absorb money in circulation.

[14] This indicator measures the level at which the semi-formal financial sector evolves to the detriment of formal and informal sectors.

[15] This proposition shows the rate at which the informal financial sector is developing at the cost of formal and semi-formal sectors.

[16] The proposition appreciates the deterioration of the formal banking sector to the benefit of other sectors (informal and semi-formal). From common sense, propositions 5 and 8 should be perfectly antagonistic, meaning the former (formal financial development at the expense of other sectors) and the later (formal sector deterioration) should display a perfectly negative coefficient of correlation (See Appendix 2). Proposition 7 has a high positive correlation with Proposition 8 and therefore, only the former will be used in the empirical section.

2.2.4 Testable hypotheses

Hypothesis 1: The informal financial sector (a previously missing component in the definition of the financial system) significantly affects KE. Propositions 3 & 4 will tackle this hypothesis.

Hypothesis 2: Disentangling different components of the existing measurement (financial system) into formal (banking) and semi-formal (other financial institutions) sector indicators could improve understanding of the KE-finance nexus. Propositions 1 & 2 will address this hypothesis.

Hypothesis 3: Introducing measures of sector importance is relevant to understand financial sector competition in KE [17]. Propositions 5, 6 & 7 will examine this hypothesis.

2.3 Scope and positioning of the paper

Much of the literature on KE has focused on the emerging economies of Latin America (Dahlan, 2007) and East Asia (Chandra & Yokoyama, 2011), particularly on the importance of good governance in KE. Based on the analysis, a clear relationship between formal institutional quality and knowledge-based economic infrastructures have been established. To the best of our knowledge, but for a thin exception (Chavula, 2010), the few SSA and MENA papers have been limited to one or two aspects of the phenomenon (Aubert, 2005; Britz et al., 2006; Makinda, 2007; African Development Bank, AfDB, 2007). In order to clearly position this paper, we shall discuss the scope in two strands: policy issues on KE and KE-growth nexus.

In the first strand, while the need for policy reforms on KE determinants in the MENA countries have already been substantiated in Section 2.1.2 above[18], Makinda (2007) provides

[17] To put this in other terms, the need to evaluate how one financial sector develops at the expense of another (and vice-versa) and the incidence of these changes on various components of KE could be crucial in grasping the KE-finance nexus.

one of the most detailed accounts of reforms required in SSA. According to Makinda, in order to rectify this gap between SSA and the Western World, African policy makers need to: (1) define the type of knowledge their countries require; (2) establish conditions for nurturing strategic leaders who will in turn, seek right forms of knowledge to tackle Africa's problems; (3) build political and legal frameworks that encourage the absorption and application of scientific innovation and; (4) revamp universities, establish regional research centers and take capacity building more seriously. Chavula (2010) has also concluded that African countries need to direct policy efforts towards restructuring economic incentives that encourage the acquisition, adaptation and utilization of knowledge into productive use. Earlier, Britz et al. (2006) had investigated the question of whether Africa is moving towards a knowledge society and found that, Africa still has a far way to go down the road and the journey could be quickened with certain preconditions, amongst other: investment in human capital, effective stopping of brain draining, as well as effective development and maintenance of a physical infrastructure.

In the second strand, the AfDB (2007) has assessed the impact of public expenditure on the education dimension of KE and found the following: (1) in the short-term, there is a positive relationship between public expenditure on education and economic growth in Africa, as well as on knowledge generation and human capital development, which have a potential to positively affect aggregate labor productivity; (2) in the long-term however, public expenditure is negatively related to economic growth due to the often lack of capacity to retrain human capital and subsequent brain drain. Chavula (2010) has recently used panel data from 1990 to 2007 to assess the role of KE in economic growth. Findings support the positive bearing of telephone lines, mobile subscribers, tertiary enrolment and FDI inflows in per capita economic prosperity. In MENA, the United Arab Emirates thanks to Dubai (an

[18] See Bizri (2009), Arab Report (2009) & Bizri (2009).

internet and media city with world class standard created from scratch), shows the best performance (Aubert & Reiffers, 2003). Among other MENA countries which have demonstrated significant improvement, it is worthwhile noting Jordan and Tunisia which have heavily invested in education and developed their ICT and/or electronic sectors. In SSA, South Africa distinguishes itself quite remarkably and among low-income countries, some significant progress is noticeable in Uganda, Senegal, Rwanda, Mauritania…etc (Aubert, 2005).

While the KE-growth nexus is important, to the best of our knowledge the debate has failed to incorporate a financial dimension. According to the World Bank (2007, p.73), a KE cannot be built without finance. Small and huge entrepreneurial knowledge based projects require relatively small and substantial amounts of development capital respectively. Hence, the need to model the KE-finance nexus with financial indicators that capture both microfinance mechanisms and financial sources from formal banking institutions. The motivations of employing these alternative financial measures and the contribution of this paper to the literature have already been substantially discussed in Section 2.2 and the introduction respectively.

3. Data and Methodology

3.1 Data

In line with the literature (Chavula, 2010; Weber, 2011), our dependent variables are gathered from World Development Indicators (WDI). Thus, the study employs the variables identified under the World Bank's four KEI components which include: the economic environment, innovation, education and information infrastructure. We estimate panel data models for 22 MENA and SSA countries over the years 1996-2010. Whereas, the choice of this time span is premised on the motivation of obtaining results with more focused and

updated policy implications, the number of countries in the sample is limited by constraints in data availability.

Financial development independent variables are propositions summarized in Table 1 above, inspired by Appendix 4. As we have earlier emphasized, we do not use traditional financial development indicators because their concept and definition fails to take into account the informal financial sector. Also, this missing segment of the IFS (2008) definition of the financial system has been used in recent studies to explain the growing phenomenon of mobile banking in the African continent (Asongu, 2012b). And by inference we know, this burgeoning phenomenon is part and parcel of KE.

The choice of instrumental variables is critical in the analysis because, by definition they need to be linked to the independent variables and not the dependent variables. To this end we instrument our propositions with traditional financial development indicators which include: money supply; liquid liabilities; banking system efficiency; financial system activity; banking system activity; financial system activity and financial size.

We control for government expenditure, population growth, inflation and economic prosperity (GDP growth). We limit the analysis to only four control variables owing to constraints in the Overidentifying Restrictions (OIR) test for instrument validity[19]. We expect government expenditure to generally stimulate KE if resources allocated for investment purposes are not tainted with corrupt practices. While the incidence of population growth on KE depends on government policies in place, it is generally believed that population has a positive linkage with the ICT and Education dimensions of the phenomenon**.** We expect inflation to increases the credit aspect of economic incentive and mitigate demand for ICT

[19]An OIR test is applicable only and only if there is an over-identification presence. That is, the instruments must be higher than the endogenous independent variables by at least one degree of freedom. In the cases of exact-identification (instruments equal to independent explaining variables) and under-identifications (instruments less than endogenous independent variables), an OIR test is by definition impossible.

owing to rising prices. From a broad standpoint, economic prosperity should be a natural driver of KE.

Details about descriptive statistics (with presentation of countries), correlation analysis (showing the relationships between key variables used in the paper), and variable definitions are presented in the appendices. The 'summary statistics' (Appendix 1) of the variables used in the panel regressions shows that there is quite some variation in the data utilized so that one should be confident that reasonable estimated linkages should emerge. The purpose of the correlation matrix (Appendix 2) is to avoid issues resulting from overparametization and multicolinearity. Based on a preliminary assessment of the correlation coefficients, there do not appear to be any serious concerns in terms of the relationships to be estimated. Appendix 3 provides definitions and sources of the variables. Bases for the propositions used in the analysis are reported in Appendix 4.

3.2 Methodology

3.2.1 Principal Component Analysis (PCA)

Owing to high correlation between various indicators in each dimension of the KEI, one might criticize the redundancy of some information. Hence, we use principal component analysis (PCA) to reduce the dimensions of each constituent of the KEI. The PCA is a widely used statistical technique to reduce a larger set of correlated variables into a smaller set of uncorrelated variables called principal components (PC) that account for most of the information in the original data set. In the choice of the PCs, the criteria applied to determine how many common factors to retain are taken from Kaiser (1974) and Jolliffe (2002). Hence, only PCs with an eigenvalue greater than one are retained. Note should be taken of the fact that, the first PCs are almost equal across dimensions. This result shows that one PC model is appropriate for KE dimensions in our sample. As shown in Table 2, the first PC accounts for approximately 65% of the variation in all the four KE dimensions. *Educatex* for example

which represents about 77% of information in the education dimension of KE is the first PC of primary school enrolment (PSE), secondary school enrolment (SSE) and tertiary school enrolment (TSE).

