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The ‘Knowledge Economy’-finance nexus: how do IPRs matter in SSA and MENA countries?

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Abstract

This paper assesses the relevance of intellectual property rights (IPRs) in the knowledge economy (KE)-finance nexus using the four variables identified under the World Bank’s knowledge economy index (KEI) and seven financial intermediary dynamics of depth, efficiency, activity and size. Three main findings are established: (1) education increases financial dynamics of depth and size; (2) economic incentives by means of credit facilities (trade openness) mitigate financial dynamics of efficiency and activity (financial dynamics of depth and size) and; (3) ICT and FDI both improve financial depth and decrease financial size (with FDI having an additional edge of improving financial activity). As a policy implication, the enforcement of IPRs is not a general and sufficient condition for positive KE-finance nexuses. Hence, blanket upholding of IPRs to achieve such positive linkages may not be successful unless policy is contingent on the prevailing ‘KE specific component’ trends and dynamics of financial development.

JEL Classification: K42; O10; O34; O38; P48

Keywords: Financial development; Knowledge economy; Intellectual property rights

1. Introduction

It has become abundantly clear that, for any country, region or continent to be actively involved in the global economy, it must be competitive. Competition derives from intellectual capital, which is protected by intellectual property laws (Asongu, 2012a) and has recently been the focus of renewed interest in knowledge economy (KE) in African and Middle East countries; either through the fight against software piracy (Asongu & Andrés, 2012ab; Asongu, 2012b) or through the impact of financial sector competition (Asongu, 2012c). For over two decades now, KE has emerged in the OECD and World Bank reports as crucial to 21st century development (World Bank, 2007; Weber, 2011). Accordingly, knowledge created via innovation and technological advancement is key to long-term economic growth. Whereas the finance-growth nexus has been abundantly assessed in theoretical and empirical literature, the finance-KE nexus has received very limited scholarly focus in developing countries

(Asongu, 2012c). Given the critical role of finance in growth, understanding the role of KE in financial development in developing countries is crucial because, financial intermediation has been substantially documented as indispensable in channeling mobilized resources to economic operators. Given the close connection between KE and intellectual property rights (IPRs), and the ongoing debate over IPRs harmonization in Africa (Asongu, 2012a), it is further interesting to assess the instrumentality of IPRs in the KE-finance nexus because the advent of KE has come with growing emphasis on IPRs. In other words knowing how the enforcement of IPRs plays out in the impact of KE on financial development is a relevant policy question.

Europe and North America have mastered the dynamics of intellectual property (IP) and inexorably driving developments in the global and international arena (Asongu, 2012b). Other regions like Asia and South America are reacting in calculated steps that underpin the role of IP in the current pursuit of national, regional and international initiatives. The Newly Industrialized Economies (Korea, Taiwan, Hong Kong & Singapore), Malaysia and China led by Japan are currently moving towards ‘knowledge-based economy’ from the ‘product economy’ in the post-industrialization period. IPRs have played quite a substantial role in the ‘East Asian miracle’ of industrial development (Chandra & Yokoyama, 2011; Asongu, 2012b). In sub-Saharan African (SSA) and the Middle East & North African (MENA) countries, IPRs and KE issues are also assuming central stage in discussions on development. In response to these growing efforts, the goal of this paper is to assess how IPRs are instrumental in the incidence of KE on financial development.

This paper’s contribution to existing literature is sixfold. Firstly, it deviates from previous research that does not incorporate all dimensions of financial development and provides an exhaustive assessment with seven financial dynamics of depth, efficiency, activity and size (World Bank, 2007, p.73)¹. Secondly, a substantial chunk of research on KE has focused on developed and the emerging economies of Latin America and East Asia (Dahlan, 2007; Chandra & Yokoyama, 2011). The scanty evidence of the nexus in SSA and MENA countries is a missing strand motivating this paper. Thirdly, in contrast to mainstream approach to the phenomenon which is premised (for the most part) on a few dimensions of KE, this paper employs all the four components in the World Bank’s Knowledge Economy Index (KEI): economic incentive, innovation, education and, information infrastructure (AfDB, 2007²; Bizri, 2009³; Aubert, 2005; Britz et al., 2006). Fourthly, the tremendous trends in knowledge-based economic development witnessed over the last decade have evolved with growing relevance of IPRs laws (treaties), hence assessing how the enforcement of these laws

¹ According to the World Bank, KE cannot be built without finance. For small entrepreneurial projects in developing countries, funding needs may be relatively small and microfinance mechanisms are enough. It further states that, a broad range of financial services is necessary to support growth and entrepreneurship in knowledge-based economies in the developing world, as elsewhere. Our paper extends the notion of finance to all dimensions identified by the Financial Development and Structure Database of the World Bank.

² The African Development Bank (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.

