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Abstract. This paper develops an analytical framework, namely the concept of entrepreneurial propensity of innovation systems by integrating knowledge intensive entrepreneurship (KIE) and innovation system (IS) concepts. It first uses a composite index methodology to measure knowledge intensive entrepreneurship and entrepreneurial opportunities at the national level. It then assesses the influence of the system's complementary activities on the emergence of KIE by OLS regressions and structural equation modeling (SEM). We argue that KIE is a *systemic* feature of IS and that new knowledge, innovation and entrepreneurship are inseparable elements of a dynamic IS. The results show that countries with more developed EO tend to have a high correlation between KIE and entrepreneurial opportunities (EO) reflecting the systemic feature of this relationship. . This paper develops conceptually and empirically the notion of the entrepreneurial propensity of innovation system and provides empirical evidence that institutions affect entrepreneurial experimentation not only directly but more via technology and markets.

Keywords. Entrepreneurial opportunities, innovation systems, knowledge-intensive entrepreneurship, structural equation modeling.

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1. Introduction

The dominant perspective on entrepreneurship views it as a nexus of enterprising individuals and valuable opportunities. Individual differences are seen as crucial in the discovery of entrepreneurial opportunities. In this perspective (the 'individual – opportunities nexus' perspective, I-O), entrepreneurship is the key property of individuals which enables them to discover and exploit new opportunities (Miller 1983; Covin and Slevin, 1989; Lumpkin and Dess, 1996, 2001; Shane and Venkataraman, 2000; Shepherd and DeTienne, 2005; Lumpkin and Lichtenstein, 2005; Wiklund and Shepherd, 2005, 2008; Mitchell and Shepherd, 2010). The philosophical basis of this perspective is rooted in methodological individualism or the idea that 'social phenomena must be explained by showing how they result from individual actions, which in turn must be explained through reference to the intentional states that motivate the individual actors' (Heath, 2010).

Recently, there has been a noticeable shift away from the I-O nexus perspective towards a more eclectic understanding of entrepreneurship. For example, Audretsch and Monsen (2008: 47) discuss factors which influence the capacity to generate entrepreneurial activity at different levels. These factors would be personal (individual level), inter-personal (team level), organisational (firm level), and related to networks (industry level). Some recent studies at a meso (industry) level have investigated why some industries host more new growth firms than others and concluded that the reason may lie in the fact that technological innovation is an important determinant of entrepreneurial opportunity and performance (Audretsch et al. 2008; Eckhardt and Shane, 2010). The introduction of databases such as the Global Entrepreneurship Monitor (GEM) has enabled research on the impact of technological entrepreneurship on economic growth to be tested at the levels of country, industry or firm (Yli-Renko et al 2001; Acs and Varga 2005; Minniti et al 2005; Wong et al 2005). However, despite the use of a multi-level perspective the dominant outlook is still rooted in individuals' behavioural characteristics. As pointed out by Heath (2010) 'too much emphasis on the action-theoretic perspective can generate its own fallacies (or) assumptions about what must be going on at the aggregate level.' The explanations of social processes in terms of individuals alone are, following Hodgson (2007: 222) 'both prominent and problematic.'

In this paper, our point of departure is that entrepreneurship is not only the property of individuals but also of economic and innovation systems (IS). By this we mean that there are significant differences in the entrepreneurial propensities of different innovation systems which cannot be explained by recourse to individual differences interacting with external institutions. In the paper, we quantify the scale and scope of an alternative systemic perspective on entrepreneurship. In Radosevic (2007, 2010, 2011) and Edquist *et al.* (2011), we developed a conceptual perspective and methodology for exploring entrepreneurship from a systemic perspective. From an IS perspective, entrepreneurship is not only the property of enterprising individuals but also of systems of innovation. Entrepreneurship activity is a social activity which is dependent on structural features of the economic system and on social processes and mechanisms. From an entrepreneurship perspective, the key structural feature of an economic system is its capacity to generate different entrepreneurial opportunities independent of individuals' capacity to recognise and exploit them. In a nutshell, entrepreneurial activities and entrepreneurial propensities of the IS are not only derived directly from the behaviour of enterprising individuals but also from the structure of entrepreneurial opportunities and activities in the IS. The paper develops a conceptual framework, namely the concept of entrepreneurial propensity of innovation systems by integrating knowledge intensive entrepreneurship (KIE) into innovation system (IS) framework. We focus on KIE because of its close

link to innovation which lies at the core of entrepreneurship.³ In this context, we seek to explore the following issues: What kind of entrepreneurial opportunities influence knowledge-intensive entrepreneurial experimentation? What are the relevant insights that can be generated based on a systemic perspective on entrepreneurship? In section 2, we explain the notion of entrepreneurial propensity of IS (EPIS). In section 3, we discuss data issues, develop a composite index methodology and aggregate a number of individually measured indicators (see also Appendix). We present descriptive results for latent constructs of entrepreneurial opportunities and knowledge-intensive entrepreneurship before applying OLS regressions and structural equation modeling (SEM) to test our models (see Section 4). The conclusion section summarises the major points.

2. Conceptual Framework: Entrepreneurial Propensity of Innovation System (EPIS)

The entrepreneurial propensity of IS is its capacity to generate and exploit entrepreneurial opportunities in order to create new knowledge-intensive enterprises, new technologies (innovations) and new knowledge (Radosevic, 2007; 2010; Edquist et al, 2010). The underlying idea is that KIE is a *systemic* feature of IS and that new knowledge, innovation and new enterprises are inseparable elements of an entrepreneurial IS.

KIE is embedded in IS, which is composed of heterogeneous actors and networks of various types and is shaped by institutions (regulatory systems). Accordingly, it could be considered that entrepreneurship in general, and knowledge-intensive entrepreneurship in particular, constitutes not only one of the activities (or functions) of an innovation system (Edquist, 2005; Bergek et al, 2008) but also one of its core properties. In that respect, we can distinguish between entrepreneurial experimentation (i.e. new enterprises) as one of the inputs or activities in the IS and entrepreneurial propensity of IS as an outcome variable. In this latter aspect, entrepreneurship (cf. as property of IS) could be understood as a social process rather than solely an individual level activity undertaken by individuals who respond to external opportunities. We consider individuals as an important but overrated 'factor' in the exploitation of opportunities: the opportunities to which individuals 'respond' are *not exogenous but are shaped by them*. For example, the 5000 programming hours invested by Bill Gates and other chieftains of IT industry as youngsters were a precondition to exploit opportunities that emerged later on (Gladwell, 2008). So, 'grasped opportunity' could not be really 'grasped' without actively creating it - i.e. shaping that opportunity.

The traditional innovation system approach focuses strongly on the components within the systems, i.e. organizations and institutions. Organizations are the players or actors, while institutions are the rules of the game, constituting constraints to the actions of the organizations or enablers of changes (Lundvall, 1992; Nelson, 1993, Breschi and Malerba, 1997; Malerba, 2004). In this research, we refer to 'activities' in innovation systems, which are regarded as the determinants of the development and diffusion of innovations (Edquist, 2005). We do not focus on the variety of organisational forms within and across IS but take a functional (activity) approach to IS (see Hekkert and Negro, 2009). The activities influence innovation processes both individually but also through mutual interaction. These determinants are not independent of each other, but instead support and reinforce – or offset – one another. Hence, in order to understand the entrepreneurial propensity of individual IS, we should study the relations among various determinants of innovation processes (i.e. between each of the

³ In this respect we follow Schumpeter who distinguishes between the 'circular flow' of an economy and innovation driven growth which generates qualitative change. For Schumpeter, unlike for Kirzner, any new business is not necessarily entrepreneurship. Metcalfe (2004) also thinks that this stretches the notion of entrepreneur too far. For him, 'Many business ventures are copies of existing businesses whose function is to ensure the continuity of economic activities through time, they are based on knowledge of well established markets and practices, and in that sense bring nothing new to the economy' (Metcalfe, 2004 :34).

activities). Highly complementary activities create a highly entrepreneurial system of innovation while mis-matching activities weaken the entrepreneurial propensity of IS. The more the different activities in the innovation system are congruent, the higher the entrepreneurial opportunities.⁴

Opportunities are at the core of entrepreneurship (Shane and Venkataraman, 2000; Shepherd and DeTienne, 2005; Lumpkin and Lichtenstein, 2005; Wiklund and Shepherd, 2005, 2008; Mitchell and Shepherd, 2010). What constitutes entrepreneurial opportunity is generally seen as unproblematic. The dominant perspective is that entrepreneurship is a nexus of enterprising individuals and valuable opportunities which ultimately leads to good firm performance (Miller 1983; Covin and Slevin, 1989; Lumpkin and Dess, 1996, 2001; Wiklund & Shepherd 2003; Salaran & Maritz 2009). Individual differences and how they interact with external factors are seen as crucial in the discovery of entrepreneurial opportunities. Yet, we argue that from an IS perspective, entrepreneurial opportunities emerge when three major sources of opportunities come together: technological opportunities, market opportunities, and institutional opportunities.

What constitutes entrepreneurial opportunities? There is probably no single general answer, as it depends on the level (firm, industry, country) as well as on the disciplinary scope of inquiry (business, economics, sociology). For example, Shane (2000) considers three major sources of opportunities: technological change, political/regulatory change and social/demographic change. From a SI perspective we consider (see Radosevic, 2010):

- Technological opportunities
- Market opportunities
- Institutional opportunities.

Our main hypothesis is that entrepreneurship at an IS level is driven by complementarities arising from the favourable interaction of all three types of opportunities. This perspective is indeed an integration of three views on entrepreneurship: Kirznerian, Schumpeterian and Listian. In each of these views, entrepreneurship is a function of different driving factors:

- Kirzner (1973): entrepreneurship = imbalances/ distortions/ asymmetries/ disequilibria in the market;
- Schumpeter (1934): entrepreneurship = technological opportunities;
- List (1909): entrepreneurship = national system of political economy/institutional complementarities or synergies.

