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Lessons and Policy Implications for the EU

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Characteristics of Dynamic Regions in the World Economy: Defining Knowledge-Driven Economic Dynamism

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1. Introduction

Economic development is and always has been knowledge-based. However, the role and significance of knowledge to economic processes has fundamentally changed over the last years. On these grounds there have been many scholars who argued that a new, knowledge-based, economy has emerged presenting significant opportunities for economic and social development.

This paper builds upon the concept of knowledge economy to define knowledge-driven economic dynamism and to provide a methodology for assessing it. In particular, it argues that conventional measures of economic performance are not capable of capturing the qualities of the knowledge economy and, on these grounds it introduces an appropriate measure of knowledge-driven economic dynamism called Economic Dynamism Indicator (EDI).

The paper is structured as follows. The next section discusses the emergence of the knowledge economy and outlines its qualities. This provides the bases for the development of an appropriate conceptual framework in Section 3 that enables to define knowledge-driven economic dynamism and to specify its dimensions. This is followed by an overview of the existing measures of knowledge-based economy. The fifth Section considers some key methodological issues in the construction of composite indicators before it embarks to operationalise the concept of knowledge-driven economic dynamism by developing the Economic Dynamism Indicator. Last, the final section concludes the paper summarising the key findings.

2. The emerging knowledge-economy paradigm

The idea that knowledge plays an important role in the economy is not new. All economic activity rests on some form of knowledge, and all economies, however simple, are based on knowledge (Smith, 2002). However, the degree of incorporation of information and knowledge into economic processes is today so great that causes substantial structural changes in the way economy operates and is organised (Brinkley 2006). It that sense, new rules, practises and institutions come to light, declaring the emergence of a new economic structure, that of the knowledge economy.

Three major shifts in the understanding of the changing role of knowledge and its links to the economy have been identified (Soete, 2006). At the first, emphasis is placed on knowledge as a commodity (Drucker, 1998; OECD, 1999). It has been asserted that knowledge is not an external, 'black-box' factor, but instead is internal to the economic system and therefore economic principles can be applied to its production and exchange. Moreover, knowledge can be produced and used in the development of goods (or even of itself), which means that it is an input in the production process. Like all goods, knowledge may be subject to depreciation and obsolescence. This is the case when people do not any longer use certain knowledge, or when new knowledge is created superseding previous one and render it worthless.

However, knowledge differs from traditional commodities on a number of points (and these differences have crucial implications for the way knowledge economy should be organised). First, it does not have a physical appearance, though it is embedded in some specific blueprint form (such as a patent, an artefact, a composition, a manuscript or a computer programme), in human beings and in organisations (Soete, 2006). Second, knowledge is non-rival, i.e. their consumption by one person does not preclude simultaneous consumption by others, and also non-excludable, that is, once discovered and made public no one can be excluded from consuming it or enjoying its benefits. Third, knowledge is not depleted by use; its consumption does not diminish in any way the amount available. In fact, the more people they use it, the greater the social return and its value become (Houghton and Sheehan, 2000). As a result positive externalities arise.

The second shift highlights the role information and communication technologies (ICTs) play in the creation and transferability of knowledge (Lundvall and Foray, 1996; Houghton and Sheehan, 2000). ITCs have advanced the storage, speed, manipulation and interpretation of information, which enabled the codification of knowledge and made it much more accessible than before to all sectors and agents in the economy. It that sense knowledge has become globally available at low cost. For technologically leading countries or firms this "…implies increasing erosion of monopoly rents associated with innovation and shortening of product life cycles" (Soete, 2006: 15).

The final shift has to do with the innovation processes. David and Foray (2002) have argued that, today, innovative capacity is related to great extent to the ability to both systematically combine and make new uses of existing knowledge, rather than discovering new technological principles. Thus, it is not the development of new knowledge that plays a significant role in the economic processes but its anew combination and reorganisation. This process is referred to as 'innovation without research' (Soete, 2006) and requires systematic access to state-of-the-art technologies and the establishment of procedures for the dissemination of the information.

3. A framework for knowledge-driven economic dynamism

With generation and exploitation of knowledge at the centre of the economic processes, an economy it transformed into a knowledge economy. Such an economy effectively acquires, creates, disseminates and uses knowledge as the main engine for long-tern economic growth. In a sense, knowledge becomes its prime source of competitive advantage. On the bases of this, we define knowledge-driven economic dynamism as the potential an area has for generating and maintaining high rates of economic performance due to its knowledge capacity.

Chen and Dahlman (2005) indicate that a successful knowledge economy involves ingredients such as long-term investments in education, sufficient innovation capacity, adequate information infrastructure and an advantageous economic environment. On these grounds we argue that knowledge-driven economic dynamism embodies four building elements. These are:

1. Human capital
2. Innovation ability
3. Information access
4. Economic performance

Human capital refers to a well educated and skilled workforce. Such a labour base is essential to the creation, acquisition, distribution and utilisation of relevant knowledge, which enhances total factor productivity and economic growth. Basic education is essential because it improves peoples' capacity to learn and to use information. Higher education is also important since it is associated with both production of new knowledge and efficient adaptation and innovative use of established one. Moreover, an educated population tends to be technologically sophisticated. This gives rise to local quality-sensitive demand for advanced goods, encouraging local firms to innovate and develop technologically sophisticated products and production techniques.