Table 2: Principal Component Analysis

Knowledge Economy dimensions		Component Matrix (Loadings)			First P.C	Eigen Value	Indexes
Education	School enrolment	PSE	SSE	TSE			
		0.535	0.620	0.574	0.771	2.313	Educatex
Information & Infrastructure	ICTs	Internet	Mobile	Telephone			
		0.653	0.661	0.371	0.705	2.115	ICTex
Economic Incentive	Trade & Tariffs	Trade		Tariffs			
		-0.707		0.707	0.645	1.290	Tradex
	Credit & IR Spread	Private Credit		Interest rate spread			
		-0.707		0.707	0.679	1.358	Creditex
Innovation	Scientific Journals FDI Inflows	Reducing the dimensions of these is impractical owing to low correlation and conceptual dissimilarity.					

PSE: Primary School Enrolment. SSE: Secondary School Enrolment. TSE: Tertiary School Enrolment. PC: Principal Component. ICTs: Information and Communication Technologies. IR: Interest Rate. FDI: Foreign Direct Investment. Educatex is the first principal component of primary, secondary and tertiary school enrolments. ICTex: first principal component of mobile, telephone and internet subscriptions. Creditex: first principal component of Private credit and Interest rate spreads. Tradex: first principal component of Trade and Tariffs.

3.2.2 Endogeneity and estimation technique

From a theoretical position, while KE cannot be built without finance (World Bank, 2007, p.73), the reverse effect cannot be ruled-out because knowledge-based economic activities substantially contribute to financial development; as documented in very recent mobile-banking literature (Asongu, 2012ab). This reverse causality inevitably results to endogeneity. From an empirical standpoint, the use of PCs that do not account for all information contained in constituents of each dimension of the KEI presents a concern of omitted variables which is also a source of endogeneity. To tackle this endogeneity concern, we shall examine its presence with the Hausman test before employing an estimation approach that is relevant to the outcome of the test. Either two-stage least squares (2SLS) or fixed effects (FE) regressions are contingent on the presence of this endogeneity issue.

Borrowing from Beck et al. (2003) and recent African development literature (Asongu, 2012ab) the paper adopts a 2SLS instrumental variable (IV) estimation technique. IV estimation tackles the puzzle of endogeneity and thus avoids the inconsistency of estimated coefficients by Ordinary Least Squares (OLS) when the independent variables are correlated with the error term in the main equation. The 2SLS approach adopted will entail the following:

First-stage regression:

$$propositions_{it} = \gamma_0 + \gamma_{1i}(instruments)_{it} + \beta_i X_{it} + \upsilon \qquad (1)$$

Second-stage regression:

$$KE_{it} = \gamma_0 + \gamma_1(propositions)_{it} + \beta_i X_{it} + \mu \qquad (2)$$

In Eq. (1) and Eq. (2), *X* is a set of control variables which include: government expenditure, population growth, inflation and economic prosperity (GDP growth). 'KE' represents the knowledge economy dimensions (education, economic incentive, information & communication infrastructure and, innovation). 'Propositions' are financial development indicators summarized in Table 1. For the first and second equations, v and u, respectively denote the error terms. Instruments include: money supply, liquid liabilities, banking system efficiency, financial system efficiency, banking system activity, financial system activity and financial size.

In the 2SLS approach, we follow three main steps: (1) justify the choice of a 2SLS over an OLS estimation technique with the Hausman-test for endogeneity; (2) verify the instruments are exogenous to the endogenous components of explaining variables (proposition channels); (3) ensure the instruments are valid and not correlated with the error-term in the main equation with an Over-identifying Restrictions (OIR) test.

3.2.3 Further robustness checks

Additional robustness of the empirical analysis is ensured with the following: (1) modeling with robust Heteroscedasticity and Autocorrelation Consistent (HAC) standard errors; (2) use of different properties of the same dataset (full data, 3 year non-overlapping intervals and 5 year non-overlapping intervals) and; (3) modeling with panel Fixed Effects (FE) to control for the unobserved heterogeneity.

4. Empirical analysis

This section aims to investigate five main issues: (1) the capacity of the exogenous components of the propositions to explain KE dimensions; (2) the ability of the instruments to explain KE dimensions beyond the propositions; (3) whether the informal sector (a previously missing component in the definition of the financial system) significantly affects KE (*Hypothesis 1*); (4) if disentangling different components in the existing measurement of the financial system contributes to the KE-finance literature (*Hypothesis 2*) and; (5) whether introducing measures of sector importance is relevant to understand financial sector competition in KE (*Hypothesis 3*). The first issue is addressed by the significance of estimated coefficients; resolving the second depends on results of the OIR Sargan test; while, the third, fourth and fifth depend on both the significance of estimated coefficients and the validity of the instruments (Sargan OIR-test).

The null hypothesis of the Sargan OIR test is the position that, the instruments explain KE only through propositions. In other words that, financial depth (money supply and liquid liabilities), financial efficiency (at banking and financial system levels), financial activity (from banking and financial systems perspectives) and financial size, account for KE only through propositions. A Hausman test for endogeneity precedes every 2SLS approach. The null hypothesis of this test is the stance that OLS estimates are efficient and consistent. Therefore, a rejection of the this hypothesis points to the presence of inconsistent estimates

owing to endogeneity and hence, lends credit to the choice of the 2SLS approach. Regressions by Fixed Effects are also presented in the last columns to control for the unobserved heterogeneity. Two main differences are noticeable between the 2SLS and FE regressions: (1) the Sargan OIR test is not relevant for FE regressions because its modeling is not contingent on instrumental variables; (2) the result of the Hausman test differ because the null hypothesis of the test in the TSLS (FE) approach is the position that OLS (GLS)[20] are efficient and consistent. Note should be taken of the fact that, the TSLS controls for endogeneity while the FE regressions controls just for the unobserved heterogeneity. Hence in event of conflict of interest between TSLS and FE regressions, priority will be given to TSLS because 'unobserved heterogeneity' implies endogeneity and not the other way round[21].

Tables 4-7, present robust HAC results for various components of KE. These findings are summarized in Table 3. The education (Table 4), information & communication technology (Table 5), economic incentive (Table 6) and innovation (Table 7) components of KE are regressed on propositions conditional on other covariates (control variables) to obtain results robust to HAC standard errors. The overwhelming rejection of the null hypothesis of the Hausman test across tables and specifications confirms the presence of endogeneity and lends credit to the paper's adoption of the 2SLS modeling approach.

As concerns the first issue, the significance of estimated coefficients across Tables 4-7 points to the explanatory power of estimated coefficients. With regard to the second issue, but for Table 5, the null hypotheses of the Sargan OIR tests are not overwhelmingly rejected, which validates the instrumental variables. In other words, the traditional financial instrumental variables of depth, efficiency, activity and size, do not explain KE components beyond the proposed financial sector mechanisms.

[20]In modeling the FE regressions, we first of all assess the presence of heteroscedasticity with the Breuch Pagan test. This has a double interest: (1) it lends credit to the use of robust HAC standard error Generalized Least Squares (GLS) with FE and; (2) it confirms the validity of controlling for heteroscedasticity in the TSLS approach with robust HAC standard errors.

[21]Unobserved heterogeneity controlled by the FE regressions is only one cause of endogeneity.

The third issue (*Hypothesis 1*)[22], which is accounted for only by Propositions 3 and 4 of Panel As in the tables reflects the following findings. (1) The informal financial sector positively affects the educational dimension of KE only when the unobserved heterogeneity (a cause of endogeneity) is controlled for. However, when instrumented with traditional financial indicators, the negative incidence is not significant. (2) No significant incidence of informal finance is found on the ICT dimension. However this interpretation should be treated with caution owing to the invalidity of instruments in Table 5. (3) From the economic incentive dimension, two results catch our attention; one the one hand, controlling only for the unobserved heterogeneity shows that informal finance improves credit facilities (*Creditex*); one the other hand, controlling for endogeneity demonstrates that informal finance improves trade openness (*Tradex*). (4) From 'scientific journal publications' and FDI inflows standpoints, informal finance is not a significant incentive to innovation.