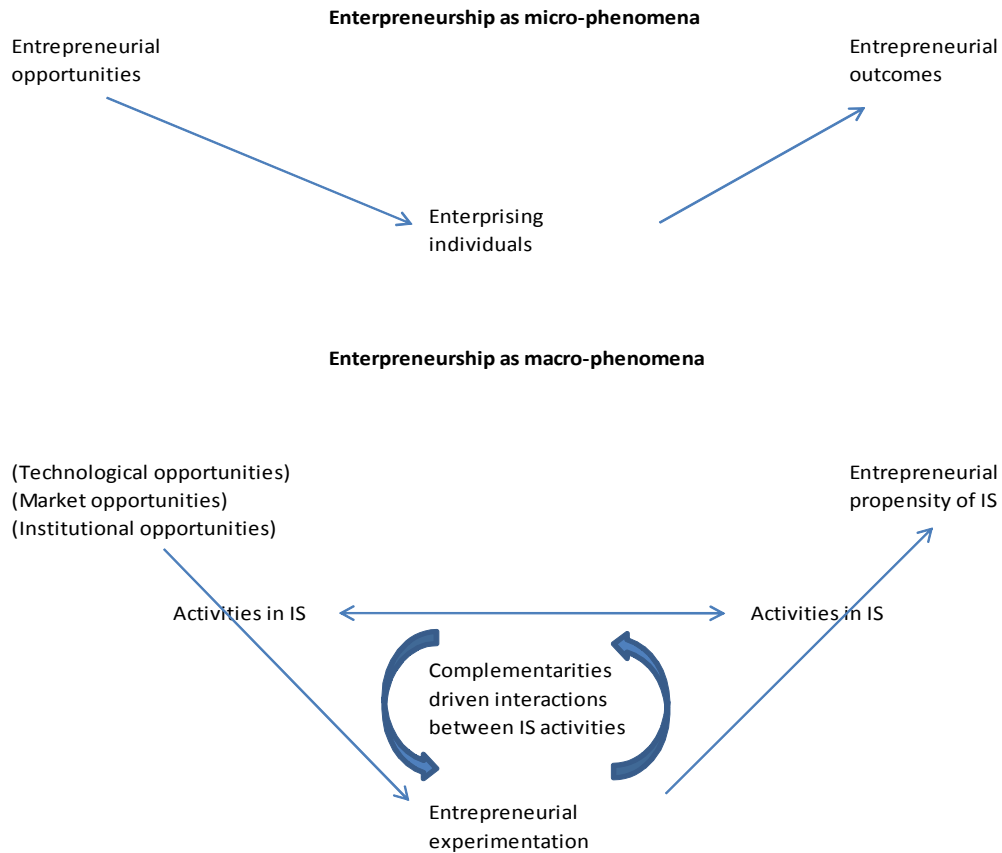
For Kirzner (1973), entrepreneurial opportunities are a function of imbalances, distortions, asymmetries and various disequilibria in the market. People use the information they possess to form a new means-ends framework that guides their entrepreneurial action. For Schumpeter (1934), entrepreneurship is a function of innovation opportunities, which are a key precondition for the generation of entrepreneurial rents, and their erosion through subsequent imitation processes. Generating innovation, which is enabled by inventions, is essential in explaining the existence of entrepreneurial opportunities. In our interpretation of List (1909), which here serves as an antecedent to the contemporary institutional economics and systems of innovation approaches, entrepreneurship is a function of the development of a national system of political economy and related institutional complementarities or synergies, which are conducive to entrepreneurship.

⁴ This resonates well with the long-term perspective on economic growth as expounded by Freeman and Louca (2001) and with Kremer's (1993) O-ring theory of economic development.

Entrepreneurship emerges through the interaction of different opportunities (technological, market and institutional opportunities) and is a systemic property of the IS. Technological opportunities are essential to innovative entrepreneurship as without them product and process innovations could not be developed technically. The question is whether these opportunities are permanent and spatially unlimited or temporary and localised. Research based on Schumpeter has shown that technological opportunities are localised, clustered in specific areas (Kogut and Zander, 1992; Antonelli, 1995) and bunched in specific periods (Perez, 2002). The role of market opportunities is central to entrepreneurship. The type of market opportunities (for example, short- vs. long-term) greatly affects the nature of entrepreneurship that emerges, and in turn is greatly influenced by the role of the institutional system in conveying information and creating incentives among similar or identical technological opportunities. These three types of opportunities cannot generate a dynamic innovation system on their own but only through their mutual interaction. Accordingly, an entrepreneurial IS is one able to nurture and exploit the interactions of these three opportunities. The determinants of opportunities in an IS are individual IS activities like those elaborated in Edquist (2005) (see Figure 2) or Bergek et al (2008).

The process or mechanisms that link entrepreneurial opportunities with outcomes in terms of entrepreneurial activities and entrepreneurial propensities are interactions between IS activities i.e. complementarities. In general, complementarities are processes when two or more phenomena reinforce each other. More formally, Milgrom and Roberts (1994) define it as a situation where doing more of any activity increases the returns of another activities. Activities and their mutual interactions including their impact on entrepreneurial experimentation, as one of the activities in IS, generates different entrepreneurial propensities. In summary, this chain of interacting mechanisms is based on the principle of complementarities and jointly generates different entrepreneurial propensities of ISs. The mechanism or process of interaction will be triggered when there is a mutually compatible set of opportunities (decomposed here into technological, market and institutional opportunities). If there is not a mutually compatible set of structural opportunities, enterprising individuals by themselves will not be able to generate entrepreneurship activities as the IS will not have sufficient entrepreneurial propensity. The individual propensity to entrepreneurship is a function not only of individuals' characteristics (social, psychological, economic, etc.) but also of structural (systemic) features independent of individuals' actions. This is different from the I – O perspective where entrepreneurial opportunity appears in the model only as a determinant of individuals' actions, while entrepreneurial activity is an aggregate effect of entrepreneurially driven individual behaviours reacting to externally given opportunities. In our perspective, entrepreneurial activities and entrepreneurial propensity are caused by structural features of the SI as depicted through different activities in the SI and their mutual interactions driven by the mechanism of complementarities or deterred by missing complementarities. So, unlike the I – O perspective, we assume that macro-level mechanisms generate entrepreneurial activities. Certainly, this is not to deny that entrepreneurial opportunities are exploited by enterprising individuals but only that such a framework is not very helpful for understanding entrepreneurship from a macro perspective i.e. at sectoral and national levels. Figure 1 depicts the conceptual differences between mainstream and systemic perspectives on entrepreneurship. In the mainstream perspective, entrepreneurship is explained as an outcome of the interaction between entrepreneurial opportunities and enterprising individuals. In the systemic perspective, entrepreneurial propensity of the IS is an outcome of entrepreneurial opportunities (technological, market and institutional) moulded through complementarities and interactions between the different activities in the IS, including entrepreneurial experimentation.

Figure 1. Two views on entrepreneurship



Source: Radosevic (2011)

Figure 2 further develops the logic of our approach by depicting the relationships between the different activities in the IS, including entrepreneurial experimentation. These activities are shaped through different types of entrepreneurial opportunities which are not exogenous (as in the mainstream approach) but rather constitutive of the SI. The co-evolution of different activities generates different entrepreneurial propensities of the SI.

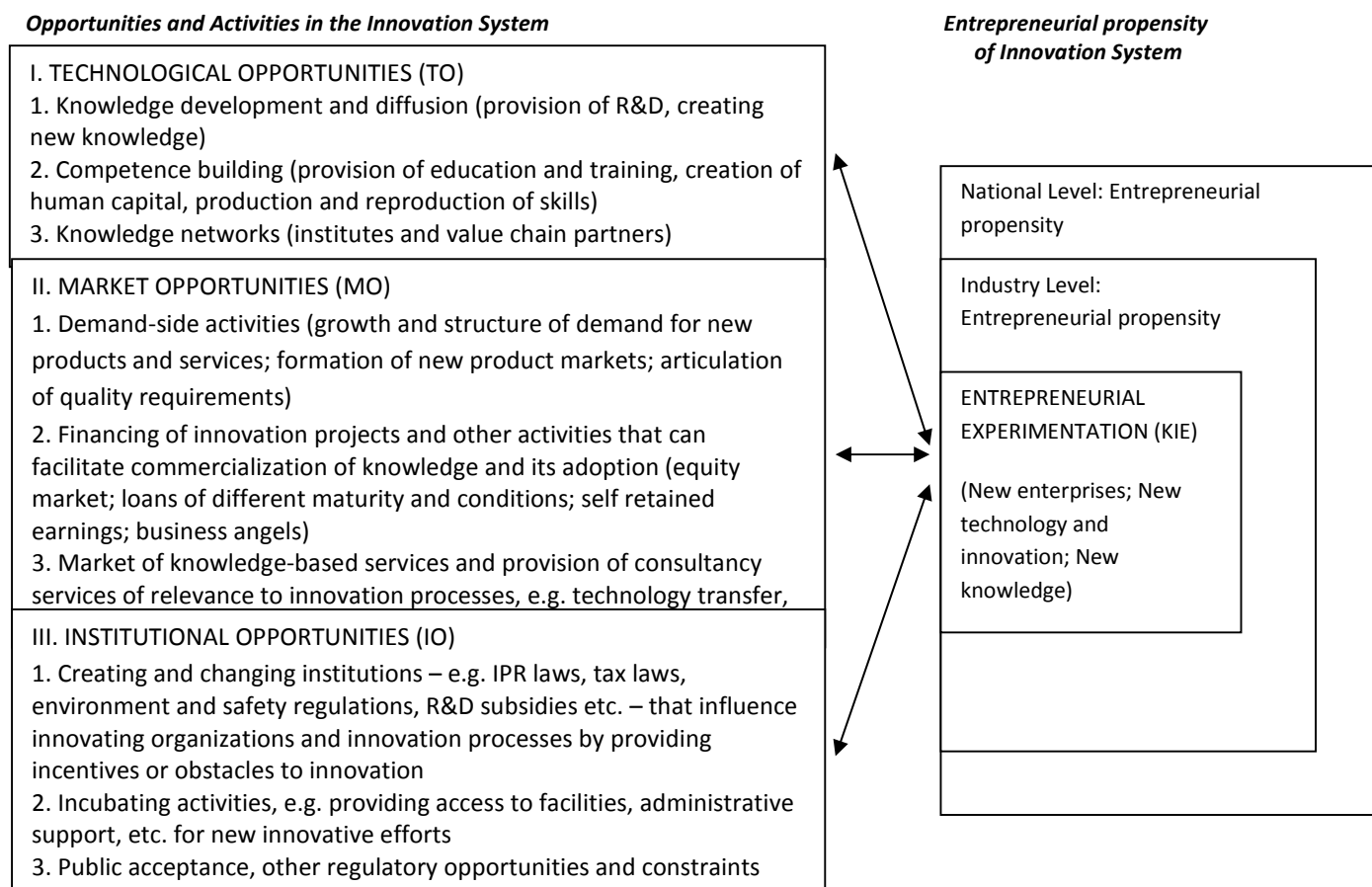
In mainstream approaches, entrepreneurship is usually reduced to entrepreneurial experimentation defined as new firm formation. Entrepreneurial propensity in this approach is a direct outcome of individual characteristics such as education, gender, psychological traits etc. and external institutional constraints or opportunities such as property rights, regulatory framework, size of state, etc. In the systemic approach, entrepreneurial experimentation is not only defined in broader terms (see below) but is influenced by other activities in the IS. Entrepreneurship is not explained with reference to individual traits but with reference to structural factors, social mechanisms and processes.

From a systemic perspective, knowledge intensive entrepreneurship (KIE) and thus entrepreneurial experimentation also includes new technology and innovation, new knowledge, and new enterprises. These three activities are based on new enterprises and on corporate entrepreneurship and assume the involvement of public organisations. For example, large enterprises play a prominent role as innovators as well as generators of new knowledge. They do not operate independently of knowledge networks many of which are either led or supported by public organisations. Our

approach is not concerned with the question ‘who is entrepreneur’ (Gartner, 1988). Who is performing the entrepreneurial function is a ‘secondary’ issue compared to the primary issue of identifying whether and what entrepreneurship activity takes place.

Figure 2 indicates our major focus on the issue of how entrepreneurial experimentation contributes to the overall functioning of a sectoral, regional or national IS. The operation of entrepreneurship cannot be understood outside the overall functional set up of a system of innovation, i.e. links with other activities.

Figure 2. The relationship between entrepreneurial experimentation and other activities in an IS.



Source: Based on Edquist (2005), Edquist and Chaminade (2006) and Radosevic (2007).

Taking a systemic approach, we construct a set of composite indicators in order to measure and explore the relationships between different types of opportunities and KIE. Within the boundaries of our conceptual framework, we explore the following hypotheses:

H1a: The higher the level of technological opportunities (TO) provided in the innovation system, the higher the level of knowledge-intensive entrepreneurship.

H1b: The higher the level of market opportunities (MO) provided in the innovation system, the higher the level of knowledge-intensive entrepreneurship.