³ According to Bizri (2009), 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 desert. It further asserts there are a few oases with more being planted and much more needed to be done specifically on the KE determinants. Hence the aim of this paper is to break new grounds on the KE-finance nexus by employing unexplored KE and financial sector dimensions which could enhanced understanding of KE dynamics and provide the much needed policy guidance on how to increase KE oases in the Arab deserts.

are instrumental in the effect of KE on financial development could provide the much needed guidance to policy makers⁴. Therefore, the wisdom behind this fourth contribution is to examine how the upholding of IPRs in order to boost KE affects financial development. Fifthly, while some aspects of KE might have been investigated prior to the availability of IPRs indicators for developing countries, the use of much recent data by this paper provides an updated account of development nexuses with more focused policy implications (Britz et al., 2006⁵; Makinda, 2007⁶; Lightfoot, 2011⁷). Sixthly, a motivation for this work also draws from the debate on the ‘East Asian miracle’ in which some evidence suggests that the ‘East Asian miracle’ could have been caused by low enforcement of IPRs regimes at the early stages of these nations’ development in addition to their accumulation of capital (Bezmen & Depken, 2004). Hence examining the debate in the context of SSA and MENA countries by assessing the instrumentality of IPRs could result in relevant policy recommendations.

The rest of the paper is organized as follows. Data and methodology issues are discussed in Section 2. Empirical analysis is covered in Section 3. Section 4 concludes.

2. Data and Methodology

2.1 Data

We examine a panel of 22 MENA and SSA countries with data from World Development Indicators (WDI) and the Financial Development and Structure Database (FDSD) of the World Bank (WB) over the period 1996-2010. Limitations to the time span and number of countries are constrained by KE data availability and the motivation of obtaining results with more updated policy implications.

2.1.1 Dependent variables

As regards the choice of the dependent variables, contrary to mainstream literature in which only one or two measures of finance (for the most part) are employed, we exploit all the dimensions of finance indentified in the FDSD. These include financial intermediary dynamics of depth, efficiency, activity and size. This plethora of financial measures have been recently employed in the general context of Africa (Asongu, 2012f), in the assessment of potential monetary zones (Asongu, 2012g) or existing monetary unions (Asongu, 2012h).

Firstly, from a financial depth standpoint, we measure financial depth both from overall-economic and financial system perspectives with indicators of broad *money supply* ($M2/GDP$) and *financial system deposits* ($FdgdP$) respectively. Whereas the former denotes the monetary base ($M0$) plus demand, saving and time deposits, the latter represents liquid

⁴ Especially as there are institutional issues on the way to achieving KE in Africa by means of financial sector development (Asongu, 2012d) or transfer of technology through development assistance (Asongu, 2012e).

⁵ Britz et al. (2006) have 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 others: investment in human capital, effective stopping of brain drain, as well as effective development and maintenance of a physical infrastructure.

⁶ Consistent with Makinda, in order to rectify the 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 (Makinda, 2007).

⁷ This imperative for policy reforms 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.

liabilities (or deposits) of the financial system⁸. Secondly, credit is measured in terms of financial intermediary activity. Therefore, the study seeks to lay emphasis on the ability of banks to grant credit to economic operators. We proxy both for *banking-system-activity* and *financial-system-activity* with “private domestic credit by deposit banks: *Pcrb*” and “private credit by deposit banks and other financial institutions: *Pcrbof*” respectively. Thirdly, *financial size* is measured in terms of deposit bank assets (credit) as a proportion of total assets (deposit bank assets plus central bank assets). Fourthly, financial efficiency⁹ appreciates the ability of deposits (money) to be transformed into credit (financial activity). This fourth indicator measures the fundamental role of banks in transforming mobilized deposits into credit for economic operators. We take into account indicators of *banking-system-efficiency* and *financial-system-efficiency* (respectively ‘bank credit on bank deposits: *Bcbd*’ and ‘financial system credit on financial system deposits: *Fcfd*’). The correlation matrices presented in Appendix 2 show that (but for financial size) the two measures adopted for each financial dynamic can be used to robustly check each another.

2.1.2 Independent, instrumental and control variables

The independent variables are in line with recent KE literature (Chavula, 2010; Weber, 2011) and consist of the four dimensions of KE identified by the World Bank KEI: education, information & communication technology (ICT), economic incentives and innovation. The procedure for selecting these variables is provided in Section 2.2.1 below.

We devote space to providing theoretical justification for the empirical validity of the instruments. This justification is very crucial for the relevance of the empirical analysis because a theoretical basis for the instrumental variables is required for sound and consistent interpretation of estimated coefficients. Hence, the choice of the instruments has a twofold justification: on the one hand, it enables us to address the issue of endogeneity and; on the other hand, it is compatible with the problem statement of the study which is to assess how IPRs are instrumental in the KE-finance nexus. Accordingly, consistent with recent IPRs literature, the instrumental variables employed include IPRs laws/treaties (Asongu & Andrés, 2012a), legal origins (Asongu, 2012b) and religious domination (Asongu & Andrés, 2012b). Hence, KE dimensions are instrumented with: *constitution, main IP laws, IPRs laws, WIPO treaties, multilateral treaties, bilateral treaties, legal-origins and religious domination*.