The following results could be drawn from *Hypothesis 2*[23] on the fourth issue which is contingent on the results of Propositions 1 & 2 of Panel As in the tables. (1) Controlling only for the unobserved heterogeneity, while formal finance stimulates the educational and ICT dimensions of KE, semi-formal finance does the contrary. (2) Formal financial development decreases both measures of economic incentive (*Creditex* and *Tradex*), while semi-formal finance has a positive (negative) incidence on *Creditex* (*Tradex*). (3) Both formal-oriented sectors of finance have a positive effect on FDI inflows with the impact of the semi-formal sector higher than that of the formal sector. (4) The formal financial sector has a positive effect on scientific publications (controlling for the unobserved heterogeneity), while the semi-formal financial sector has a negative impact.

[22]Whether the informal sector (a previously missing component in the definition of the financial system) significantly affects KE .

[23]Disentangling different components of the existing measurement of the financial system contribute the KE-finance literature?

Hypothesis 3[24] which addresses the fifth issue is based on Propositions 5, 6 & 7 of Panel Bs in the tables. (1) Whereas, Proposition 6 stimulates education, when controlling only for the unobserved heterogeneity Proposition 5 (Proposition 7) increases (mitigates) education. (2) Proposition 6 mitigates ICTs, while controlling for the unobserved heterogeneity Proposition 5 (Proposition 7) increases (decreases) it. (3) Propositions 6 & 7 stimulate economic incentive while Proposition 5 has the opposite effect on the dimension of KE. (4) Controlling only for the unobserved heterogeneity, Proposition 5 (Proposition 7) increases (decreases) innovation, while Proposition 6 decreases (increases) scientific publication (FDI inflows).

Most of the control variables are significant with the right signs. (1) As expected, inflation increases the credit aspect of economic incentive and mitigates the demand for ICT. This is logical because, with inflation, purchasing power reduces and hence there is more demand for credit to compensate for the loss in purchasing power. Also, a rise in prices of ICT services decreases demand for these services. (2) Government expenditure improves education, ICT and could decrease demand for credit if more public services are provided at subsidized rates. (3) Economic prosperity stimulates education, the ICT sector and FDI inflows.

Table 3 : Summary of results

		Education		ICT		Economic Incentive				Innovation			
		Educatex		ICTex		Creditex		Tradex		Journals		FDI Inflows	
		E	UH	E	UH	E	UH	E	UH	E	UH	E	UH
Hypothesis 1	Prop.3	n.a	+	n.a	n.a	n.a	+	+	n.a	n.a	n.a	n.a	n.a
	Prop.4	n.a	+	n.a	n.a	n.a	+	+	n.a	n.a	n.a	n.a	n.a
Hypothesis 2	Prop.1	n.a	+	n.a	+	-	-	-	-	n.a	+	+	+
	Prop.2	n.a	-	-°	-	+	+	-	n.a	-	n.a	+	n.a
	Prop.5	n.a	+	n.a	+	n.a	-	-	-	n.a	+	n.a	+
Hypothesis 3	Prop.6	+	-	-	-	+	+	+	n.a	-	-	+	-
	Prop.7	n.a	-	n.a	-	n.a	+	+	+	n.a	-	n.a	-

E: Controlling for Endogeneity. UH: Controlling for the Unobserved Heterogeneity. Prop: Proposition. n.a: not applicable due to insignificance of estimated coefficient. °: invalid instruments. Educatex is the first principal component of primary, secondary and tertiary school enrolments. ICTex: first principal component of mobile, telephone and internet subscriptions. Creditex: first principal component of Private credit and Interest rate spreads. Tradex: first principal component of Trade and Tariffs.

[24] Introducing measures of sector importance is relevant to understand financial sector competition in KE

Table 4: Robust (HAC) standard errors Two-stage least squares for Education

Dependent variable: Educatex

Panel A: Impact of GDP based measures

	Full data		3 Year NOI		5 Year NOI		Fixed Effects	
Constant	-1.943	-1.943	0.322	0.322	1.203	1.203	**-1.649*** **	**-1.649*** **
	(-0.493)	(-0.493)	(0.030)	(0.030)	(0.187)	(0.187)	**(-3.200)**	**(-3.200)**
Proposition 1	-2.463	-2.463	-1.386	-1.386	-3.137	-3.137	**3.381*** **	**3.381*** **
	(-0.540)	(-0.540)	(-0.408)	(-0.408)	(-0.397)	(-0.397)	**(4.054)**	**(4.054)**
Proposition 2	-2.743	1.998	-8.630	-3.496	-15.81	-19.21	**-12.23*** **	**-12.49*** **
	(-0.120)	(0.110)	(-0.477)	(-0.383)	(-0.710)	(-0.654)	**(-5.835)**	**(-5.933)**
Proposition 3	-4.741	---	-5.133	---	3.404	---	**0.256*** **	---
	(-0.400)		(-0.356)		(0.222)		**(2.810)**	
Proposition 4	---	-4.741	---	-5.133	---	3.404	---	**0.256*** **
		(-0.400)		(-0.356)		(0.222)		**(2.810)**
Gov. Expenditure	0.257	0.257	0.204	0.204	0.303	0.303	**-0.017***	**-0.017***
	(1.434)	(1.434)	(1.212)	(1.212)	(0.845)	(0.845)	**(-1.798)**	**(-1.798)**
Inflation	0.016	0.016	-0.131	-0.131	-0.086	-0.086	-0.003	-0.003
	(0.084)	(0.084)	(-0.717)	(-0.717)	(-0.861)	(-0.861)	(-0.214)	(-0.214)
Economic Prosperity	0.308	0.308	-0.121	-0.121	-0.476	-0.476	0.009	0.009
	(0.527)	(0.527)	(-0.049)	(-0.049)	(-0.283)	(-0.283)	(0.754)	(0.754)
Hausman test	**49.885*** **	**49.885*** **	**52.861*** **	**52.861*** **	**25.069*** **	**25.069*** **	**15.75** **	**15.75** **
Sargan OIR test	**1.478**	**1.478**	**0.547**	**0.547**	**0.761**	**0.761**	n.a	n.a
	[0.477]	**[0.477]**	**[0.760]**	**[0.760]**	**[0.382]**	**[0.382]**		
Adjusted R^2	0.204	0.204	0.208	0.208	0.018	0.018	0.955	0.955
Fischer	1.204	1.204	**2.004***	**2.004***	1.085	1.085	**108.94*** **	**108.94*** **
Observations	98	98	49	49	33	33	107	107

Panel B: Impact of financial sector importance measures

	Full data		3 Year NOI		5 Year NOI		Fixed Effects	
Constant	2.385	-0.350	10.601	6.899	-3.963	-2.029	**-11.71*** **	**2.402*** **
	(0.438)	(-0.123)	(0.701)	(0.783)	(-1.261)	(-1.077)	**(-5.413)**	**(6.908)**
Proposition 5	-2.735	---	-3.702	---	1.933	---	**14.11*** **	---
	(-0.628)		(-0.513)		(0.493)		**(5.654)**	
Proposition 6	**13.445** **	**16.180***	3.165	6.867	**5.469***	3.535	-3.279	**-17.39*** **
	(2.488)	**(1.818)**	(0.353)	(0.459)	**(1.686)**	(0.550)	(-1.251)	**(-9.806)**
Proposition 7	---	2.735	---	3.702	---	-1.933	---	**-14.11*** **
		(0.628)		(0.513)		(-0.493)		**(-5.654)**
Gov. Expenditure	**0.135*** **	**0.135*** **	**0.137** **	**0.137** **	**0.166*** **	**0.166*** **	-0.011	-0.011
	(4.948)	**(4.948)**	**(2.001)**	**(2.001)**	**(3.822)**	**(3.822)**	(-1.536)	(-1.536)
Population Growth	**-2.085***	**-2.085***	-1.461	-1.461	**-1.495*** **	**-1.495*** **	---	---
	(-1.729)	**(-1.729)**	(-0.661)	(-0.661)	**(-3.164)**	**(-3.164)**		
Inflation	**0.234***	**0.234***	-0.123	-0.123	0.130	0.130	-0.003	-0.003
	(1.899)	**(1.899)**	(-0.567)	(-0.567)	(1.626)	(1.626)	(-0.179)	(-0.179)
Economic Prosperity	0.273	0.273	-1.273	-1.273	**0.671*** **	**0.671*** **	-0.013	-0.013
	(0.826)	(0.826)	(-0.739)	(-0.739)	**(2.969)**	**(2.969)**	(-1.214)	(-1.214)
Hausman test	**57.261*** **	**57.261*** **	**37.241*** **	**37.241*** **	**12.565***	**12.565*** **	**28.500*** **	**28.500*** **
Sargan OIR test	**2.239**	**2.239**	**0.853**	**0.853**	**2.6**	**2.6**	n.a	n.a
	[0.326]	**[0.326]**	**[0.652]**	**[0.652]**	**[0.272]**	**[0.272]**		
Adjusted R^2	0.242	0.242	0.121	0.121	0.455	0.455	0.948	0.948
Fischer	**8.014*** **	**8.014*** **	**3.304** **	**3.304** **	**31.887*** **	**31.887*** **	**95.475*** **	**95.475*** **
Observations	98	98	44	44	25	25	104	104