H1c: The higher the level of institutional opportunities (IO) provided in the innovation system, the higher the level of knowledge-intensive entrepreneurship.

H2: Interactions between TO, MO and IO create a favourable habitat for KIE in the IS. (However, the nature of that interaction is unknown; we will explore this below using the SEM statistical technique).

3. Research Methodology

3.1 Data and Sample

Primary data for individual indicators (see Table 1) have been acquired from a variety of publicly available sources: EUROSTAT, World Bank, WEF Global Competitiveness Report and EC Innobarometer at national level for 26 EU countries and Croatia for the base year 2007. Relevance to the analysis, availability and comparability were the criteria used to select the indicators. Missing data accounted for less than 5% of the data. Missing values in the data set have been treated using several methods. Where possible, missing values were replaced with a value from an external source, e.g. from a previous round of the same survey. The remaining missing values are treated by multiple imputation method.⁵ Afterwards, the data are classified into four main categories and eleven subcategories (activities in the innovation system) of the entrepreneurial propensity of innovation system (EPIS) framework (see Figure 1 and Table 1).

3.2 Developing Measures by Composite Index Methodology

The individual measured indicators in Table 1 have then been used to construct latent variables for KIE, TO, MO and IO by using composite index methodology.^{6,7}

A typical composite indicator will take the form (Freudenberg, 2003: 7):

$$(1) \quad I = \sum_{i=1}^n w_i X_i$$

where

I : Composite index,

X_i : Normalised variable,

w_i : Weight of the X_i , $\sum_{i=1}^n w_i = 1$ and $0 \leq w_i \leq 1$
 i : 1, ..., n.

⁵ Multiple imputation (MI) is a general approach that does not require a specification of parameterised likelihood for all data. The imputation of missing data is performed with a random process that reflects uncertainty. Imputation is done N times, to create N "complete" datasets. We have used *Markov Chain Monte Carlo* (MCMC) method. MCMC is a sequence of random variables in which the distribution of the actual element depends on the value of the previous one. It assumes that data are drawn from a multivariate normal distribution and requires MAR or MCAR assumptions i.e. that missing values are missing at random. The theory of MCMC is most easily understood using Bayesian methodology (OECD, 2008).

⁶ Composite indexes are widely used in economic and business statistics for benchmarking the relative progress of countries in a variety of policy domains such as competitiveness, globalization and innovation. Even though Grupp and Mogege (2004) criticize the approach for its vulnerability to manipulation, Archibugi et al. (2009) stress that when they are used in the right perspective and within a sound theoretical framework they can be extremely useful tools.

⁷ See Radosevic and Yoruk (2011) for a comprehensive interpretation of indexes.

Equation (2) shows explicitly the normalisation method (Min-Max) used:

$$(2) \quad = \sum_{c=1}^n \sum_{m=1}^m \left\{ \left(\frac{c_{jm} - [\min]_{jm}}{[\max]_{jm} - [\min]_{jm}} \right) \right\}$$

where c indicates country, j and m are indicator and component subscripts and min and max denote the minimum and maximum values of each indicator across countries.

Based on our analytical framework, the **IKIE (index of knowledge intensive entrepreneurship)** is composed of three components: new enterprises, new technology and innovations and knowledge intensity, each created from a number of output indicators, 9 in total. The **IKIEO (index of knowledge intensive entrepreneurial opportunities)** is composed of three sub-indexes: technological opportunities (TO), market opportunities (MO) and institutional opportunities (IO). TO further involves three components: knowledge development and diffusion, competence building in skills and knowledge & value chain networks, created from 9 indicators. MO is further composed of three components, namely demand side activities, financing of innovation and other activities and market for knowledge intensive services, created from 10 indicators. Finally, IO is composed of two components: regulatory environment and public support for incubating and other supporting activities, generated from 9 indicators in total.⁸ The sources, availability and weights for each of these two indexes and their indicators are presented in Table 1. IKIE and IKIEO are estimated based on the normalization⁹ of 9 individual indicators (for IKIE) and 26 individual indicators (for IKIEO) followed by aggregation¹⁰ of components with equal weights given to each component.¹¹ We provide Cronbach's alpha coefficient of reliability for each of the latent constructs (see Table 1) to further indicate the correlation between the selected individual indicators (Gerbing and Anderson, 1988). C-alpha in each case is above the 0.70 threshold of acceptable reliability (Nunnally, 1978). This shows that they are highly likely to share common factors as outlined by our conceptual framework and it is evidence that the indicators are measuring the same underlying construct (OECD, 2008: 71-2).

⁸ See Appendix A for a detailed explanation of indicators and the formation of indexes.

⁹ We have used Min-Max (distance from the best and worst performers) normalization method in this research, since this is the most compatible method with the indicators we have chosen.

¹⁰ Linear, geometric or multi-criteria aggregation might be applied. We opted for linear aggregation method where substitution along dimensions (components) is constant, which we prefer in accordance with our conceptual framework. It is also compatible with Min-Max method of normalization, especially when individual indicators are measured in different units. Technical weaknesses of the aggregation convention are widely discussed in Munda & Nardo (2009).

¹¹ In the existing literature there are numerous weighting methods with pros and cons. These vary from equal weighting to use of statistical models such as factor analysis (FA)/principal component analysis (PCA) or a 'benefit of the doubt' (BOD) approach which is sensitive to national priorities and weights are country specific (OECD, 2008: 32). Based on our already developed conceptual framework, we use an equal weighting method applied on each component. OECD (2008:31) states that "most composite indicators rely on equal weighting, i.e. all variables are given the same weight. This essentially implies that all variables are 'worth' the same in the composite, but it could also disguise the absence of a statistical or empirical basis, e.g. when there is insufficient knowledge of causal relationships or a lack of consensus on the alternative. Moreover, if variables are grouped into dimensions (components) and those are further aggregated into the composite, then applying equal weighting to the variables may imply an unequal weighting of the dimension (the dimensions grouping the larger number of variables will have higher weight). This could result in an unbalanced structure in the composite index." That is why we have given the same weight to each component as based on our conceptual framework and then determined the weight of each individual indicator to achieve a balanced structure in the composite index. We provide the results of Confirmatory Factor Analysis (CFA) applied to indicators for each component separately in the Appendix B. The indicators selected for the components merge into factor groups assuring the validity of our conceptual framework.

Table 1. Indicators for composite indexes at national level.

Index	Sub-index	Component	Quantitative Indicators	Source	Year	Comp weight	Indicator weight	Cronbach's alpha
Index of Knowledge Intensive Entrepreneurship IKIE = NE + NTI + KI		New enterprises (NE)	1.Net entry rate 2.Five-year old enterprises employment growth rate 3.Survival rate 5 4.Five- year old enterprises' share of the business population	Eurostat	2007 2007 2007 2007	1/3	1/12 1/12 1/12 1/12	0.7069
		New technology and innovations (NTI)	5.% of innovative enterprises 6.% of innovation expenditures in turnover	Eurostat	2006-8 2006-8	1/3	1/6 1/6	
		Knowledge intensity (KI)	7. EPO patent applications (per M inhabitant) 8.Royalty and license fees receipts (% of GDP) 9.Knowledge intensive services value added (% of GDP)	Eurostat WBank Eurostat	2007 2007 2007	1/3	1/9 1/9 1/9	
Index of Knowledge Intensive Entrepreneurial Opportunities IKIEO = TO + MO + IO	Technological Opportunities TO = RND + SKILL + KNWK	Knowledge development and diffusion (RND)	10.GERD % GDP 11.BERD %GDP	Eurostat	2007 2007	1/3	1/6 1/6	0.9054
		Competence building in skills (SKILL)	12.R&D personnel (% in total employment) 13.% of population with tertiary education 14. Quality of scientific research institutions 15.Availability of scientists and engineers	Eurostat WEFGCR	2007 2008 2009 2009	1/3	1/12 1/12 1/12 1/12	
		Knowledge and value chain networks (KNWK)	16.Firms involved in innovation cooperation (% in total) 17.Job-to-job mobility of HRST (% in total employment) 18.Value chain breadth	Eurostat WEFGCR	2006-8 2007 2009	1/3	1/9 1/9 1/9	
	Market Opportunities MO = DEMAND + FINANCE + MKIS	Demand side activities (DEMAND)	19.GDP per capita (USD) 20.GDP growth (annual %) 21.Share of trade(X+M) in GDP 22. Buyer sophistication: buyer's purchasing decision	WBank Eurostat WEFGCR	2007 2007 2008 2009	1/3	1/12 1/12 1/12 1/12	0.8848
		Financing of innovation processes and other activities (FINANCE)	23.Domestic credit to private sector (% of GDP) 24.Stocks traded (% in GDP) 25. Venture capital availability	WBank WEFGCR	2007 2007 2009	1/3	1/9 1/9 1/9	
		Market for knowledge intensive services (MKIS)	26.High-tech sector enterprises (manufacturing & KIS) (% in total enterprises) 27.High-tech exports (% of total X) 28.Employment in high tech manufacturing and knowledge intensive sectors (% in total employment)	Eurostat	2007 2007 2007	1/3	1/9 1/9 1/9	
	Institutional Opportunities IO = REGULATION + SUPPORT	Regulatory environment (REGULATION)	29. Number of procedures required to start a business(Q. 6.06) 30. Time required to start a business (Q. 6.07) 31. IPR protection(Q. 1.02) 32. Burden of government regulation (Q. 1.09) 33. Efficiency of legal framework (Q. 1.11)	WEFGCR	2009 2009 2009 2009 2009	1/2	1/10 1/10 1/10 1/10 1/10	0.7760
		Public support to incubating & other supporting activities (SUPPORT)	34. State of cluster development (Q. 11.03) 35. Declared clustered membership among enterprises in cluster-like environment (%) 36.Interest in public procurement (% firms in total) 37.Firms with opportunity to sell innovations on public tenders (% in enterprises with direct experience with public tenders)	WEFGCR EC Innobarometer	2009 2006 2009 2009	1/2	1/8 1/8 1/8 1/8	

*Every component within each index is assumed to have equal weight. Thus, each indicator weight is determined accordingly.

Note: WEFGR = World Economic Forum, Global Competitiveness Reports

4. Results and Discussion

4.1 Descriptive Results for Composite Indexes

We present the calculated indexes (IKIE – Index of knowledge intensive entrepreneurship; and IKIEO – Index of knowledge intensive entrepreneurial opportunities, made up of TO – Index of technological opportunities, MO – Index of market opportunities and IO – Index of institutional opportunities) in **Table 2** along with the ranking of EU countries (except Malta) and Croatia. Table 2 suggests several interesting conclusions.

Table 2. IKIEO, IKIE and IKIEO sub-indexes ranks for 26 EU countries and Croatia and their rankings.