Control variables include: *population growth, GDP growth, government expenditure and domestic investment*. The choice of only four control variables is contingent on constraints in the Overidentifying Restrictions (OIR) test for instrument validity¹⁰. Government expenditure and investment have been used in recent African finance literature (Asongu, 2012i). Government expenditure could decrease financial development if the budget allocated for investment is misallocated through corrupt practices (Ndikumana, 2000). Accordingly, GDP growth, population growth and domestic investment should naturally improve financial development.

The summary statistics (with presentation of countries), correlation analysis (showing the relationships between key variables used in the paper), and variable definitions are

⁸ It is imperative to distinguish between these two aggregates of money supply because, since we are dealing exclusively with developing (SSA and MENA) countries, a great chunk of the monetary base does not transit via formal banking institutions.

⁹ By financial efficiency in this context, we neither refer to the profitability-related concept (notion) nor to the production efficiency of decision making units in the financial sector (through Data Envelopment Analysis: DEA).

¹⁰ An OIR test is only applicable in the presence of over-identification. That is, the instruments must be higher than the endogenous explaining variables by at least one degree of freedom. In the cases of exact-identification (instruments equal to endogenous explaining variables) and under-identifications (instruments less than endogenous explaining variables) an OIR test is by definition impossible.

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 nexuses should emerge. The purpose of the correlation matrix (Appendix 2) is to mitigate issues resulting from overparametization and multicollinearity. From a preliminary assessment of the correlation coefficients, there do not appear to be any serious issues in terms of the relationships to be estimated. Appendix 3 provides definitions and corresponding sources of the variables.

2.2 Methodology

2.2.1 Principal Component Analysis (PCA)

We are interested in empirically evaluating the impact of KE on financial development. Accordingly, one might also criticize the redundancy in the information provided for each dimension of the KEI because each dimension could be correlated with its component variables individually. Hence, we use principal component analysis (PCA). The PCA is a common statistical technique that is employed to reduce a larger set of correlated variables into a smaller set of uncorrelated variables, called principal components (PC) that account for most of variation in the original data set.

Table 1: Principal Component Analysis (PCA)

Knowledge Economy dimensions		Component Matrix(Loadings)			First P.C	Eigen Value	Indexes
Education	School enrolment	PSE	SSE	TSE	0.771	2.313	Educatex
		0.535	0.620	0.574			
Information & Infrastructure	ICTs	Internet	Mobile	Telephone	0.705	2.115	ICTex
		0.653	0.661	0.371			
Economic Incentive	Trade & Tariffs	Trade	Tariffs		0.645	1.290	Tradex
		-0.707	0.707				
	Credit & IR Spread	Private Credit	Interest rate spread		0.679	1.358	Creditex
		-0.707	0.707				
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.

Without going into an in depth account of the PCA technique, as it can be seen from Table 1 above, the first principal component (PC) accounts for approximately 65% of the variation in all four KE dimensions. The criteria used to determine how many common factors to retain are taken from Kaiser (1974) and Jolliffe (2002). Kaiser recommends dropping factors with an eigenvalue smaller than one. It is also interesting to note that the weights in the first PC are almost equal across dimensions. This result indicates that a one PC model is convenient for each KE dimension in our sample.

2.2.2 Endogeneity and estimation technique

While financial development depends on dimensions of KE, the reverse effect cannot be ruled-out because financial services are indispensable for KE. This presents a situation of

reverse-causality that could result in endogeneity. To tackle this endogeneity concern, we shall examine its presence with the Hausman test before employing an estimation technique compatible with the outcome of the test. Borrowing from recent KE literature (Asongu & Andrés, 2012a), the paper adopts a Two-Stage Least Squares (2SLS) Instrumental Variable (IV) estimation technique. IV estimation tackles the puzzle of endogeneity and therefore avoids the inconsistency of estimated coefficients by Ordinary Least Squares (OLS) when the exogenous variables are correlated with the error term in the main equation. The estimation procedure entails the following steps:

First-stage regression:

$$KE_{it} = \gamma_0 + \gamma_1(Instructions)_{it} + v \quad (1)$$

Second-stage regression:

$$Finance_{it} = \gamma_0 + \gamma_1(KE)_{it} + \beta_i X_{it} + \mu \quad (2)$$

In Eq. (2), X is a set of control variables which include: *population growth, GDP growth, government expenditure and domestic investment*. KE denotes the knowledge economy dimensions (*education, economic incentive, information & communication infrastructure and innovation*). $Finance$ represents financial intermediary dynamics of *depth, efficiency, activity and size*. For the first and second equations, v and u , respectively represent the error terms. Instrumental variables are: *constitution, main IP laws, IPRs laws, WIPO treaties, multilateral treaties, bilateral treaties, legal-origins and religious domination*.