*;**;***: significance levels of 10%, 5% and 1% respectively. t-statistics in parentheses for FE regressions. Z-statistics for 2SLS. [ ]:P-values. OIR: Overidentifying Restrictions. HAC: Heteroscedasticity and Autocorrelation Consistent. NOI: Non Overlapping Intervals. Educatex is the first principal component of primary, secondary and tertiary school enrolments. n.a: not applicable.

Table 5: Robust (HAC) standard errors Two-stage least squares for ICT (ICTex)

Dependent variable: ICTex

Panel A: Impact of GDP based measures

	Full data		3 Year NOI		5 Year NOI		Fixed Effects	
Constant	-2.053	-2.053	0.924	0.924	0.622	0.619	**-4.238*** **	**-4.238*** **
	(-0.438)	(-0.438)	(0.220)	(0.220)	(0.781)	(0.777)	**(-4.272)**	**(-4.272)**
Proposition 1	-0.724	-0.724	0.284	0.284	1.031	1.032	**8.340*** **	**8.340*** **
	(-0.609)	(-0.609)	(0.228)	(0.228)	(0.951)	(0.951)	**(4.296)**	**(4.296)**
Proposition 2	**-9.696** **	**-12.997** **	**-15.238** **	**-18.76*** **	**-21.35*** **	**-18.21*** **	**-25.129** **	**-24.77** **
	(-2.000)	**(-1.996)**	**(-2.413)**	**(-3.685)**	**(-5.014)**	**(-5.316)**	**(-2.425)**	**(-2.401)**
Proposition 3	3.300	---	3.522	---	-3.134	---	-0.357	---
	(0.415)		(0.604)		(-0.808)		(-0.943)	
Proposition 4	---	3.300	---	3.522	---	-3.114	---	-0.357
		(0.415)		(0.604)		(-0.802)		(-0.943)
Gov. Expenditure	**0.130*** **	**0.130*** **	0.071	0.071	0.003	0.003	0.003	0.003
	(2.938)	**(2.938)**	(1.039)	(1.039)	(0.058)	(0.058)	(0.298)	(0.298)
Population Growth	-0.436	-0.436	---	---	---	---	0.076	0.076
	(-0.389)	(-0.389)					(1.103)	(1.103)
Inflation	---	---	**-0.108***	**-0.108***	**-0.141*** **	**-0.141*** **	---	---
			(-1.912)	**(-1.912)**	**(-2.670)**	**(-2.669)**		
Economic Prosperity	0.394	0.394	-0.305	-0.305	---	---	**0.065*** **	**0.065*** **
	(0.867)	(0.867)	(-0.341)	(-0.341)			**(2.976)**	**(2.976)**
Hausman test	**5.364*** **	**18.369*** **	**13.922** **	**13.922** **	**13.187** **	**13.177** **	**53.57*** **	**53.57*** **
Sargan OIR test	17.327***	17.327***	9.359***	9.359***	9.656**	9.674**	n.a	n.a
	[0.000]	[0.000]	[0.009]	[0.009]	[0.021]	[0.021]		
Adjusted R²	0.047	0.047	0.012	0.012	0.050	0.051	0.547	0.547
Fischer	**5.364*** **	**5.364*** **	**12.282*** **	**12.282*** **	**8.256*** **	**8.237*** **	**12.043*** **	**12.043*** **
Observations	192	192	67	67	40	40	220	220

Panel B: Impact of financial sector importance measures

	Full data		3 Year NOI		5 Year NOI		Fixed Effects	
Constant	2.086	-0.093	2.599	-1.324	-0.375	-0.375	**-26.74*** **	**5.506*** **
	(0.873)	(-0.053)	(0.713)	(-0.808)	(-0.103)	(-0.298)	**(-10.15)**	**(8.464)**
Proposition 5	-2.180	---	-3.924	---	0.0002	---	**32.255*** **	---
	(-0.740)		(-0.767)		(0.000)		**(9.903)**	
Proposition 6	**-10.45*** **	**-8.273** **	**-10.59*** **	-6.670	**-8.45*** **	-8.450	-2.591	**-34.84*** **
	(-3.594)	**(-2.123)**	**(-2.796)**	(-1.104)	**(-3.798)**	(-1.597)	(-0.607)	**(-7.540)**
Proposition 7	---	2.180	---	3.924	---	-0.0002	---	**-32.25*** **
		(0.740)		(0.767)		(-0.000)		**(-9.903)**
Gov. Expenditure	**0.099***	**0.099***	0.110	0.110	0.0432	0.043	0.0005	0.0005
	(1.746)	**(1.746)**	(1.255)	(1.255)	(0.839)	(0.839)	(0.055)	(0.055)
Population Growth	-0.304	-0.304	---	---	---	---	0.028	0.028
	(-0.455)	(-0.455)					(0.554)	(0.554)
Inflation	**-0.094** **	**-0.094** **	**-0.101*** **	**-0.101*** **	**-0.087*** **	**-0.087*** **	**-0.043***	**-0.043***
	(-2.032)	**(-2.032)**	**(-2.794)**	**(-2.794)**	**(-3.697)**	**(-3.697)**	**(-1.700)**	**(-1.700)**
Economic Prosperity	---	---	---	---	---	---	**0.052*** **	**0.052*** **
							(3.483)	**(3.483)**
Hausman test	**51.796*** **	**51.796*** **	**10.519*** **	**10.519** **	3.091	3.091	**180.3*** **	**180.3*** **
Sargan OIR test	19.475***	19.475***	**6.463**	**6.463**	8.352*	8.352*	n.a	n.a
	[0.000]	[0.000]	**[0.167]**	**[0.167]**	[0.079]	[0.079]		
Adjusted R²	0.086	0.086	0.045	0.045	0.121	0.121	0.681	0.681
Fischer	**4.729*** **	**4.729*** **	**2.984** **	**2.984** **	**5.873*** **	**5.873*** **	**20.237*** **	**20.237*** **
Observations	192	192	55	55	26	26	217	217

*;**;***: significance levels of 10%, 5% and 1% respectively. t-statistics in parentheses for FE regressions. Z-statistics for 2SLS. [ ]:P-values. OIR: Overidentifying Restrictions. HAC: Heteroscedasticity and Autocorrelation Consistent. NOI: Non Overlapping Intervals. ICT: Information and Communication Technology. ICTex: first principal component of mobile, telephone and internet subscriptions. n.a: not applicable. Creditex: first principal component of Private credit and Interest rate spreads. Tradex: first principal component of Trade and Tariffs.