Country	IKIEO	Country	IKIE	Ranking comparison					
				Country	IKIEO rank	IKIE rank	TO rank	MO rank	IO rank
Finland	224.68	Sweden	71.75	Finland	1	2	1	6	1
Sweden	222.18	Finland	66.82	Sweden	2	1	2	3	2
Denmark	202.98	Germany	59.79	Denmark	3	4	3	7	3
Luxembourg	189.57	Denmark	57.49	Luxembourg	4	5	10	1	4
United Kingdom	179.99	Luxembourg	55.67	United Kingdom	5	11	9	2	6
Netherlands	177.48	Netherlands	53.34	Netherlands	6	6	8	4	5
Belgium	158.00	France	53.17	Belgium	7	8	7	9	7
Germany	155.36	Belgium	51.54	Germany	8	3	4	10	12
Ireland	151.91	Estonia	47.70	Ireland	9	16	12	5	9
France	150.08	Cyprus	46.11	France	10	7	6	11	11
Austria	147.94	United Kingdom	43.37	Austria	11	12	5	12	14
Cyprus	131.05	Austria	42.53	Cyprus	12	10	20	8	8
Slovenia	124.43	Slovenia	41.96	Slovenia	13	13	11	14	13
Estonia	118.76	Romania	39.11	Estonia	14	9	15	16	10
Czech Republic	114.53	Hungary	37.59	Czech Republic	15	19	13	13	18
Portugal	102.95	Ireland	36.34	Portugal	16	21	14	20	17
Spain	93.44	Italy	36.20	Spain	17	24	16	15	24
Italy	90.53	Croatia	35.19	Italy	18	17	17	19	21
Hungary	84.34	Czech Republic	33.99	Hungary	19	15	18	18	26
Lithuania	82.88	Greece	32.16	Lithuania	20	25	19	23	20
Latvia	79.63	Portugal	31.45	Latvia	21	22	25	22	16
Slovakia	79.03	Latvia	31.43	Slovakia	22	26	24	17	23
Poland	78.18	Bulgaria	31.32	Poland	23	27	21	21	22
Bulgaria	72.52	Spain	30.04	Bulgaria	24	23	26	24	15
Croatia	65.06	Lithuania	27.88	Croatia	25	18	22	25	25
Romania	62.65	Slovakia	27.76	Romania	26	14	27	27	19
Greece	60.67	Poland	23.56	Greece	27	20	23	26	27

First, both IKIE and IKIEO broadly reflect levels of development as expressed by GDP per capita. Table 3 confirms this based on simple regressions which indicate that IKIE and IKIEO are closely associated with GDP measured in PPP terms when considered for all EU-27 countries.¹² This is expected given that both composite indexes employed reflect a systemic view of entrepreneurship which is based not only on new enterprises but also new technologies and innovation and new knowledge (IKIE) or based on an assessment of entrepreneurial opportunities across a number of activities in the IS (IKIEO). IKIEO scores are somewhat more closely associated with GDP_{ppp} compared to IKIE scores. This may be expected as opportunities which are *de facto* inputs into entrepreneurially driven growth reflect the broad structural features of the IS. The broad structural features of the IS also

¹² GDP_{ppp} data for the EU-27 countries is taken from EUROSTAT.

reflect the effectiveness and efficiency of entrepreneurial processes and mechanisms, i.e. the extent to which entrepreneurial opportunities (EO) are converted into entrepreneurial outcomes.

Table 3. OLS regressions of IKIE and IKIEO with GDP_{ppp}.

Dependent variables	Model 1		Model 2	
	IKIE		IKIEO	
	Coef.	t-value	Coef.	t-value
GDP _{ppp}	0.001	3.30***	0.003	4.80***
constant	25.59	5.58***	51.56	3.02**
Adjusted R ²	0.28		0.46	
N	27		27	

***Statistically significant at 1% level. ** 5% level.

Second, there seems to be a high correlation between IKIE and IKIEO.¹³ This suggests that entrepreneurial opportunities available in a country's IS are associated with the larger scale of KIE. This may also be expected given the systemic nature of entrepreneurship. Economic growth is largely a cumulative process driven by virtuous or vicious cycles (Krueger, 1993). Complementarities between different activities in an IS stimulate entrepreneurial experimentation which in turn tends to open new entrepreneurial opportunities. On the other hand, mismatches between different activities in an IS – expressed as obstacles or barriers to entrepreneurial experimentation – tend to further reduce entrepreneurial opportunities. In that respect, it may be wrong to think of EO as inputs and KIE as outputs. From a systemic perspective, the analytical focus is on the differing propensities of an IS to generate KIEO and KIE, rather than on the 'black box' of the (in)efficiency of narrowly defined entrepreneurial processes.

Although our methodology enables us to rank countries based on IKIE and IKIEO, our focus on the entrepreneurial propensity of IS makes it more amenable to taxonomies and groupings rather than to an analysis based on 'league tables.' To begin with, we use cluster analysis (CA) as a descriptive technique¹⁴ to benchmark the countries' knowledge intensive entrepreneurial opportunities. CA is a collection of algorithms to classify objects such as countries, species, and individuals (Anderberg, 1973; Spath, 1980; Massart & Kaufman, 1983). The classification aims to maximize the homogeneity of objects within the clusters while also maximizing the heterogeneity between the clusters (Hair et al. 1998: 470). We first do hierarchical cluster analyses separately for IKIE and IKIEO from Table 2. From the dendograms and the agglomeration schedules,¹⁵ it seems possible to group countries into three or four major groups. To be more precise about the clusters, we have applied non-hierarchical K-means cluster analysis to achieve exactly three groups to be used in further analysis. Three clusters of countries are profiled by entrepreneurial activity (low, medium, high) and entrepreneurial opportunity (low, medium, high). Cluster memberships are reported in Table 4 for IKIE and IKIEO and the sub-indexes of IKIEO (TO, MO and IO).

Results confirm that KIE and KIEO are strongly systemic activities which are much more developed in high-income compared to lower-income countries. Although this dimension is not applicable to every

¹³ The pairwise correlation coefficient between IKIE and IKIEO is 0.8761.

¹⁴ Even though cluster analysis is a descriptive technique which must be used with utmost care, it has always had a strong tradition of grouping individuals (in these case countries) and extended to classifying objects (Hair et al., 1998).

¹⁵ These are available upon request from the authors.

single country, there is a strong trend in Table 4. This reinforces the results from the simple regressions of IKIE and IKIEO on GDPppp.

Another layer of interesting results are countries which do not confirm to this expected trend and those in the 'medium' group. The explanatory scope for this component seems to be large as the level of development explains less than 50% of variance in IKIE and IKIEO (Table 3). In such cases, the logic of varieties of capitalism (VoC) with their different entrepreneurial propensities or a country specific logic play an important role in explaining the country's position. Table 4 indicates that a variety of capitalism logic does not operate across a simple East – West EU divide. In fact, in terms of the emergence of KIE and opportunities, Europe is structured into three groups, with the CEECs split across two EU groups (less and medium-developed). The less-advanced CEECs cluster together , while the advanced CEECs are similar to the medium EU group.

Table 4. Clustering of countries based on their entrepreneurial opportunities.

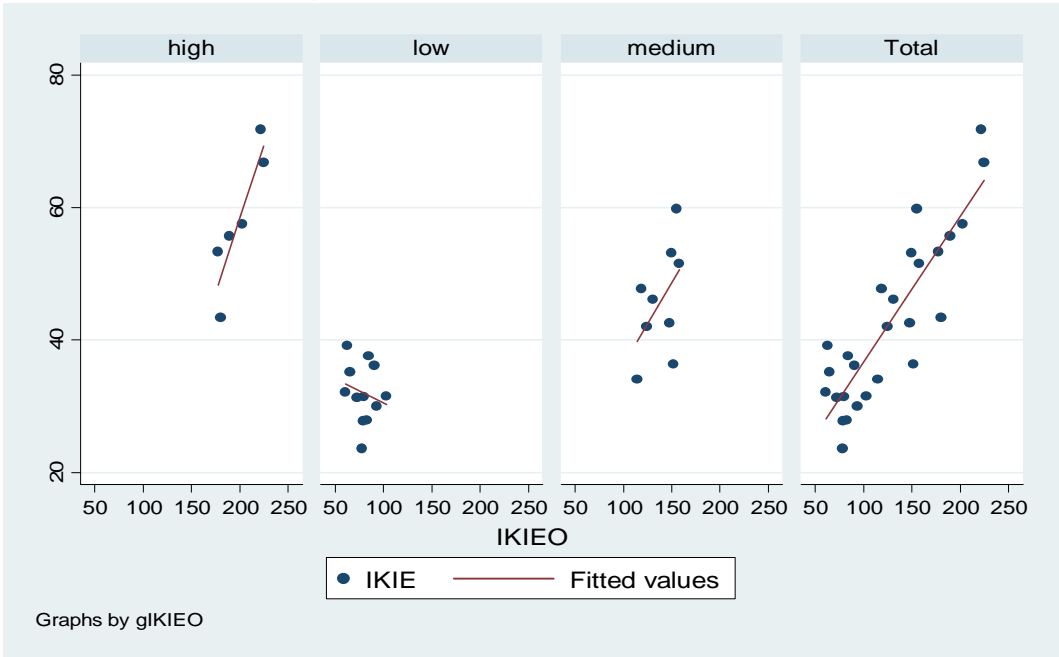
By entrepreneurial activity	Low	Medium	High
IKIE	Bulgaria Greece Latvia Poland Croatia	Czech Rep. Spain Lithuania Portugal Ireland Italy Hungary Slovakia	Belgium Cyprus Romania UK
		Estonia Austria Slovenia	Denmark France Netherlands Sweden Germany Luxembourg Finland
By entrepreneurial opportunities	Low	Medium	High
IKIEO	Bulgaria Italy Hungary Romania	Greece Latvia Poland Slovakia	Spain Lithuania Portugal Croatia
		Belgium Germany Ireland Cyprus Slovenia	Czech Rep. Estonia France Austria
TO	Bulgaria Latvia Romania Croatia	Greece Poland Slovakia	Czech Rep Ireland Italy Lithuania Hungary Slovenia
		Estonia Spain Cyprus Luxembourg Portugal	Belgium Germany Netherlands Finland UK
MO	Bulgaria Latvia Poland Romania	Greece Lithuania Portugal Croatia	Belgium Germany Spain Italy Austria Slovakia
		Czech Rep Estonia France Hungary Slovenia	Denmark Cyprus Finland UK
IO	Greece Italy Hungary Romania Croatia	Spain Lithuania Poland Slovakia	Belgium Czech Rep Estonia France Latvia Austria UK
		Bulgaria Germany Ireland Cyprus Netherlands Slovenia	Denmark Finland Luxembourg Sweden

In terms of IKIEO, the Scandinavian countries (Denmark, Finland and Sweden) and two liberal types of capitalisms (UK, Netherlands) form their own cluster with the highest IKIEO. The largest cluster (12 countries) by far is the low IKIEO cluster, composed of the CEECs and all South EU (Greece, Spain, Italy and Portugal). The medium level cluster is composed of continental EU members like Germany and Austria with the upper tier of the CEECs.

In the rest of this section, we base our exploratory analysis on the distinction between countries from a KIEO perspective. We base this categorization on cluster analysis results for IKIEO and its associations with IKIE, and also the associations between IKIE and the sub-indexes of IKIEO, namely TO, MO and IO. In this way, we aim to explore in a descriptive way the degree to which there is a relationship between KIE and KIEO across different groups of countries grouped by IKIEO.