We adopt the following steps in the analysis: (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 (KE channels) and; (3) ensure the instruments are valid and not correlated with the error-term in the main equation with an Over-identifying Restrictions (OIR) test. Further robustness check will be ensured with robust Heteroscedasticity and Autocorrelation Consistent (HAC) standard errors. Given the absence of an additional variable for the financial size indicator, we take a minimalistic approach in using restricted and unrestricted regressions to further assess robustness.

3. Empirical analysis

This section aims to investigate two main issues: (1) the capacity of the exogenous components of the KE channels to explain financial development dynamics and; (2) the ability of the instruments to explain financial development through KE channels. Whereas the first issue is addressed by the significance of estimated coefficients, the second is contingent on the outcome of the OIR Sargan test. The null hypothesis of this test is the position that, the instruments explain finance only through KE channels. In other words, IPR laws (treaties) that affect finance are enforced only through KE mechanisms. Hence a rejection of this null hypothesis is a rejection of the stance that IPR laws (treaties) affecting financial dynamics are not enforced beyond KE dimensions. A Hausman test for endogeneity precedes every 2SLS approach. The null hypothesis of this test is the position that OLS estimates are efficient and consistent. Hence, a rejection of this hypothesis points to the presence of inconsistent estimates owing to endogeneity and hence, lends credit to the choice of the 2SLS approach.

The financial depth (Table 3), financial efficiency (Table 4), financial activity (Table 5) and financial size (Table 6) results are summarized in Table 2 below. The overwhelming rejection of the null hypothesis of the Hausman test justifies the issue of endogeneity and hence, the choice of the estimation technique. Based on the summary of the results, the

following could be established with respect to the first issue: (1) *education* increases financial dynamics of *depth* and *size*; (2) *economic incentives* by means of credit facilities (trade openness) mitigate financial dynamics of *efficiency* and *activity* (financial dynamics of *depth* and *size*) and; (3) ICT and FDI both improve financial *depth* and decrease financial *size* (with FDI having an additional edge of improving financial *activity*). As concerns the second issue, the rejection of the null hypothesis of the Sargan test in some of the financial *depth* and financial *activity* regressions shows that IPRs impact these financial dynamics beyond the identified KE mechanisms.

The negative nexus between *Creditex* and financial dynamics of *efficiency* and *activity* could be explained from the substantially documented issues of surplus liquidity in African financial institutions (Saxegaard, 2006). Hence, mobilized deposits are not easily transformed into credit for economic operators (bank *inefficiency*) and this correspondingly leads to a decline in financial *activity*. The fact that *Tradex* decreases financial *depth* has a twofold explanation: on the one hand, it could be due to substantial restrictions on trade through tariffs and; on the other hand, it could be due to a detrimental impact of too much openness on domestic financial industries, with foreign financial institutions having a competitive edge in financial services. *ICTex* affects financial *depth* positively owing to the growing importance of mobile banking and other informal financial activities related to high mobile phone penetration rates. The positive incidences of FDI on financial dynamics of *depth* and *activity* are obviously logical, since FDI is a process of injecting funds into the economy through investment which ultimately stimulates financial activity and increase money velocity. From general standpoint, two implications could be discussed. (1) Rejection of the null hypothesis of the Sargan test in a few regressions of financial depth and activity imply, other determinants are instrumental in their nexuses with KE beside the enforcement of IPRs. (2) The negative incidences of KE on financial development dynamics (especially with respect to *Educatex*) have a twofold explanation: on the one hand, it may be the result of the authorities falling short of enforcing the IPRs thresholds necessary for positive KE-finance nexuses and; on the other hand, the enforcement of IPRs may not be a sufficient condition for the achievement of positive KE-finance nexuses. Hence, blanket upholding of IPRs to achieve positive KE-finance linkages may not be successful unless policy is contingent on the prevailing ‘KE specific component’ trends and dynamics of financial development.

Table 2: Summary of results

		Financial Depth		Financial Efficiency		Financial Activity		Fin. Size
		Money Supply	Liquid Liability	Banking Efficiency	Financial Efficiency	Banking Activity	Financial Activity	
Education	Educatex	+	+	n.a	-°	-	-	+
Economic Incentive	Creditex	-°	-°	-	-	-	-	n.a
	Tradex	-	-	n.a	n.a	n.a	n.a	-
ICT	ICTex	+	+	n.a	-°	n.a	n.a	-
Innovation	Journals	n.a	n.a	n.a	+°	n.a	n.a	+
	FDI	+	+	n.a	n.a	+	n.a	-

°: invalid instruments, insignificant Fisher statistics or negative R².