Table 6: Robust (HAC) standard errors Two-stage least squares for Economic Incentive (Creditex and Tradex)

	Panel A1: Impact of GDP based measures for Creditex								Panel A2: Impact of GDP based measures for Tradex							
	Full data		3 Year NOI		5 Year NOI		Fixed Effects		Full data		3 Year NOI		5 Year NOI		Fixed Effects	
Constant	**4.885*** **	**4.885*** **	1.419	1.419	**1.389** **	**1.393** **	**0.589** **	**0.589** **	**2.154** **	**2.154*** **	-0.014	0.499	0.600	0.601	**2.745*** **	**2.745*** **
	(2.956)	**(2.956)**	(1.192)	(1.192)	**(2.092)**	**(2.101)**	**(2.335)**	**(2.335)**	**(2.429)**	**(2.429)**	(-0.006)	(0.232)	(0.899)	(0.898)	**(5.672)**	**(5.672)**
Proposition 1	**-2.009** **	**-2.009** **	**-2.22*** **	**-2.22*** **	**-3.01*** **	**-3.01*** **	**-1.133** **	**-1.133** **	-1.865	-1.865	-3.001	-2.077	**-1.889***	**-1.897***	**-4.90*** **	**-4.90*** **
	(-2.212	**(-2.212)**	**(-2.722)**	**(-2.722)**	**(-5.073)**	**(-5.072)**	**(-2.254)**	**(-2.254)**	(-1.364)	(-1.364)	(-1.208)	(-1.180)	**(-1.732)**	**(-1.736)**	**(-4.885)**	**(-4.885)**
Proposition 2	-4.059	0.376	1.940	3.486	**5.243***	**4.737*** **	**7.767***	**7.258***	0.561	**-8.768***	3.998	2.769	0.570	**-7.491***	-2.332	-2.338
	(-0.487)	(0.087)	(0.492)	(1.168)	**(1.721)**	**(2.968)**	**(1.803)**	**(1.688)**	(0.0733)	**(-1.844)**	(0.149)	(0.137)	(0.092)	**(-1.703)**	(-0.186)	(-0.187)
Proposition 3	-4.436	---	-1.546	---	0.505	---	**0.508*** **	---	**9.330** **	---	**10.617***	---	**8.040** **	---	0.006	---
	(-0.817)		(-0.851)		(0.280)		**(6.103)**		**(2.029)**		**(1.681)**		**(2.045)**	**8.054** **	(0.035)	
Proposition 4	---	-4.436	---	-1.546	---	0.481	---	**0.508*** **	---	**9.330** **	---	**10.39** **	---	**(2.045)**	---	0.006
		(-0.817)		(-0.851)		(0.268)		**(6.103)**		**(2.029)**		**(1.976)**				(0.035)
Gov. Expenditure	**-0.08*** **	**-0.08*** **	-0.065	-0.065	-0.025	-0.025	0.002	0.002	-0.045	-0.045	-0.009	-0.017	0.004	0.004	0.005	0.005
	(-2.879)	**(-2.879)**	(-1.531)	(-1.531)	(-0.900)	(-0.906)	(0.656)	(0.656)	(-0.872)	(-0.872)	(-0.202)	(-0.356)	(0.115)	(0.123)	(1.527)	(1.527)
Population Growth	---	---	0.146	0.146	---	---	---	---	---	---	-0.571	-0.022	---	---	---	---
			(0.352)	(0.352)							(-0.401)	(-0.023)				
Inflation	---	---	0.050	0.050	**0.079** **	**0.079** **	---	---	---	---	0.052	0.032	0.014	0.014	---	---
			(1.183)	(1.183)	**(2.466)**	**(2.462)**					(1.167)	(0.971)	(0.391)	(0.391)		
Economic Prosperity	-0.533	-0.533	---	---	---	---	**-0.015***	**-0.015***	-0.330	-0.330	0.411	---	---	---	**-0.075** **	**-0.075** **
	(-1.643)	(-1.643)					**(-1.803)**	**(-1.803)**	(-1.497)	(-1.497)	(0.892)				**(-2.596)**	**(-2.596)**
Hausman test	**76.70*** **	**76.70*** **	**19.40*** **	**19.40*** **	6.398	6.399	**25.94*** **	**25.94*** **	3.643	3.643	**33.98*** **	**24.50*** **	**23.62*** **	**23.77*** **	**24.95*** **	**24.95*** **
Sargan OIR	**0.536**	**0.536**	**1.764**	**1.764**	**4.379**	**4.381**	n.a	n.a	**1.587**	**1.587**	**0.975**	**2.334**	**1.082**	**1.058**	n.a	n.a
	[0.910]	**[0.910]**	**[0.413]**	**[0.413]**	**[0.223]**	**[0.223]**			**[0.662]**	**[0.662]**	**[0.323]**	**[0.311]**	**[0.781]**	**[0.787]**		
Adjusted R²	0.264	0.264	0.578	0.578	0.749	0.748	0.926	0.926	0.312	0.312	0.029	0.202	0.084	0.083	0.735	0.735
Fischer	**15.56*** **	**15.56*** **	**27.97*** **	**27.97*** **	**31.18*** **	**31.34*** **	**111.1*** **	**111.1*** **	**4.233*** **	**4.233*** **	**2.030***	**3.932*** **	**2.589** **	**2.597** **	**14.88*** **	**14.88*** **
Observations	159	159	56	56	33	33	175	175	100	100	53	53	36	36	116	116

	Panel B1: Impact of financial sector importance measures for Creditex								Panel B2: Impact of financial sector importance measures for Tradex							
	Full data		3 Year NOI		5 Year NOI		Fixed Effects		Full data		3 Year NOI		5 Year NOI		Fixed Effects	
Constant	1.759	0.950	-1.906	-1.158	0.665	-0.003	**2.583***	-0.250	**6.918***	2.307	6.154	-1.226	**9.891*** **	**-0.925***	**11.00*** **	**-1.47*** **
	(0.583)	(0.191)	(-1.122)	(-0.922)	(0.404)	(-0.004)	**(1.809)**	(-0.810)	**(1.826)**	(0.637)	(1.278)	(-0.947)	**(5.866)**	**(-1.867)**	**(7.677)**	**(-3.710)**
Proposition 5	-0.808	---	0.748	---	-0.668	---	**-2.833***	---	-4.611	----	**-7.665***	---	**-10.8*** **	---	**-12.4*** **	---
	(-0.262)		(0.414)		(-0.313)		**(-1.660)**		(-0.730)		**(-1.903)**		**(-5.259)**		**(-6.963)**	
Proposition 6	-0.561	0.247	-0.132	-0.880	**5.528*** **	**6.197***	**3.763** **	**6.597*** **	-7.395	-2.783	7.810	**15.78***	**-4.370** **	**6.446** **	-5.792	6.690
	(-0.094)	(0.028)	(-0.032)	(-0.172)	**(4.179)**	**(1.884)**	**(1.993)**	**(2.858)**	(-1.341)	(-0.298)	(0.618)	**(1.803)**	**(-2.545)**	**(2.528)**	(-1.201)	(1.382)
Proposition 7	---	0.808	---	-0.748	---	0.668	---	**2.833***		4.611	---	**7.300***	---	**10.81*** **	---	**12.48*** **
		(0.262)		(-0.414)		(0.313)		**(1.660)**		(0.730)		**(1.872)**		**(5.259)**		**(6.963)**
Gov. Expenditure	**-0.153***	**-0.153***	**-0.15*** **	**-0.15*** **	**-0.07*** **	**-0.07*** **	0.002	0.002	-0.065	-0.065	---	---	-0.027	-0.027	0.001	0.001
	(-1.801)	**(-1.801)**	**(-2.911)**	**(-2.911)**	**(-2.601)**	**(-2.601)**	(0.676)	(0.676)	(-0.791)	(-0.791)			(-1.280)	(-1.280)	(0.461)	(0.461)
Population Growth	**0.937***	**0.937***	**1.206***	**1.206***	---	---	**-0.06*** **	**-0.060***	0.039	0.039	0.047	0.133	---	---	-0.034	-0.034
	(1.726)	**(1.726)**	**(1.854)**	**(1.854)**			**(-3.432)**	**(-3.432)**	(0.070)	(0.070)	(0.046)	(0.147)			(-0.645)	(-0.645)
Inflation	0.034	0.034	**0.084***	**0.084***	**0.135*** **	**0.135*** **	0.007	0.007	-0.054	-0.054	0.023	0.015	0.0002	0.0002	**-0.05*** **	**-0.05*** **
	(0.252)	(0.252)	**(1.861)**	**(1.861)**	**(10.91)**	**(10.91)**	(0.922)	(0.922)	(-0.590)	(-0.590)	(0.461)	(0.433)	(0.018)	(0.018)	**(-4.110)**	**(-4.110)**
Economic Prosperity	-0.354	-0.354	---	---	---	---	-0.012	-0.012	-0.452	-0.452	0.074	---	---	---	-0.031	-0.031
	(-0.556)	(-0.556)					(-1.595)	(-1.595)	(-1.217)	(-1.217)	(0.291)				(-1.632)	(-1.632)
Hausman test	**263.3*** **	**263.3*** **	**90.37*** **	**90.37*** **	**15.37*** **	**15.37*** **	**15.72** **	**15.72** **	**39.29*** **	**39.29*** **	**23.05*** **	**22.84*** **	**19.89*** **	**19.89*** **	**24.88*** **	**24.88*** **
Sargan OIR	**2.931**	**2.931**	**2.002**	**2.002**	**5.313**	**5.313**	n.a	n.a	**0.905**	**0.905**	**3.560**	**3.786**	**1.533**	**1.533**	n.a	n.a
	[0.230]	**[0.230]**	**[0.571]**	**[0.571]**	**[0.256]**	**[0.256]**			**[0.635]**	**[0.635]**	**[0.313]**	**[0.435]**	**[0.820]**	**[0.820]**		
Adjusted R²	0.134	0.134	0.286	0.286	0.404	0.404	0.922	0.922	0.215	0.215	0.086	0.126	0.614	0.614	0.757	0.757
Fischer	**6.350*** **	**6.350*** **	**12.38*** **	**12.38*** **	**58.44*** **	**58.44*** **	**98.58*** **	**98.58*** **	**2.730** **	**2.730** **	**6.990*** **	**6.944*** **	**34.28*** **	**34.28*** **	**15.59*** **	**15.59*** **
Observations	159	159	47	47	22	22	172	172	100	100	45	45	22	22	113	113