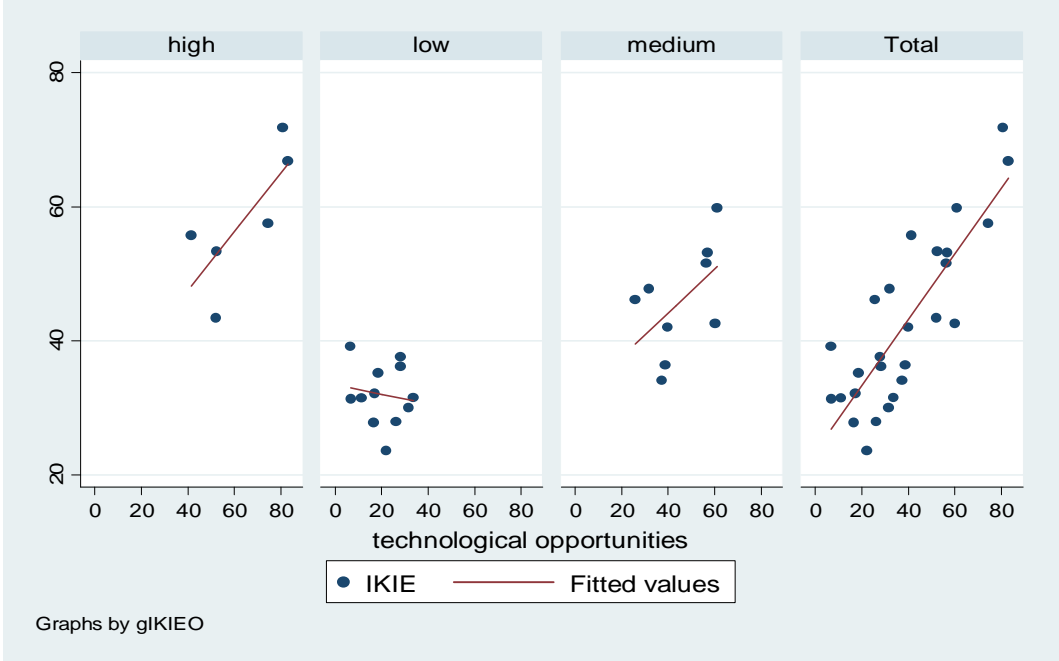
First, we investigate the association between IKIE and IKIEO for country clusters based on IKIEO. The scatter diagrams in Graph 1 suggest that IKIE and IKIEO are positively and closely associated with each other and this relationship is statistically significant for all 27 countries as well as for the high EO and medium EO groups. This suggests that favourable conditions and (possibly) interactions of activities in entrepreneurial opportunities create favourable conditions for KIE in these groups. However, for the low EO group, this relationship is not significant pointing to unfavourable conditions for KIEO. This may indicate that low KIEO economies suffer from larger mismatches between activities in the IS, thus weaker complementarities between activities and decreased EO. Again, we do not see this as an issue of (in)efficiency, but rather the absence of complementarities in the IS which hinders the generation of virtuous cycles between KIE and KIEO.

Graph 1. IKIE v. IKIEO by IKIEO clusters. (R squared for high EO: 0.824, for medium EO: 0.265, for low EO: 0.044, for total: 0.768)



In continuation, we investigate the sub-indexes of IKIEO by way of scatter diagrams. In Graph 2, we look for the association between IKIE and **technological opportunities (TO)**. For countries in the high and medium EO groups, there is a positive and statistically significant relationship between technological opportunities and KIE. Yet again, this relationship is inconclusive for the low EO group reflecting deficiencies in the main technological indicators for these countries – i.e. R&D expenditures, R&D personnel, firms’ innovation collaboration, etc. and absence of complementarities in the IKIEO. A lack of any relationship between TO and KIE in the low EO countries reinforces the conclusion that KIE in these economies is not driven by TO.

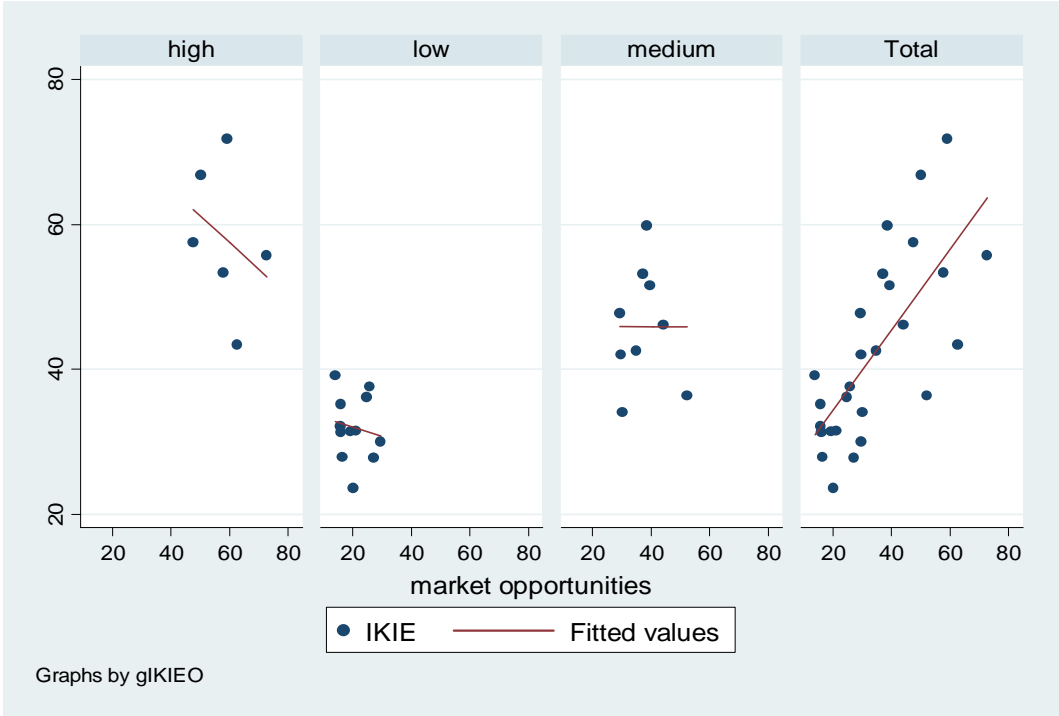
Graph 2. IKIE v TO by IKIEO clusters (R squared for high EO: 0.576, for medium EO:0.282, for low EO: 0.022, for total: 0.7)



The analysis of the effect of the EO sub-index **market opportunities (MO)** on KIE presents interesting results (Graph 3). For all countries, there is a positive and statistically significant relationship between IKIE and MO although when compared to TO and IO this relationship is the weakest.¹⁶ However, this positive relationship is not reflected in the sub-groups of countries. For the high EO group, there is a negative but insignificant relationship. It seems that in the high EO group (which contains the higher income countries), market indicators such as GDP per capita, share of trade, buyer sophistication do not create sufficient incentives for KIE. We should not forget that we are monitoring KIE and not ordinary entrepreneurship. Hence, the evidence that MO levels are not correlated with KIE levels may be unsurprising. In particular, this may be expected in the case of the high KIEO countries – most of which operate on the technology frontier and where technology-led (Schumpeterian) entrepreneurship should be present more than market-led (Kirznerian) entrepreneurship. In the case of Schumpeterian entrepreneurship, it is TO not MO that drives KIE.

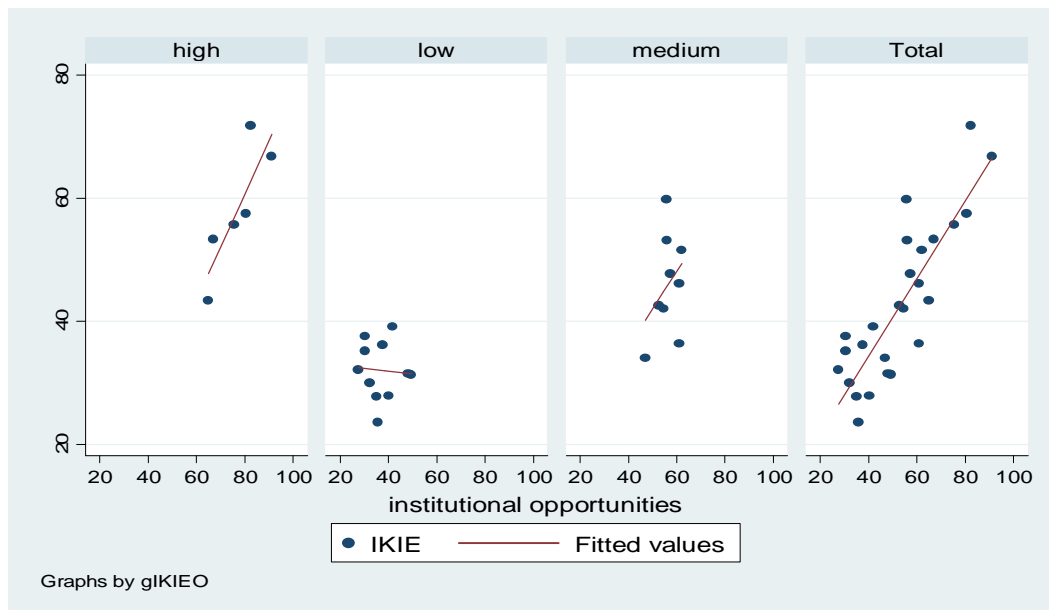
¹⁶R squared in MO regressions is 0.52 while in TO and IO it is 0.76 and 0.71 respectively.

Graph 3. IKIE v MO by IKIEO clusters (R squared for high EO: 0.11, for medium EO: 3.06×10^{-5} , for low EO: 0.021, for total: 0.521)



Finally, graph 4 presents the relationship between IKIE and **institutional opportunities (IO)**. It shows that the level of IO is closely related to KIE in all countries. This relationship is also positive and conclusive for the high EO group, and positive and mildly conclusive for the medium EO group, whereas it is statistically insignificant and inconclusive for the low EO group. This reinforces the systemic view on entrepreneurship employed here as it suggests that KIE in medium and high-level EO countries is associated with higher levels of IO. On the other hand, although the relationship is statistically insignificant, weak IO might be the main reason hindering KIE in low KIEO countries.

Graph 4. IKIE v IO by IKIEO clusters (R squared for high EO: 0.714, for medium EO: 0.123, for low EO: 0.005, for total: 0.717)



4. 2 Results of OLS and SEM Analyses

The analyses have been conducted in multiple stages so that the results can collectively help to assess the proposed framework. Table 5 shows the descriptive statistics of latent constructs used in the analyses.

Table 5. Descriptive statistics, correlation matrix and covariances (N=27)

	Descriptives				Correlations				Covariances			
	Min	Max	Mean	Std. Dev.	KIE	TO	MO	IO	KIE	TO	MO	IO
KIE	23.56	71.75	42.42	12.65	1.00	0.836	0.722	0.845	154.03	219.62	144.00	175.14
TO	6.69	83.09	38.54	21.56		1.00	0.708	0.784		447.66	240.89	277.16
MO	14.04	72.74	34.56	16.38			1.00	0.808			258.47	217.06
IO	27.56	91.33	52.85	17.02				1.00				278.87

We first used OLS regression to test the hypotheses. Separate models were estimated (Table 6). Models 1 to 3 provide support for hypotheses 1a, 1b and 1c (individual entrepreneurial opportunities are positively correlated with KIE). Knowledge-intensive entrepreneurship has a positive and highly statistically significant association with technological opportunities, market opportunities and institutional opportunities generated by the innovation system. Despite relatively high correlation between the explanatory variables (Table 5), we run Model 4 accommodating all of the explanatory variables. Testing for multicollinearity shows that each of these variables has significant explanatory power by itself and the extent of multicollinearity is within acceptable limits. The tolerance values for each explanatory variable are above the cut-off point of 0.10, ranging between 0.35 and 0.50, and the variance inflation factor (VIF) values are well below the cut-off value of 10, ranging between 2 and 2.9 (Hair *et al.*, 1998: 193). Model 4 partly supports hypothesis 2 (interactions between TO, MO and IO create a favourable habitat for KIE in the IS). However, it also reveals that incorporating TO and IO into the model with MO suppresses the importance of the relationship between MO and KIE. Demand is supposed to be the major determining factor for ordinary entrepreneurship. However, here we are monitoring KIE where innovation is very often not market led (Kirznerian) but the Schumpeterian type. The major constraints of this latter type of innovation may be financial due to bigger uncertainties and the undeveloped market for knowledge intensive services. If we approach

these results from this angle, then the results seem quite plausible. Thus, the technological and institutional aspects of the opportunities in the system seem to be more influential in creating knowledge-intensive entrepreneurialships.