Table 3: ‘KE-financial depth’ nexus (HAC standard errors consistent)

		Dependent variable: Financial depth							
		Overall economic financial depth (M2)				Financial system depth (Liquid liabilities)			
Constant		0.411** (2.442)	1.392** (2.468)	0.595*** (3.111)	0.989 (1.348)	0.429*** (4.898)	1.081*** (2.863)	0.515*** (4.632)	0.685 (1.307)
Education	Educatex	0.123* (1.954)	0.113 (1.331)	---	---	0.110*** (3.207)	0.103* (1.652)	---	---
Economic Incentive	Creditex	---	---	-0.354** (-2.095)	-0.402** (-2.380)	---	---	-0.26*** (-2.725)	-0.301** (-2.120)
	Tradex	0.113 (0.636)	-0.22*** (-3.370)	0.073 (0.689)	0.150 (1.527)	-0.007 (-0.088)	-0.18*** (-4.101)	0.030 (0.430)	0.072 (0.917)
ICT Infrastructure	ICTex	0.031 (0.415)	0.364*** (2.926)	0.021 (0.316)	0.081 (0.511)	0.036 (0.938)	0.239** (2.409)	-0.003 (-0.070)	0.017 (0.143)
Innovation	Journals	---	-0.366 (-1.439)	---	-0.201 (-0.591)	---	-0.253 (-1.473)	---	-0.093 (-0.381)
	FDI	0.059** (2.256)	---	-0.007 (-0.185)	---	0.033*** (3.462)	---	-0.004 (-0.184)	---
Hausman test		47.35*** [0.000]	34.00*** [0.000]	22.49*** [0.000]	30.25*** [0.000]	32.20*** [0.000]	24.24*** [0.000]	13.49*** [0.009]	21.65*** [0.000]
Sargan OIR		1.183 [0.553]	2.825 [0.243]	5.208* [0.073]	7.452** [0.024]	2.668 [0.263]	3.811 [0.148]	5.953* [0.050]	8.897** [0.011]
Adjusted R ²		0.245	0.293	0.497	0.566	0.488	0.418	0.550	0.613
Fisher		31.19***	28.45***	3.507**	5.799***	64.67***	41.22***	3.830***	7.010***
Observations		54	51	95	81	57	54	98	84

*,**,***: significance levels of 10%, 5% and 1% respectively. OIR: Overidentifying Restrictions. [] :P-values, z-statistics in brackets. HAC: Heteroscedasticity and Autocorrelation Consistent. Educatex is the first principal component of primary, secondary and tertiary school enrolments. ICTex is the first principal component of mobile phones, telephone and internet users. Tradex is the first principal component of trade openness and tariffs. Creditex is the first principal component of private domestic credit and interest rate spreads.

Table 4: ‘KE-financial efficiency’ nexus (HAC standard errors consistent)

		Dependent variable: Financial efficiency							
		Banking system efficiency (BcBd)				Financial system efficiency (FcFd)			
Constant		2.283*** (3.305)	-1.009 (-0.092)	1.563*** (2.922)	2.362 (0.868)	2.518*** (4.993)	-0.334 (-0.243)	1.615*** (3.119)	2.442 (0.928)
Education	Educatex	-0.064 (-0.115)	-0.197 (-0.576)	---	---	0.466 (0.449)	-0.43*** (-3.207)	---	---
Economic Incentive	Creditex	---	---	-0.239** (-2.482)	-0.564 (-1.054)	---	---	-0.224** (-2.412)	-0.548 (-1.046)
	Tradex	0.063 (0.246)	-0.015 (-0.035)	-0.099 (-0.979)	---	-0.042 (-0.126)	-0.117 (-0.868)	-0.095 (-0.958)	-0.213 (-0.838)
ICT Infrastructure	ICTex	-0.086 (-0.137)	-1.019 (-0.303)	0.018 (0.200)	-0.078 (-0.850)	0.427 (0.735)	-0.673** (-2.456)	0.014	-0.072 (-0.342)
Innovation	Journals	---	1.306 (0.273)	---	0.122 (0.243)	---	1.004* (1.831)	---	0.088 (0.184)
	FDI	0.029 (0.168)	---	-0.001 (-0.050)	---	0.239 (0.994)	---	0.0009 (0.033)	---
Population Growth		-0.252 (-0.199)	-0.825 (-0.489)	---	---	0.830 (0.381)	-1.00*** (-3.990)	---	---
Economic Prosperity		-0.292 (-0.591)	0.144 (0.120)	---	---	-0.769 (-0.965)	0.151 (1.131)	---	---
Government Expenditure		0.027	0.009	-0.027**	-0.082	-0.100	0.027	-0.026**	-0.077