*;**;***: significance levels of 10%, 5% and 1% respectively. t-statistics in parentheses for FE regressions. Z-statistics of 2SLS. [ ]:P-values. OIR: Overidentifying Restrictions. n.a: not applicable. NOI: Non Overlapping Intervals. Creditex: first principal component of Private credit and Interest rate spreads. Tradex: first principal component of Trade and Tariffs.

Table 7 : Robust (HAC) standard errors Two-stage least squares for Innovation (Scientific & Technical Journals and FDI inflows)

	Panel A: Impact of GDP based measures for Journals								Panel A1: Impact of GDP based measures for FDI inflows							
	Full data		3 Year NOI		5 Year NOI		Fixed Effects		Full data		3 Year NOI		5 Year NOI		Fixed Effects	
Constant	3.203	3.203	**1.668*** **	**1.668*** **	**3.202** **	**3.202** **	**1.871*** **	**1.871*** **	-7.308	-7.308	-0.711	-0.711	-0.296	-0.298	**-4.327***	**-4.327***
	(0.768)	(0.768)	**(4.190)**	**(4.190)**	**(1.985)**	**(1.985)**	**(17.55)**	**(17.55)**	(-1.073)	(-1.073)	(-0.311)	(-0.311)	(-0.138)	(-0.138)	**(-1.841)**	**(-1.841)**
Proposition 1	0.626	0.626	0.515	0.515	-0.140	-0.140	**0.718*** **	**0.71*** **	**4.528** **	**4.528** **	**6.097** **	**6.097** **	5.480	5.484	**12.78*** **	**12.78*** **
	(0.450)	(0.450)	(0.364)	(0.364)	(-0.108)	(-0.108)	**(3.366)**	**(3.366)**	**(2.235)**	**(2.235)**	**(2.099)**	**(2.099)**	(1.478)	(1.481)	**(2.779)**	**(2.779)**
Proposition 2	-4.091	-5.114	-1.299	-2.909	-2.544	**-6.690** **	-0.422	-0.442	31.135	**31.28** **	**49.303***	**51.126***	**40.274** **	**44.49*** **	-30.250	-29.684
	(-0.521)	(-1.261)	(-0.218)	(-0.620)	(-0.353)	**(-2.044)**	(-0.725)	(-0.760)	(1.384)	**(2.214)**	**(1.728)**	**(1.933)**	**(2.262)**	**(2.671)**	(-1.235)	(-1.209)
Proposition 3	1.022	---	1.609	---	4.146	---	0.019	---	-0.148	---	-1.823	---	-4.214	---	-0.565	---
	(0.201)		(0.399)		(0.829)		(0.681)		(-0.012)		(-0.144)		(-0.458)		(-0.905)	
Proposition 4	---	1.022	---	1.609	---	4.146	---	0.019	---	-0.148	---	-1.823	---	-4.213	---	-0.565
		(0.201)		(0.399)		(0.829)		(0.681)		(-0.012)		(-0.144)		(-0.457)		(-0.905)
Gov. Expenditure	0.015	0.015	0.032	0.032	0.025	0.025	-0.0002	-0.0002	0.054	0.054	-0.072	-0.072	-0.062	-0.062	-0.008	-0.008
	(0.267)	(0.267)	(0.538)	(0.538)	(0.794)	(0.794)	(-0.183)	(-0.183)	(0.478)	(0.478)	(-0.937)	(-0.937)	(-0.545)	(-0.547)	(-0.397)	(-0.397)
Population Growth	---	---	---	---	---	---	**0.011***	**0.011***	----	---	---	---	---	---	0.144	0.144
							(1.718)	**(1.718)**							(0.940)	(0.940)
Inflation	-0.051	-0.051	-0.017	-0.017	**-0.038***	**-0.038***	**-0.003***	**-0.003***	**0.290** **	**0.290** **	**0.213***	**0.213***	**0.212** **	**0.213** **	0.077	0.077
	(-0.728)	(-0.728)	(-0.792)	(-0.792)	**(-1.702)**	**(-1.702)**	**(-1.664)**	**(-1.664)**	**(1.981)**	**(1.981)**	**(1.959)**	**(1.959)**	**(2.420)**	**(2.419)**	(1.048)	(1.048)
Economic Prosperity	-0.267	-0.267	---	---	-0.275	-0.275	0.002	0.002	1.281	1.281	---	---	---	---	**0.213** **	**0.213** **
	(-0.368)	(-0.368)			(-0.852)	(-0.852)	(1.051)	(1.051)	(1.191)	(1.191)					**(2.260)**	**(2.260)**
Hausman test	2.300	2.300	2.558	2.558	0.447	0.447	7.20	7.20	3.184	3.184	5.836	5.836	4.517	4.526	**28.27*** **	**28.27*** **
Sargan OIR	4.907*	4.907*	**4.692**	**4.692**	**2.056**	**2.056**	n.a	n.a	**0.405**	**0.405**	**3.043**	**3.043**	**2.719**	**2.720**	n.a	n.a
	[0.085]	[0.085]	**[0.195]**	**[0.195]**	**[0.357]**	**[0.357]**			**[0.816]**	**[0.816]**	**[0.384]**	**[0.384]**	**[0.436]**	**[0.436]**		
Adjusted R²	**0.059**	**0.059**	**0.090**	**0.090**	**0.059**	**0.059**	0.976	0.976	0.113	0.113	0.088	0.088	0.088	0.088	0.421	0.421
Fischer	**6.691*** **	**6.691*** **	**2.113***	**2.113***	**7.635*** **	**7.635*** **	**341.8*** **	**341.8*** **	**5.167*** **	**5.167*** **	**2.904** **	**2.904** **	**3.936*** **	**3.937*** **	**7.465*** **	**7.465*** **
Observations	177	177	56	56	26	26	207	207	193	193	67	67	40	40	223	223