Table 6. OLS regression
Dependent variable: KIE

Independent variables	Model 1	Model 2	Model 3	Model 4
TO	0.491***			0.263***
MO		0.557***		0.012
IO			0.628***	0.358***
Constant	23.508***	23.161***	9.225***	12.978***
R ²	0.70	0.52	0.71	0.79

* $p < 0.10$; ** $p < 0.05$; *** $p < 0.01$. (N=27)

By using only OLS regressions, we cannot comment on the mutual interactions between the explanatory variables and the effect of these on KIE. We can, however, test hypothesis 2 more effectively by employing SEM using SPSS AMOS, which estimates multiple dependent relationships between the constructs by applying several regression equations, simultaneously exploring the direct and indirect effects of exploratory variables on each other and on the dependent variable. Thus, we can look for the interplay and complementarities between the technological, market and institutional opportunities and how they influence KIE. Moreover, we can look for these complementarities by exploring the direct and indirect relationships between the exploratory variables themselves.

For this reason, we established two separate SEM models: Figure 3 provides the path diagram for Model 5 and Figure 4 shows the path diagram for Model 6.¹⁷ Model 5 regards IO as exogenous to entrepreneurial experimentation whereas MO and TO are endogenous and also dependent on IO. Model 6 regards MO and TO as exogenous to entrepreneurial activities in the system and influencing IO. Both models represent the hypothesis that knowledge-intensive entrepreneurial experimentation is affected by the complementarities between institutional, technological and market opportunities in the IS. More precisely, from a macro perspective, in Model 5 we test the direct influence of institutional, technological and market opportunities on KIE as well as the indirect influence of institutional opportunities on KIE via its direct effect on technological and market opportunities. In accordance with the usual convention, where institutions are seen as endogenous to entrepreneurship, in Model 6 we test the alternative for the direct influence of institutional, technological and market opportunities on KIE as well as the indirect influence of technological and market opportunities via institutional opportunities on KIE.

¹⁷ Since we have constructed composite indexes from measured variables in the first part of our analysis, we skip the measurement stage of SEM and go to the structural modeling stage. This is mostly due to limitations in sample size. However, as Kline (2011: 12) notes sample size adequacy also depends on factors such as the complexity of model. Therefore, smaller sample sizes may be accommodated in simple models when the associations between variables are all linear. As we currently have a simple, neat model (compared to many models tested using SEM in sociology, psychology, medicine, management, etc.), we believe the validity and accuracy of our model will not be effected. Despite this, we acknowledge the necessity of testing our model with larger sample sizes.

Figure 3. Path diagram for EPIS structural indirect effect Model 5: Causes and effects of KIE and opportunities interaction (IO are exogenous to MO and TO)

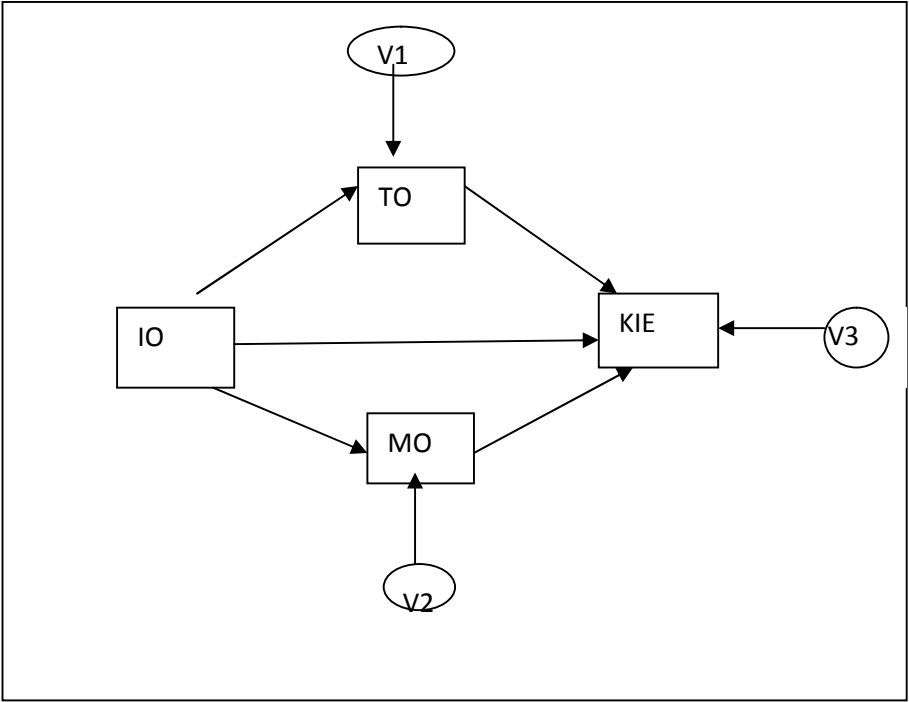
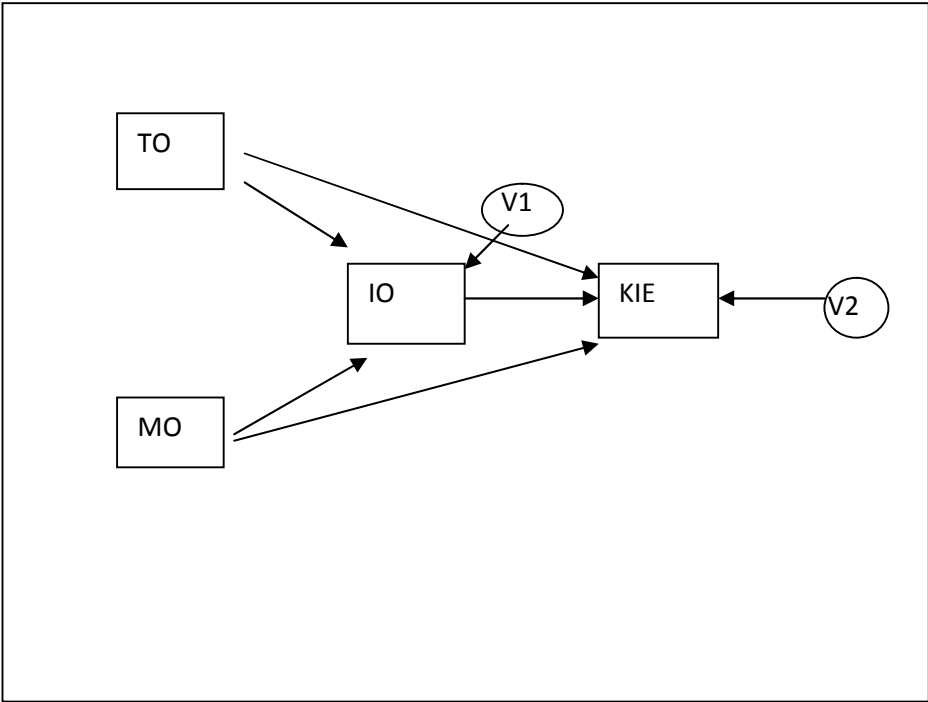


Figure 4. Path diagram for EPIS structural indirect effect Model 6: Causes and effects of KIE and opportunities interaction (IO are endogenous to MO and TO)



The covariance matrix is provided in Table 5. The ratio of the largest to the smallest variance is not greater than 10 confirming that the covariances are not ill-scaled (Kline, 2011: 67). The overall model fit values are presented in Table 7. Unlike traditional models, SEM relies on non-significance. A non-significant difference indicates that the errors are non-significant, lending support to the model (Shook *et al.*, 2004: 400). The chi-square value of 1.090 and its significance value of 0.296 shows that Model 5 has a good fit. In contrast, Model 6 – with a chi-square value of 18.1 and a significance value of 0.000 – has an inferior fit.¹⁸

The most widely reported fit indexes in SEM are: Steiger–Lind root mean square error of approximation (RMSEA; Steiger, 1990), a parsimony-corrected index, with its 90% confidence interval; Jöreskog–Sörbom Goodness of Fit Index (GFI; Jöreskog & Sörbom, 1982), an absolute fit index; and Bentler Comparative Fit Index (CFI; Bentler, 1990), an incremental fit index (Kline, 2011: 204). For Model 5, the value of the RMSEA is 0.059, and the close-fit hypothesis is not rejected ($p = 0.312$) based on the value of the lower bound of the 90% confidence interval, or .000. The covariance matrix predicted by the model in Table 7 explains about 99% of the total variability in the sample covariance matrix (GFI = 0.980) and the relative fit of the model is approximately a 99.9% improvement over that of the independence model fit (CFI = 0.999). Even though we must be cautious in interpreting the chi-square value for Model 6 because of the small sample size, other fit statistics such as RMSEA, GFI and CFI also confirm the inferior fit of Model 6 compared to Model 5.

Table 7. Values of model fit statistics.

	Model 5	Model 6	Saturated model	Independence model
χ^2_M	1.090	18.1	0.000	94.380
A.Number of distinct sample moments	10	10	10	10
B.Number of parameters	9	9	10	4
$df_M = (A-B)$	1	1	0	6
P	0.296	0.000	-	0.000
RMSEA (90%CI)	0.059 (0.000-0.527)	0.811 (0.512-1.157)	-	0.753 (0.623-0.890)
$P_{close-fit Ho}$	0.312	0.000	-	0.000
GFI	0.980	0.800	1.000	0.380
CFI	0.999	0.807	1.000	0.000

We provide the unstandardized and standardized path coefficient estimates for direct, indirect and total effects for Model 5 only in Table 8. Standardized path coefficients are easy to interpret for comparison as they are not restricted by measurement unit. The standardized path coefficients for direct effects are shown in Table 8 and Figure 5. For example, the standardized coefficients for the direct effects of TO and MO on KIE are positive and 0.45 and 0.20, respectively. In other words, a level of TO one full standard deviation above the mean predicts a KIE level of 0.45 standard deviations below the mean. In addition, it is 0.20 for MO, however this direct effect is not statistically significant as it was in the OLS regression (Model 4, Table 6). We explain this by the nature of KIE where technology-led (Schumpeterian) entrepreneurship is more present than market-led (Kirznerian) entrepreneurship.

¹⁸ A chi-square test is the most common fit measure, but it is only recommended with moderate samples (e.g., 100 to 200). With large samples, trivial differences between the two matrices become significant. The test is also suspect when using small samples because some are not distributed as chi-square populations (Shook *et al.*, 2004).

Indirect effects are estimated statistically as the product of direct effects, either standardized or unstandardized and they are also interpreted as path coefficients (Kline, 2011: 164). For example, the standardized indirect effect of IO on KIE through the mediator TO is estimated as the product of the standardized coefficients for the constituent paths, which is 0.78×0.45 , or 0.351 (see Figure 5). The rationale for this derivation is as follows: IO has a certain direct effect on TO (0.78), but only part of this effect (0.45 of it) is transmitted to KIE. The result 0.351 says that the level of positive KIE is expected to increase by about 0.35 standard deviations for every one full standard deviation increase in IO via its prior effect on TO. Similarly, the standardized indirect effect of IO on KIE through the mediator MO is estimated as the product of the standardized coefficients for the constituent paths: $0.81 \times 0.2 = 0.162$ (see Figure 5). The rationale for this derivation is as follows: IO has a certain direct effect on MO (0.81), but only part of this effect (0.20 of it) is transmitted to KIE. The result 0.162 says that the level of positive KIE is expected to increase by about 0.16 standard deviations for every one full standard deviation increase in IO via its prior effect on MO. However, IO has a direct effect on KIE of 0.48 meaning the level of positive KIE is expected to increase by about 0.48 standard deviations for every increase in IO of one full standard deviation.