Domestic Investment	(0.196)	(0.090)	(-2.328)	(-1.002)	(-0.532)	(0.884)	(-2.164)	(-0.968)
	---		-0.027	-0.053	---	---	-0.030	-0.054
			(-1.022)	(-0.717)			(-1.176)	(-0.771)
Hausman test	73.24***	70.69***	73.68***	90.07***	227.5***	101.1***	65.90***	77.50***
	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]
Sargan OIR	1.524	0.988	0.320	0.144	0.110	1.742	0.130	0.229
	[0.216]	[0.320]	[0.851]	[0.930]	[0.739]	[0.186]	[0.937]	[0.891]
Adjusted R ²	-0.138	-0.111	0.178	0.022	-0.137	-0.042	0.192	0.040
Fisher	13.60***	1.146	6.200***	0.567	13.54***	14.94***	6.252***	0.555
Observations	58	56	79	69	55	52	79	69

*,**,***: significance levels of 10%, 5% and 1% respectively. OIR: Overidentifying Restrictions. [] :P-values. z-statistics in brackets. HAC: Heteroscedasticity and Autocorrelation Consistent. Educatex is the first principal component of primary, secondary and tertiary school enrolments. ICTex is the first principal component of mobile phones, telephone and internet users. Tradex is the first principal component of trade openness and tariffs. Creditex is the first principal component of private domestic credit and interest rate spreads.

Table 5: ‘KE-financial activity’ nexus (HAC standard errors consistent)

		Dependent variable: Financial activity							
		Banking system activity (Pcbr)				Financial system activity (Pcrbof)			
Constant		2.105***	1.350*	0.897***	2.391	2.163**	1.117	0.955***	2.356
		(2.805)	(1.877)	(2.579)	(1.377)	(2.514)	(1.406)	(2.879)	(1.430)
Education	Educatex	-0.30***	-0.235**	---	---	-0.30***	-0.221**	---	---
		(-6.281)	(-2.491)			(-5.614)	(-2.075)		
	Creditex	---	---	-0.28***	-0.682**	---	---	-0.26***	-0.650**
Economic Incentive	Tradex	-0.069	-0.100	-0.061	-0.072	-0.054	-0.098	-0.064	-0.084
		(-0.910)	(-1.308)	(-0.960)	(-0.334)	(-0.655)	(-1.267)	(-1.044)	(-0.419)
ICT Infrastructure	ICTex	0.028	0.056	0.041	0.055	0.004	-0.008	0.030	0.041
		(0.359)	(0.874)	(0.617)	(0.342)	(0.051)	(-0.117)	(0.459)	(0.274)
	Journals	---	-0.105	---	-0.163	---	-0.026	---	-0.148
Innovation	FDI	0.050*	---	0.006	---	0.051	---	0.008	---
		(1.666)		(0.329)		(1.513)		(0.493)	
Population Growth		-0.73***	-0.53***	-0.032	---	-0.76***	-0.53***	-0.031	---
		(-4.668)	(-3.286)	(-0.937)		(-4.325)	(-3.147)	(-0.982)	
Government Expenditure		0.037***	0.048***	-0.018**	-0.063	0.039***	0.046***	-0.017*	-0.060
		(2.651)	(3.372)	(-2.031)	(-1.091)	(2.599)	(2.821)	(-1.940)	(-1.083)
Domestic Investment		-0.037	-0.005	-0.012	-0.049	-0.037	0.0001	-0.015	-0.049
		(-1.368)	(-0.404)	(-0.708)	(-1.021)	(-1.200)	(0.013)	(-0.928)	(-1.083)
Hausman test		142.3***	45.37***	193.6***	375.4***	115.9***	41.16***	158.6***	263.2***
		[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]
Sargan OIR		0.333	4.008**	0.712	0.002	0.705	4.794**	0.537	0.020
		[0.563]	[0.045]	[0.398]	[0.998]	[0.400]	[0.028]	[0.463]	[0.989]
Adjusted R ²		0.415	0.386	0.490	0.267	0.368	0.365	0.508	0.286
Fisher		741.6***	42.12***	44.24***	4.411***	387.7***	47.01***	69.15***	4.464***
Observations		55	52	79	69	55	52	79	69

*,**,***: significance levels of 10%, 5% and 1% respectively. OIR: Overidentifying Restrictions. [] :P-values. z-statistics in brackets. HAC: Heteroscedasticity and Autocorrelation Consistent. Educatex is the first principal component of primary, secondary and tertiary school enrolments. ICTex is the first principal component of mobile phones, telephone and internet users. Tradex is the first principal component of trade openness and tariffs. Creditex is the first principal component of private domestic credit and interest rate spreads.