	Panel B: Impact of financial sector importance measures for Journals								Panel B1: Impact of financial sector importance measures for FDI inflows							
	Full data		3 Year NOI		5 Year NOI		Fixed Effects		Full data		3 Year NOI		5 Year NOI		Fixed Effects	
Constant	5.470	7.024	-2.427	-1.149	**6.534*** **	2.841	0.556	**2.53*** **	-11.509	-7.853	-22.374	-14.598	3.621	-0.980	**-27.9** **	**7.85*** **
	(1.035)	(0.815)	(-0.346)	(-0.220)	**(2.577)**	(1.222)	(1.139)	**(25.22)**	(-1.360)	(-0.637)	(-1.362)	(-1.274)	(0.508)	(-0.510)	**(-2.885)**	**(3.801)**
Proposition 5	1.554	---	1.277	---	-3.692	---	**1.981*** **	---	3.656	---	7.775	---	-4.601	---	**35.81*** **	---
	(0.290)		(0.273)		(-0.853)		**(3.407)**		(0.467)		(0.870)		(-0.521)		**(3.057)**	
Proposition 6	-3.459	-5.013	1.479	0.201	**-4.738***	-1.045	0.540	**-1.440** **	**16.701***	13.045	**38.056** **	30.280	**34.49*** **	**39.09*** **	8.948	**-26.86** **
	(-0.650)	(-0.558)	(0.189)	(0.021)	**(-1.831)**	(-0.178)	(1.099)	**(-2.329)**	**(1.694)**	(0.885)	**(2.125)**	(1.612)	**(3.415)**	**(3.088)**	(0.679)	**(-2.210)**
Proposition 7	---	-1.554	---	-1.277	---	3.692	---	**-1.98*** **	---	-3.656	---	-7.775	---	4.601	---	**-35.8*** **
		(-0.290)		(-0.273)		(0.853)		**(-3.407)**		(-0.467)		(-0.870)		(0.521)		**(-3.057)**
Gov. Expenditure	0.015	0.015	0.036	0.036	0.046	0.046	0.0001	0.0001	0.209	0.209	0.119	0.119	0.099	0.099	-0.005	-0.005
	(0.226)	(0.226)	(0.669)	(0.669)	(1.189)	(1.189)	(0.130)	(0.130)	(1.427)	(1.427)	(0.819)	(0.819)	(1.334)	(1.334)	(-0.290)	(-0.290)
Population Growth	-0.344	-0.344	-0.637	-0.637	---	---	0.005	0.005	---	---	---	---	---	---	0.073	0.073
	(-0.421)	(-0.421)	(-0.319)	(-0.319)			(0.693)	(0.693)							(0.327)	(0.327)
Inflation	-0.094	-0.094	0.050	0.050	**-0.051** **	**-0.051** **	**-0.00*** **	**-0.00*** **	0.247	0.247	**0.353** **	**0.353** **	**0.204*** **	**0.204*** **	0.050	0.050
	(-0.821)	(-0.821)	(0.359)	(0.359)	**(-2.122)**	**(-2.122)**	**(-2.862)**	**(-2.862)**	(1.166)	(1.166)	**(2.399)**	**(2.399)**	**(5.184)**	**(5.184)**	(0.805)	(0.805)
Economic Prosperity	-0.727	-0.727	0.982	0.982	-0.292	-0.292	0.0007	0.0007	1.728	1.728	3.496	3.496	---	---	**0.173***	**0.173***
	(-0.572)	(-0.572)	(0.189)	(0.798)	(-0.921)	(-0.921)	(0.278)	(0.278)	(0.865)	(0.865)	(1.388)	(1.388)			**(1.793)**	**(1.793)**
Hausman test	**47.36*** **	**47.36*** **	**24.88*** **	**24.88*** **	6.089	6.089	7.60	7.60	5.797	5.797	6.257	6.257	**23.20*** **	**23.20*** **	**19.81*** **	**19.81*** **
Sargan OIR	**0.654**	**0.654**	**0.143**	**0.143**	**2.165**	**2.165**	n.a	n.a	**3.694**	**3.694**	**2.869**	**2.869**	**4.783**	**4.783**	n.a	n.a
	[0.720]	**[0.720]**	**[0.930]**	**[0.930]**	**[0.538]**	**[0.538]**			**[0.296]**	**[0.296]**	**[0.412]**	**[0.412]**	**[0.310]**	**[0.310]**		
Adjusted R²	0.001	0.001	-0.123	-0.123	0.029	0.029	0.974	0.974	0.095	0.095	0.309	0.309	0.366	0.366	0.404	0.404
Fischer	**2.302** **	**2.302** **	0.606	0.606	**4.886*** **	**4.886*** **	**323.7*** **	**323.7*** **	1.861	1.861	**2.247***	**2.247***	**9.941*** **	**9.941*** **	**7.188*** **	**7.188*** **
Observations	177	177	55	55	26	26	204	204	193	193	55	55	26	26	220	220

*;**;***: significance levels of 10%, 5% and 1% respectively. t-statistics in parentheses for FE regressions. Z-statistics of 2SLS. [ ]:P-values. OIR: Overidentifying Restrictions. n.a: not applicable. NOI: Non Overlapping Intervals. Creditex: first principal component of Private credit and Interest rate spreads. Tradex: first principal component of Trade and Tariffs

5. Conclusion and policy recommendations

The governments of The Newly Industrialized Economies (Hong Kong, Korea, Taiwan & Singapore), Malaysia and China led by Japan are playing a substantial role in moving towards 'knowledge-based economy' from the 'product economy' in the post-industrialization period (Chandra & Yokoyama, 2011). The main idea is that, the process of creation and diffusion of knowledge depends on financial sectors that are the outcome of financial policies. Therefore, it has been important to identify how financial sectors promote the diffusion of knowledge.

The existing theory and evidence suggest that, better developed financial systems ease external financing constraints facing firms, which illuminates one mechanism via which financial development influences economic growth (Levine, 2005) and in the same vein KE.
In a nutshell, financial systems have a bearing on the savings rates, investment decisions, technological innovation and long-run growth rates (Levine, 2005, p.3). A natural extension of this thesis will imply, finance significantly influences the World Bank's KEI. Spreading rapidly through-out the world following the pioneering initiative of the Bangladesh Grameen Bank, microfinance hinges on the social responsibility of borrowers belonging to a narrow group to ensure repayment. Other entrepreneurial projects require a substantial amount of development capital. Indeed a broad range of financial services is necessary to support growth and entrepreneurship in knowledge-based economies in the developing world, as elsewhere (World Bank, 2007).

The goal of this paper has been to assess how financial sector competition plays-out in the development of knowledge economy (KE). Understanding how the growth of different financial sectors play-out in KE dimensions is crucial in developing economies because, unlike the developed world, informal and semi-formal financial sectors play an important role in economic development. The study has contributed at the same time to the macroeconomic

literature on measuring financial development and responded to the growing field of KE by means of informal sector promotion, micro finance and mobile banking. It has suggested a practicable way to disentangle the effects of various financial sectors on different components of KE. The variables identified under the World Bank's four knowledge economy index (KEI) have been employed and three hypotheses based on seven propositions tested. Results show: (1) the informal financial sector, a previously missing component in the definition of the financial system by the IMF significantly affects KE dimensions; (2) disentangling different components of the existing measurement of the financial system improve dynamics in the KE-finance nexus and; (3) the introduction of measures of sector importance provides relevant new insights into how financial sector competition affects KE dimensions.

Appendices

Appendix 1: Summary statistics and presentation of countries

Panel A: Summary Statistics

		Mean	S.D	Min	Max	Obs.
Knowledge Economy	Educatex (Education)	-0.038	1.370	-4.344	1.858	126
	ICTex (Information & Infrastructure)	0.028	1.440	-3.750	3.183	310
	Tradex (First Economic Incentive)	-0.058	1.143	-2.901	2.635	161
	Creditex (Second Economic Incentive)	0.118	1.224	-2.296	3.488	193
	Scientific and Technical Journals	2.142	0.676	0.518	3.821	284
	Foreign Direct Investment Inflows	3.119	3.908	-4.025	33.566	319
GDP-based financial development indicators	Proposition 1	0.446	0.265	0.081	1.092	243
	Proposition 2	0.005	0.022	-0.047	0.188	329
	Proposition 3	0.046	0.106	-0.872	0.224	329
	Proposition 4	0.052	0.106	-0.872	0.244	330
Measures of financial sector importance	Proposition 5	0.824	0.094	0.475	1.034	240
	Proposition 6	0.012	0.041	-0.069	0.250	240
	Proposition 7	0.162	0.103	-0.176	0.524	240
	Proposition 8	0.175	0.094	-0.034	0.524	240
Control variables	Population growth	2.759	2.668	-0.157	18.588	330
	Inflation	5.585	6.274	-9.797	43.073	296
	Government Expenditure	12.318	11.321	-34.88	80.449	295
	Economic Prosperity	4.689	3.450	-4.300	26.750	313

Panel B: Presentation of Countries

Algeria, Bahrain, Botswana, Cameroon, Egypt, Israel, Jordan, Kenya, Kuwait, Lebanon, Libya, Mauritius, Morocco, Nigeria, Oman, Qatar, Saudi Arabia, Senegal, Tunisia, United Arab Emirates, Yemen, Zambia.