Total effects are the sum of all direct and indirect effects of one variable on another (Kline, 2011: 166). For example, the standardized total effect of IO on KIE is the sum of the direct effect and its sole indirect effects through TO and MO, or $0.48 + (0.78 \times 0.45) + (0.81 \times 0.20) = 0.48 + 0.351 + 0.162 = 0.993$. Standardized total effects are also interpreted as path coefficients and the value of 0.993 means that increasing IO by one standard deviation increases KIE by almost 1 standard deviation via all presumed direct and indirect causal links between these variables (see Table 9).

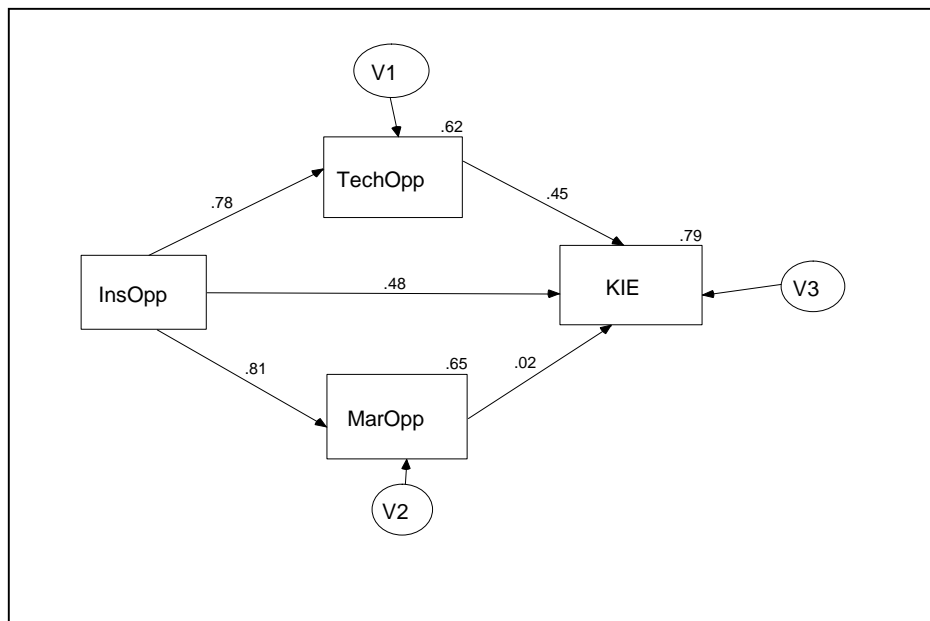
Finally, in Figure 5 the value 0.62 is the squared multiple correlation of TO with IO. Likewise, the squared multiple correlation of MO with IO is 0.65, and KIE with IO, MO and TO – 0.79. The squared multiple correlation of a variable is the proportion of its variance that is accounted for by its predictors. It means that IO, MO, and TO account for 79% of the variance in KIE.

Table 8. Maximum likelihood estimates of direct effects and disturbance variances for interactions in Model 5.

Parameter	Unstandardized	S.E.	Standardized
Direct effects			
IO → TO	0.994***	0.154	0.784
IO → MO	0.778***	0.111	0.808
IO → KIE	0.358**	0.141	0.481
TO → KIE	0.263***	0.085	0.448
MO → KIE	0.012	0.117	0.015
Disturbance variances			
IO	278.868***	77.344	
V1	172.191***	47.757	0.615
V2	89.524***	24.829	0.654
V3	31.970***	8.867	0.792

Note. Standardized estimates for disturbance variances are proportions of unexplained variance.
 *** $p < 0.001$, ** $p < 0.01$.

Figure 5. Output path diagram with standardized coefficients for Model 5.



To summarise, SEM analysis of the EPIS conceptual framework shows that IO and TO have the most direct effects on KIE (0.48 and 0.45 respectively) whereas MO has a less direct effect compared to IO and TO. However, the total effect of IO on KIE including its direct effect and indirect effects via MO and TO adds up to 0.99. This suggests that the institutional framework has substantial influence on the creation of technological and market opportunities to provide a favourable habitat for KIE to flourish.

Table 9. Summary matrix for direct, indirect and total effects for interactions in EPIS indirect effect model.

			Dependent variables		
		Parameter	TO	MO	KIE
Independent variables	IO	Direct	0.78	0.81	0.48
		Indirect	-	-	0.351 via TO 0.162 via MO
		Total	0.78	0.81	0.993
	TO	Direct	-	-	0.45
		Indirect	-	-	-
		Total	-	-	0.45
	MO	Direct	-	-	0.20
		Indirect	-	-	-
		Total	-	-	0.20

5. Conclusions, Limitations and Further Research

This paper has introduced the systemic view of entrepreneurship, provided composite index methodology for its measurement and reported preliminary, exploratory empirical results for testing the model using SEM analysis. Our results reflect a systemic perspective on entrepreneurship as a system of activities which mutually affect entrepreneurial experimentation and generate different entrepreneurial propensities of an IS. We believe this is a useful macro perspective on entrepreneurship, which is complementary to ongoing research still largely rooted within the logic of methodological individualism and the ‘individual – opportunity nexus’.

1. Our results demonstrate that KIE and KIEO reflect levels of development but also types of capitalism. This is *de facto* confirmation of the systemic nature of entrepreneurship which has been empirically tested for the first time in this paper.

2. There is a high correlation between KIE and KIEO which again reflects the systemic nature of entrepreneurship. Both ‘outcomes’ (KIE) and ‘inputs’ (KIEO) are an essential part of the same socio-economic context. Hence, the relationship between KIE and KIEO should not be understood through input – output logic but as different reflections of the same innovation systems. Because SEM statistical technique is able to capture not only direct but also indirect linkages, it is a useful methodology to address systemic aspects of entrepreneurship.

3. Clustering of EU 26 economies and Croatia shows groupings based on a mixture of developmental and varieties of capitalism (VoC) differences. Developmental differences operate as strong drivers of KIE but explain less than 50% of the variation in KIE. The VoC criterion seems quite important in interpreting groupings but it does not seem independent of levels of development and does not operate across the EU East – West divide. Instead, three groups of countries resemble groupings from Europe’s ‘long 19th century’ (historian Eric Hobsbawm’s definition for the period 1789-1914). CEE countries are split across two clusters of the less and medium developed EU groups. The EU cohesion/South countries are firmly part of a cluster with the less developed CEECs, a similar situation to that found in the long 19th century (Berend and Ranki, 1982).

4. A systemic view on entrepreneurship dispels with conventional views on entrepreneurship seen from the perspective of the ‘individual – opportunities nexus.’ For example, from a systemic perspective we do not find big differences between countries in terms of their MO, TO and IO. Countries that are high for one of these opportunities will most likely be classified as high for the other two opportunities.

Overall, countries with more developed EO tend to have higher levels of KIE. However, this positive relationship is not present at lower levels of EO development, which confirms evolutionary views of economic growth as dominated by virtuous and vicious circles and also confirms views on economic growth based on complementarities (see Kremer’s (1993) O-ring theory of development).

5. Countries at the lower levels of KIEOs exhibit absence of positive relationship between EO and KIE and. An analysis of MO as a determinant of KIE gives some seemingly puzzling results. The overall positive relationship between MO and KIE is not significant in a regression model with all three types of opportunities. We explain this by the specific features of KIE: KIE is not ordinary (market led) but rather technology led (Schumpeterian) entrepreneurship.

6. We explored the interactions between different types of opportunities by using SEM methodology. A view by which institutions are endogenous to TO and MO has not been found significant.¹⁹ A model in which IO influence KIE through TO and MO as well as directly, turned out to be robust and a significant reflection of the interaction process. This result confirms the primacy of institutions in economic growth but it also goes against ‘institutional fundamentalism’ and ‘market fundamentalism’ (Rodrik, 2008). It calls for a more nuanced understanding of institutions and how they affect growth *through* technology and markets. In a nutshell, institutions affect entrepreneurship not only directly but especially via technology and markets. We do not discuss here the divergent implications of a systemic view on entrepreneurship compared to the traditional I-O nexus perspective. This would require a separate paper and cannot be treated here.

¹⁹ For an example of this argument in the context of entrepreneurship, see Desai et al. (2010).

Finally, in working on this paper we have identified several issues that merit further research. First, the indicators and framework used largely assume a closed rather than highly globalised IS. It is very difficult to capture the international dimension of TO, MO and IO. Whether value chains are enhancing or diminishing entrepreneurial propensity of IS depends on interactions in an open economy context. Moreover, accounting for this phenomenon remains a challenge. Second, it is also necessary to replicate the analysis at sectoral and regional levels, since opportunities are largely affected by sector and region-specific policies of governments. Third, the choice of indicators is never satisfactory and future work should re-examine the existing portfolio of indicators. We are fully aware of the limitations of composite indicators as well as weaknesses arising from inadequate or poor proxies. Despite these limitations, we believe that a more rigorous conceptual and quantitatively oriented framework is necessary in order to organise qualitative presentations and discussions of the slippery concept of entrepreneurial propensity of innovation systems. In that respect, we see this macro, quantitatively oriented perspective on entrepreneurship as indispensable to more qualitative accounts.

Acknowledgments.

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Appendix A. Explanations for measures.

(i) Index of knowledge intensive entrepreneurship (IKIE)

IKIE = NE + NTI + KI where

NE= new enterprises

NTI = new technology and innovation

KI = knowledge intensity

Key indicators of scale and scope of entrepreneurship are mostly drawn from business demography statistics while entrepreneurial performance is measured by related firm and employment statistics – i.e. start-up rates, business churn, new firm growth rates (by turnover and/or by employee), survival rates (OECD,2010). The OECD/EUROSTAT framework also takes into account the wealth dimension captured by indicators of value added, productivity contribution, innovation and export performance (Ahmad and Hoffman, 2008). For the purposes of this research, not only the absolute new firm creation and growth, but also existing firms' innovativeness and knowledge intensity are factors determining entrepreneurship activities as well as entrepreneurial opportunities.

New enterprises (NE) component aims to capture the rate of creation of new firms in the countries as well as their survival rate. It is composed of four indicators sourced from EUROSTAT Business Demography Indicators for 2007:

- Net entry rate (net business population growth²⁰),
- Five-year old enterprises employment growth rate (number of persons employed in the reference period (t) among enterprises newly born in t-5 having survived to t divided by the number of persons employed in t-5 by the same enterprises, expressed as a percentage growth rate),
- Survival rate 5 (number of enterprises in the reference period (t) newly born in t-5 having survived to t divided by the number of enterprise births in t-5) and
- Five-year old enterprises' share of the business population.

New technology and innovations (NTI) component captures the innovativeness dimension of knowledge intensive entrepreneurship and it is composed of two indicators taken from EUROSTAT Community Innovation Survey for 2006-2008:

- Per cent of innovative enterprises and
- Per cent of innovation expenditures in turnover.