Table 6: ‘KE-financial size’ nexus (HAC standard errors consistent)

		Dependent variable: Financial size							
		Restricted Regressions				Unrestricted Regressions			
Constant		---	---	---	---	-0.055 (-0.078)	0.577*** (3.708)	-1.103 (-0.812)	0.370* (1.772)
Education	Educatex	0.064*** (3.816)	0.032 (0.711)	---	---	0.068* (1.672)	0.024 (0.851)	---	---
Economic Incentive	Creditex	---	---	-0.036 (-0.700)	-0.022 (-0.463)	---	---	0.044 (0.333)	-0.045 (-1.061)
	Tradex	-0.08*** (-4.244)	-0.040 (-0.681)	-0.118* (-1.655)	-0.053 (-1.026)	-0.08*** (-2.679)	-0.050* (-1.645)	-0.224* (-1.692)	-0.066* (-1.692)
ICT Infrastructure	ICTex	-0.11*** (-4.247)	-0.08*** (-3.389)	-0.044 (-1.415)	0.009 (0.333)	-0.124 (-1.325)	-0.018 (-0.836)	-0.140 (-1.093)	0.030 (1.146)
Innovation	Journals	0.253*** (10.32)	---	0.175** (2.225)	---	0.266 (1.567)	---	0.451* (1.805)	---
	FDI	---	-0.03*** (-6.103)	---	-0.006 (-0.401)	---	-0.02*** (-3.372)	---	-0.014 (-1.384)
Population Growth		0.041 (1.046)	---	-0.007 (-0.536)	0.011 (0.282)	0.046 (0.693)	---	-0.038 (-0.699)	0.020 (0.681)
Government Expenditure		-0.01*** (-5.546)	0.014*** (3.934)	-0.014 (-1.050)	0.0006 (0.081)	-0.016* (-1.836)	0.005 (1.102)	-0.018 (-0.868)	-0.0009 (-0.149)
Domestic Investment		0.020*** (10.89)	0.043*** (23.25)	0.030*** (5.801)	0.040*** (13.38)	0.021 (1.466)	0.018*** (2.727)	0.059 (1.352)	0.024*** (2.930)
Hausman test		192.5*** [0.000]	293.6*** [0.000]	90.24*** [0.000]	65.98*** [0.000]	40.73*** [0.000]	56.09*** [0.000]	33.76*** [0.000]	20.46*** [0.004]
Sargan OIR		1.876 [0.391]	2.919 [0.404]	2.817 [0.244]	3.737 [0.154]	1.718 [0.189]	0.285 [0.867]	0.568 [0.450]	1.509 [0.219]
Adjusted R ²		0.096	0.004	0.301	0.216	0.067	0.131	0.019	0.324
Fisher		2023***	703.6***	3896***	717.9***	9.413***	9.388***	5.495***	9.155***
Observations		51	53	60	70	51	53	60	70

***, **, *: significance levels of 10%, 5% and 1% respectively. OIR: Overidentifying Restrictions. [] :P-values, z-statistics in brackets. HAC: Heteroscedasticity and Autocorrelation Consistent. Educatex is the first principal component of primary, secondary and tertiary school enrolments. ICTex is the first principal component of mobile phones, telephone and internet users. Tradex is the first principal component of trade openness and tariffs. Creditex is the first principal component of private domestic credit and interest rate spreads.

4. Conclusion

This paper has assessed the relevance of intellectual property rights (IPRs) in the knowledge economy (KE)-finance nexus using the four variables identified under the World Bank’s knowledge economy index (KEI) and seven financial intermediary dynamics of depth, efficiency, activity and size. The following findings have been established: (1) education increases financial dynamics of depth and size; (2) economic incentives by means of credit facilities (trade openness) mitigate financial dynamics of efficiency and activity (financial dynamics of depth and size) and; (3) ICT and FDI both improve financial depth and decrease financial size (with FDI having an additional edge of improving financial activity). Rejection of the null hypothesis of the Sargan test in some financial depth and activity regressions implies, other determinants are instrumental in their nexuses with KE beside the enforcement of IPRs. As a policy implication, the enforcement of IPRs is not a general and sufficient condition for positive KE-finance nexuses. Hence, blanket upholding of IPRs to achieve such positive linkages may not be successful unless policy is contingent on the prevailing ‘KE specific component’ trends and dynamics of financial development.

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
Financial development variables	Overall economic depth : (M2)	0.523	0.291	0.121	1.279	240
	Financial system depth (Liquid liabilities)	0.453	0.269	0.081	1.095	243
	Banking system efficiency (BcBd)	0.751	0.288	0.143	2.103	308
	Financial system efficiency (FcFd)	0.811	0.332	0.144	1.871	243
	Banking system activity (Pcrb)	0.348	0.245	0.041	1.006	243
	Financial system activity (Pcrbof)	0.375	0.256	0.041	1.002	243
	Financial system size (Dbacba)	0.851	0.216	0.124	1.609	261
Control variables	Population growth	2.759	2.668	-0.157	18.588	330
	Government Expenditure	12.318	11.321	-34.88	80.449	295
	Economic Prosperity	4.689	3.450	-4.300	26.750	313
	Domestic Investment	20.531	6.910	-1.380	39.348	301
Instrumental variables	Constitution	0.150	0.357	0.000	1.000	300
	Main Intellectual Property Law	1.366	1.534	0.000	7.000	300
	Intellectual Property Rights Law	1.130	1.793	0.000	7.000	300
	WIPO Treaties	2.453	1.219	0.000	6.000	300
	Multilateral Treaties	8.440	3.948	0.000	20.00	300
	Bilateral Treaties	0.380	0.806	0.000	4.000	300
	English	0.409	0.492	0.000	1.000	330
Christian	0.227	0.419	0.000	1.000	330	