S.D: Standard Deviation. Min: Minimum. Max: Maximum. Obs: Observations.

Appendix 2 : Correlation analysis

Knowledge Economy						Financial (Fin) Development								Control Variables				
				S& T	FDI	GDP based measures				Financial sector importance measures								
Educatex	ICTex	Tradex	Creditex	Journals	inflows	Prop1	Prop2	Prop3	Prop4	Prop5	Prop6	Prop7	Prop8	Popg	Infl.	G.Exp	GDPg	
1.000	0.381	-0.388	-0.844	0.438	0.267	0.660	0.096	-0.14	-0.13	0.491	0.112	-0.499	-0.491	-0.241	-0.33	0.606	0.119	Educatex
	1.000	-0.221	-0.405	0.489	0.166	0.271	-0.17	0.006	-0.03	0.058	-0.20	0.030	-0.058	0.090	-0.15	0.179	0.050	ICTex
		1.000	0.490	0.161	-0.423	-0.41	-0.17	0.179	0.155	-0.46	-0.21	0.521	0.469	-0.442	0.025	-0.28	-0.266	Tradex
			1.000	-0.502	-0.147	-0.79	-0.003	0.048	0.048	-0.35	0.034	0.309	0.358	-0.081	0.460	-0.44	-0.114	Creditex
				1.000	0.073	0.393	-0.09	0.007	-0.01	0.025	-0.13	0.029	-0.025	-0.101	-0.18	0.117	-0.105	S&T Journals
					1.000	0.234	0.216	-0.05	-0.01	0.188	0.232	-0.264	-0.188	0.122	0.095	0.137	0.193	FDI inflows
						1.000	0.081	0.027	0.045	0.483	0.042	-0.458	-0.483	-0.111	-0.28	0.288	0.008	Prop1
							1.000	-0.12	0.085	0.055	0.967	-0.435	-0.055	0.034	-0.12	-0.01	0.011	Prop2
								1.000	0.977	-0.45	-0.39	0.567	0.450	-0.117	-0.02	-0.09	-0.012	Prop3
									1.000	-0.46	0.038	0.410	0.465	-0.109	-0.05	-0.10	0.128	Prop4
										1.000	0.011	-0.917	-1.000	0.098	0.034	0.101	0.128	Prop5
											1.000	-0.407	-0.011	0.128	-0.14	-0.03	0.020	Prop6
												1.000	0.917	-0.140	0.024	-0.07	-0.124	Prop7
													1.000	-0.098	-0.03	-0.10	-0.128	Prop8
														1.000	0.076	0.106	0.405	Popg
															1.000	-0.20	0.130	Inflation(Infl)
																1.000	0.046	G. Exp.
																	1.000	GDPg

S & T Journals: Scientific & Technical Journals. Popg: Population growth. Infl: Inflation. G. Exp: Government Expenditure. GDPg: Economic Prosperity.

Appendix 3: Variable definitions

Variables	Signs	Variable definitions	Sources
Panel A: Dimensions in Knowledge Economy (KE)			
Primary School Enrolment	PSE	Log of PSE	World Bank (WDI)
Secondary School Enrolment	SSE	Log of SSE	World Bank (WDI)
Tertiary School Enrolment	TSE	Log of TSE	World Bank (WDI)
Education in KE	Educatex	First PC of PSE, SSE & TSE	PCA
Internet Users	Internet	Log of Internet	World Bank (WDI)
Mobile Cellular Subscriptions	Mobile	Log of Mobile	World Bank (WDI)
Telephone lines	Tel	Log of Tel	World Bank (WDI)
Information & Infrastructure in KE	ICTex	First PC of Internet, Mobile & Tel	PCA
Trade Openness	Trade	Exports plus Imports of Commodities (% of GDP)	World Bank (WDI)
Tariff Barriers	Tariff	Tariff rate, most favored nation, weighted mean, all products (%)	World Bank (WDI)
1st Economic Incentive dimension in KE	Tradex	First PC of Trade & Tariffs	PCA
Private domestic credit	Credit	Private domestic credit (% of GDP)	World Bank (WDI)
Interest rate spread	Spread	Lending rate minus deposit rate (%)	World Bank (WDI)
2nd Economic Incentive dimension in KE	Creditex	First PC of Credit and Spread	PCA
1st Innovation dimension in KE	Journals	Log of Number of Technical & Scientific Journals	World Bank (WDI)
2nd Innovation dimension in KE	FDI	Net Foreign Direct Investment (% of GDP)	World Bank (WDI)
Panel B: Financial Development			
GDP based measures			
Formal Financial Development	Prop.1	Bank deposits/GDP. Bank deposits here refer to demand, time and saving deposits in deposit money banks(Lines 24 and 25 of International Financial Statistics (IFS); October 2008)	Asongu (2012)
Semi-formal financial development	Prop.3	(Financial deposits – Bank deposits)/ GDP. Financial deposits are demand, time and saving deposits in deposit money banks and other financial institutions. (Lines 24, 25 and 45 of IFS, October, 2008)	Asongu (2012)
Informal financial development	Prop.3	(Money Supply – Financial deposits)/GDP	Asongu (2012)
Informal and semi-formal financial development	Prop.4	(Money Supply – Bank deposits)/GDP	Asongu (2012)
Measures of financial sector importance			

Financial intermediary formalization	Prop.5	Bank deposits/ Money Supply (M2). From 'informal and semi-formal' to *formal* financial development (formalization)	Asongu (2012)
Financial intermediary 'semi-formalization'	Prop.6	(Financial deposits - Bank deposits)/ Money Supply. From 'informal and formal' to *semi-formal* financial development (Semi-formalization)	Asongu (2012)
Financial intermediary 'informalization'	Prop.7	(Money Supply – Financial deposits)/ Money Supply. From 'formal and semi-formal' to *informal* financial development (Informalisation)	Asongu (2012)
Financial intermediary 'semi-formalization and informalization'	Prop.8	(Money Supply – Bank Deposits)/Money Supply. Formal to '*informal and semi-formal'* financial development: (Semi-formalization and informalization)	Asongu(2012)
Panel C: Control Variables			
Government Expenditure	Gov. Exp.	Government final consumption expenditure (% of GDP)	World Bank (WDI)
Inflation	Infl.	Consumer Price Index (annual %)	World Bank (WDI)
Population Growth	Popg	Population Growth Rate (annual %)	World Bank (WDI)
Economic Prosperity	GDPg	GDP growth rate (annual %)	World Bank (WDI)

WDI: World Bank Development Indicators. FDSD: Financial Development and Structure Database. WIPO: World Intellectual Property Organization. GDP: Gross Domestic Product. PC: Principal Component. PCA: Principal Component Analysis. Log: logarithm.

Appendix 4: Segments of the financial system by degree of formality in Paper's context

Paper's context			Tiers	Definitions	Institutions	Principal Clients
Formal financial system	IMF Definition of Financial System from International Financial Statistics (IFS)	Formal Financial sector (Deposit Banks)	Formal banks	Licensed by central bank	Commercial and development banks	Large businesses, Government
Semi-formal and informal financial systems		Semi-formal financial sector (Other Financial Institutions)	Specialized non-bank financial institutions		Rural banks, Post banks, Saving and Loan Companies, Deposit taking Micro Finance banks	Large rural enterprises, Salaried Workers, Small and medium enterprises
			Other non-bank financial institutions	Legally registered but not licensed as financial institution by central bank and government	Credit Unions, Micro Finance NGOs	Microenterprises, Entrepreneurial poor
	Missing component in IFS definition	Informal financial sector	Informal banks	Not legally registered at national level(though may be linked to a registered association)	Savings collectors, Savings and credit associations, Money lenders	Self-employed poor

Source (Asongu, 2011)

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