Knowledge intensity (KI) component intends to represent the codified knowledge generated in the countries. It is composed of three indicators drawn from EUROSTAT and World Bank for 2007:

- Patent applications to EPO (per million inhabitant),
- Royalty and license fees receipts as per cent of GDP,
- Knowledge intensive services value added as per cent of GDP.

(ii) Index of knowledge intensive entrepreneurial opportunities (IKIEO)

²⁰ We do not use churning rate but growth rate of new enterprises. Churning rate is not the best indicator in view of the industrial dynamics literature which shows that high entry and exit rates are correlated and not really a sign of industrial dynamics. For example, EU countries have similar churning rates as the USA but rank behind in terms of growth of survivors.

According to our conceptual approach, KIE is the outcome of the interaction of three types of opportunities: technological, market and institutional opportunities each of which are formed by selected input indicators.

$$IKIEO = TO + MO + IO$$

where

TO = technological opportunities

MO = market opportunities

IO = institutional opportunities

(iii) Technological opportunities sub-index (TO)

Technological opportunities lie in the capabilities and skills of enterprises and the population, investments in new knowledge creation and diffusion, and the extent of knowledge linkages. They are essential to entrepreneurship as without them product and process innovations could not be developed. Thus, in this research stocks and flows of knowledge generation and diffusion are used as a proxy for technological opportunities.

TO sub-index of IKIEO is composed of three components: knowledge generation (RND), skills or proxies of competence building (SKILL) and knowledge networks (KNWK). Accordingly:

$$TO = RND + SKILL + KNWK$$

Knowledge generation (RND) intends to capture the knowledge developed by investments in R&D. It is composed of two indicators taken from EUROSTAT for year 2007:

- Relative R&D expenditures in GDP (GERD % GDP) and
- Relative business expenditures for R&D in GDP (BERD %GDP).

Competence building in skills (SKILL) is built on measuring the influence of capabilities embodied in people, i.e. R&D personnel, scientists and the wider population with education, and on creating favourable conditions for TO. It is composed of four indicators drawn from EUROSTAT for years 2007 and 2008 and World Economic Forum (WEF) for year 2009-10:

- R&D personnel (per cent in total employment),
- Per cent of population with tertiary education,
- Quality of scientific research institutions²¹, and
- Availability of scientists and engineers.^{22,23}

Knowledge and value chain networks (KNWK) component signifies the importance of firm-firm interactions and mobility of skilled people whereby knowledge flows take place contributing to innovativeness. It is composed of three indicators taken from EUROSTAT for years 2006-8 for Community Innovation Survey indicator and WEF for year 2009-10:

²¹ The indicator is taken from WEF GCR Q.12.02. How would you assess the quality of scientific research institutions in your country? [1 = very poor; 7 = the best in their field internationally] for 2009–10 weighted average.

²² The indicator 'R&D personnel' is primarily in terms of R&D supply while 'Availability of scientists and engineers' is about degree to which demand is satisfied.

²³ The indicator is taken from WEF GCR Q. 12.06. To what extent are scientists and engineers available in your country? [1 = not at all; 7 = widely available] for 2009–10 weighted average.

- Firms involved in innovation cooperation (per cent in total),
- Job-to-job mobility of HRST (per cent in total employment) and
- Value chain breadth.²⁴

(iv) Market opportunities sub-index (MO)

The role of market opportunities is central to entrepreneurship. The (non)existence and the type of market opportunities may greatly affect the nature of KIE that emerges, and in turn may be greatly influenced by the role of the institutional system in conveying information and creating incentives among similar or identical technological opportunities. Market opportunities can be conceived as real and potential purchasing power of an economy, and reflection of the changing number of potential and existing users for knowledge intensive products and services.

MO sub-index consists of three components: Demand side activities (DEMAND), Financing of innovation processes and other activities (FINANCE), and Market for KIS including provision of consultancy services relative to innovation processes (MKIS). MKIS helps articulate MO and is a market itself (intermediate services). Accordingly:

$$MO = DEMAND + FINANCE + MKIS$$

Demand activities (DEMAND) component aims at measuring quality, growth of internal demand as well as external demand and openness of the economy. It consists of four indicators drawn from the World Bank, EUROSTAT and World Economic Forum for years 2007 and 2009:

- GDP per capita (USD) (as proxy for quality of demand),
- GDP growth (annual per cent) (as proxy for growth of demand),
- Share of trade (exports + imports) in GDP (as proxy of external demand and openness),
- Buyer sophistication as buyer's purchasing decision.²⁵

Financing of innovation and other activities (FINANCE) intends to capture the influence of positive/negative financial opportunities on entrepreneurship. It consists of three indicators taken from the World Bank and EUROSTAT for years 2007 and 2009:

- Domestic credit to private sector (per cent of GDP),
- Stocks traded (per cent in GDP), and
- Venture capital availability.²⁶

Market for knowledge intensive services (MKIS) intends to capture the characteristics of knowledge-intensive manufacturing and services that are potential areas for KIE and consists of three indicators acquired from EUROSTAT for year 2007:

- High-tech sector enterprises (manufacturing & KIS) (per cent in total enterprises),
- High-tech exports (per cent in total exports), and
- Employment in knowledge intensive sectors (per cent in total employment).

²⁴ The indicator is taken from WEFGCR Q.11.05. In your country, do exporting companies have a narrow or broad presence in the value chain? [1 = narrow, primarily involved in individual steps of the value chain (e.g., resource extraction or production); 7 = broad, present across the entire value chain (i.e., do not only produce but also perform product design, marketing sales, logistics, and after-sales services)] for 2009-10 weighted average.

²⁵ The indicator is taken from WEFGCR Q.6.15. In your country, how do buyers make purchasing decisions? [1 = based solely on the lowest price; 7 = based on a sophisticated analysis of performance attributes] for 2009-10 weighted average.

²⁶ The indicator is taken from WEFGCR Q.8.05. In your country, how easy is it for entrepreneurs with innovative but risky projects to find venture capital? [1 = very difficult; 7 = very easy] for 2009-10 weighted average.

(v) Institutional opportunities sub-index (IO)

Institutional opportunities are legal, regulatory, policy, social and cultural factors which can either enable or hinder the development of KIE.

IO sub-index of IKIEO consists of two components: regulatory (REGULATION) and policy support for KIE (SUPPORT). Accordingly:

IO = REGULATION + SUPPORT

Regulatory environment (REGULATION) reflects government regulations aimed at starting up businesses in particular and the legal framework in general, as well as IPR protection . It consists of five indicators drawn from the World Bank and WEF for year 2009:

- Number of procedures required to start a business;²⁷
- Time required to start a business;^{28,29}
- IPR protection;³⁰
- Burden of government regulation;³¹
- Efficiency of legal framework.³²

Public support to incubating and other supporting activities (SUPPORT) intends to signify the extent of public support in the form of cluster formation and presenting opportunities for firms in public tenders as well as firms' perceptions and interests in such issues. It consists of four indicators taken from WEF and EC Innobarometer for years 2009:

- State of cluster development;³³
- Declared clustered membership among enterprises in cluster-like environment (per cent);
- Interest in public procurement (per cent firms in total);
- Opportunity to sell innovations on public tenders (per cent of enterprises with direct experience of public tenders).

²⁷ The indicator is taken from WEF GCR Q.6.05.

²⁸ The indicator is taken from WEF GCR Q. 6.07.

²⁹ The values for indicators 'Number of procedures required to start a business' and 'Time required to start a business' are transformed by taking their difference from 100 (100-X) in order to reverse their expected impact on the index from negative to positive.

³⁰ The indicator is taken from WEF GCR Q.1.02. How would you rate intellectual property protection, including anti-counterfeiting measures, in your country? [1 = very weak; 7 = very strong]

³¹ The indicator is taken from WEF GCR Q.1.09. How burdensome is it for businesses in your country to comply with governmental administrative requirements (e.g., permits, regulations, reporting)? [1 = extremely burdensome; 7 = not burdensome at all]

³² The indicator is taken from WEF GCR Q.1.11. How efficient is the legal framework in your country for private businesses in challenging the legality of government actions and/or regulations? [1 = extremely inefficient; 7 = highly efficient]

³³ The indicator is taken from WEF GCR Q.11.03. In your country's economy, how prevalent are well-developed and deep clusters? [1 = nonexistent; 7 = widespread in many fields]

Appendix B. Confirmatory Factor Analysis Results.

Index	Sub-index	Component	Quantitative Indicators	Factor component	Factor loadings	KMO	Bartlett's sphericity sig.
Index of Knowledge Intensive Entrepreneurship KIE = NE + NTI + KI		New enterprises (NE)	1.Net entry rate 2.Five-year old enterprises employment growth rate	2	0.85 0.78	0.585	0.001
		New enterprises (NE)	3.Survival rate 5 4.Five-year old enterprises' share of the business population	3	0.74 0.88		
		New technology and innovations (NTI)	5.% of innovative enterprises 6.% of innovation expenditures in turnover	1	0.64 0.58		
		Knowledge intensity (KI)	7. EPO patent applications (per M inhabitant) 8.Royalty and license fees receipts (% of GDP) 9.Knowledge intensive services value added (% of GDP)	1	0.91 0.83 0.68		
Index of Knowledge Intensive Entrepreneurial Opportunities KIEO = TO + MO + IO	Technological Opportunities TO = RND + SKILL + KNWK	Knowledge development and diffusion (RND)	10.GERD % GDP 11.BERD %GDP	1	0.96 0.96	0.832	0.000
		Competence building in skills (SKILL)	12.R&D personnel (% in total employment) 13.% of population with tertiary education 14. Quality of scientific research institutions 15.Availability of scientists and engineers	1	0.80 0.82 0.80 0.79		
		Knowledge and value chain networks I (KNWK)	16.Firms involved in innovation cooperation (% in total) 17.Job-to-job mobility of HRST (% in total employment)	2	0.81 0.79		
		Knowledge and value chain networks (KNWK)	18.Value chain breadth	1	0.88		
	Market Opportunities MO = DEMAND + FINANCE + MKIS	Demand side activities (DEMAND)	19.GDP per capita (USD) 20.GDP growth (annual %) 21.Share of trade(X+M) in GDP 22. Buyer sophistication: buyer's purchasing decision	1	0.90 -0.30 0.60 0.80	0.726	0.000
		Financing of innovation processes and other activities (FINANCE)	23.Domestic credit to private sector (% of GDP) 24.Stocks traded (% in GDP) 25. Venture capital availability	1	0.60 0.31 0.74		
		Market for knowledge intensive services (MKIS)	26.High-tech sector enterprises (manufacturing & KIS) (% in total enterprises) 27.High-tech exports (% of total X) 28.Employment in high tech manufacturing and knowledge intensive sectors (% in total employment)	1	0.68 0.88 0.76		
	Institutional Opportunities IO = REGULATION + SUPPORT	Regulatory environment (REGULATION)	29. Number of procedures required to start a business(Q. 6.06) 30. Time required to start a business (Q. 6.07)	2	0.78 0.85	0.631	0.000
		Regulatory environment (REGULATION)	31. IPR protection(Q. 1.02) 32. Burden of government regulation (Q. 1.09) 33. Efficiency of legal framework (Q. 1.11)	1	0.94 0.50 0.93		
		Public support to incubating &other supporting activities (SUPPORT)	34. State of cluster development (Q. 11.03) 35. Declared clustered membership among enterprises in cluster-like environment (%)	1	0.88 0.25		
		Public support to incubating &other supporting activities (SUPPORT)	36.Interest in public procurement (% firms in total) 37.Firms with opportunity to sell innovations on public tenders (% in enterprises with direct experience with public tenders)	3 4	0.88 0.85		