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				
Educatex	ICTex	Tradex	Creditex	S& T Journals	FDI inflows	Fin. depth		Fin. efficiency		Fin. activity		Fin Size	Popg	G.Exp	GDPg	D.Invt	
						M2	fdgdp	BcBd	FcFd	Pcrb	Pcrbof	Dbacba					
1.000	0.381	-0.388	-0.844	0.438	0.267	0.619	0.666	0.221	0.283	0.672	0.692	0.530	-0.241	0.606	0.119	0.078	Educatex
	1.000	-0.221	-0.405	0.489	0.166	0.268	0.248	0.189	0.153	0.305	0.285	0.455	0.090	0.179	0.050	0.013	ICTex
		1.000	0.490	0.161	-0.423	-0.33	-0.42	-0.22	-0.16	-0.45	-0.45	-0.317	-0.442	-0.28	-0.266	-0.18	Tradex
			1.000	-0.502	-0.147	-0.78	-0.78	-0.39	-0.43	-0.82	-0.82	-0.554	-0.081	-0.44	-0.114	-0.15	Creditex
				1.000	0.073	0.392	0.373	0.338	0.375	0.474	0.482	0.210	-0.101	0.117	-0.105	-0.11	S&T Journals
					1.000	0.223	0.256	-0.03	-0.02	0.230	0.208	0.051	0.122	0.137	0.193	0.163	FDI inflows
						1.000	0.981	0.125	0.088	0.887	0.856	0.377	-0.135	0.268	0.005	0.295	M2
							1.000	0.158	0.080	0.900	0.866	0.399	-0.097	0.285	0.011	0.259	fdgdp
								1.000	0.812	0.501	0.519	0.336	0.168	0.093	0.125	-0.14	BcBd
									1.000	0.348	0.527	0.215	0.036	0.228	0.010	-0.12	FcFd
										1.000	0.968	0.398	-0.080	0.289	0.031	0.207	Pcrb
											1.000	0.403	-0.054	0.350	0.019	0.177	Pcrbof
												1.000	0.029	0.215	0.084	0.279	Dbacba
													1.000	0.106	0.405	0.172	Popg
														1.000	0.046	-0.03	G. Exp.
															1.000	0.153	GDPg
																1.000	D.Invt.

S & T Journals: Technical & Scientific Journals. M2: Money Supply. fdgdp: liquid liabilities. BcBd: Bank credit on bank deposit. FcFd: Financial credit on financial deposit. Pcrb: Private domestic credit by deposit banks. Pcrbof: Private domestic credit by deposit banks and other financial institutions. Dbacba: Deposit bank assets on deposit bank assets plus central bank assets. Popg: Population growth. G. Exp: Government Expenditure. GDPg: Economic Prosperity. DInvt: Domestic Investment.

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 & Tariff	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			
Financial system Depth	M2	Money Supply (% of GDP)	FDSO (World Bank)
Banking System Depth	Fdgd	Liquid Liabilities (% of GDP)	FDSO (World Bank)
Banking System Efficiency	BcBd	Bank credit on Bank deposit	FDSO (World Bank)
Financial System Efficiency	FcFd	Financial credit on Financial deposit	FDSO (World Bank)
Banking System Activity	Pcrb	Private domestic credit by deposit banks (% of GDP)	FDSO (World Bank)
Financial System Activity	Pcrbof	Private domestic credit by deposit banks and other financial institutions (% of GDP)	FDSO (World Bank)
Financial System Size	Dbacba	Deposit bank assets on (Deposit bank assets plus Central bank assets)	FDSO (World Bank)
Panel C: Control Variables			
Government Expenditure	Gov. Exp.	Government final consumption expenditure (% of GDP)	World Bank (WDI)

Population Growth	Popg	Population Growth Rate (annual %)	World Bank (WDI)
Economic Prosperity	GDPg	GDP growth rate (annual %)	World Bank (WDI)
Domestic Investment	DI	Gross Domestic Investment (% of GDP)	World Bank (WDI)

Panel D: Instrumental Variables

Constitution	Con	IPRs enshrined in country's constitution	WIPO
Main_IP_law	MIPlaw	Main Intellectual Property Law	WIPO
IP_rlaw	IPrlaw	Intellectual Property Rights Law	WIPO
Wipo_treaties	Wipo	World Intellectual Property Organization	WIPO
Multilateral	Multiter	Multilateral Treaties	WIPO
Bilateral	Bilater	Bilateral Treaties	WIPO
Legal Origins		English Common Law and French Civil Law Countries	La Porta et al. (2008, p.289)
Religious Domination		Christian and Islam domination	CIA Factbook (2011)

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.

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