There are a large number of studies which has found evidence suggesting that human capital is a key determinant of economic dynamism. Barro (1991) showed a significant positive association between real GDP per capita growth and education (proxied by school-enrolment rates) for 98 countries in the period 1960-1985. Mankiw *et al* (1992) and Brunetti *et al* (1998) provided similar findings. Interestingly, Barro and Sala-i-Marin (1995) found that higher education has the largest effect on growth compared to both secondary and primary schooling. More recently, Hanushek and Kimko (2000), measuring the quality of education with tests of mathematics and scientific skills for a sample of 31 countries, reaffirmed the significant and positive link between education and growth.

Innovation ability refers to the development of an effective innovation system of firms, research centres and other relevant organisations and institutions, that nurtures research and development (R&D) which results in new goods, new processes and new knowledge. Such a system is expected to sustain the knowledge economy not only by producing new knowledge, but also by drawing on the growing stock of global knowledge and assimilating it to local needs.

There have been a number of studies exploring the role innovation and R&D play in economic progress. For example, Fagerberg (1987) examining 25 industrial countries for the period 1960-1983 reported a close correlation between economic growth and technological development (measured by R&D and patent statistics). Lichtenberg (1992), using a sample of 74 countries, reaffirmed this strong link. So did Ulku (2004), who used panel-data techniques to examine the relation between R&D, innovation and growth for two groups of countries, developed and developing.

Information access has to do with the usage of information and communication technologies (ICTs). With relatively low usage costs and the ability to overcome distances, ICTs have revolutionised the transmission of information around the globe. The provision of a modern and adequate such infrastructure is deemed to facilitate the

effective communication, distribution, assimilation and development of ideas and knowledge.

ICTs is an essential ingredient of knowledge-based dynamism. Over the last years there have been a few studies exploring the links between ICT and economic growth. Thus, Schreyer (2000) has argued that ICT producing sectors induce large gains in total factor productivity at the level of the economy, whereas Oliner and Sichel (2000) and Whelan (2000) provided evidence that ICT usage increases productivity and contributes to economic growth.

The final element of the knowledge-driven economic dynamism, but by no means the least, is economic performance. The idea behind this is that exiting economic conditions affect to a great extent the ability of an economy to generate and exploit knowledge as a key engine of economic growth. Put it differently, initial economic conditions determine the qualities and dynamics of a knowledge-based economy in a self-sustained way. On these grounds, a positive relation is envisaged: a weak economic basis is seen as a hindrance (and a robust economy as a supporter) to knowledge-driven economic dynamism.

The relation between past economic performance and current economic growth is well explored in the literature, and particularly in studies examining the issue of economic convergence/divergence (see for instance Kormendi and Meguire, 1985; Baumol, 1986; Grier and Tullock, 1989; Barro, 1991; Barro and Sala-i-Martin, 1995; Fagerberg and Verspagen, 1996; Sala-i-Martin, 1996). This research has made clear that initial economic conditions do matter for economic growth.

Concluding this section it should be emphasised that all four constructive elements just examined are important for knowledge-driven economic dynamism are necessary for sustained creation, adoption, adaptation and use of knowledge in domestic economic production, which will consequently result in higher value added goods and services.

This would tend to increase the probability of economic success, and hence economic development, in the current highly competitive and globalised world economy.

4. Existing measures of the knowledge-based economy

There are literally hundreds of indicators and composite indices that have been developed throughout the world to assess economic (or socioeconomic) conditions at supranational, national, or local levels[1] (Sharpe, 2004). Those discussed in this section are composite indices which are either widely known and used, or related specifically to the knowledge economy.

The real GDP[2] *per capita* of an economy is the most widely used measure of economic performance. Accordingly, the rate of change in real GDP, commonly known as economic growth, is taken as a measure of economic change and, as such, constitutes a measure of economic dynamism. Although this approach has certain advantages, stemming from the fact that GDP is measured frequently, widely (worldwide coverage) and consistently, scholars have criticized its applicability as an indicator of economic health for a number of reasons (see Cobb *et al*, 1995; Hamilton, 1998; Rowe and Silverstein, 1999; Vaury, 2003; Bergheim, 2006). In the current context, GDP is deemed as a rather limited measure of the knowledge-driven economic dynamism for two reasons. Firstly, it does not take into account positive externalities that may arise from education or knowledge development. Secondly, since it only counts monetary transactions, it misses other knowledge building activities that take place outside of the market system (such as tacit knowledge).

[1] For surveys on this literature see Booysen (2002), Freudenberg (2003), Gadrey and Jany-Catrice (2003), Share (2004) and Saisana *et al* (2005).

[2] Simply put, the GDP is the total value of all products and services bought and sold. It consists of consumption expenditures made by households, domestic investment, government purchases, and net exports.

Some economists (Cobb *et al*, 1995; Rowe and Silverstein, 1999; Lawn, 2003) have created an alternative to GDP called Genuine Progress Indicator (GPI), which attempts to resolve many of the problems addressed to former. The GPI basically consists of two blocks of measures: one for the current economic state (assessed using indicators of consumer spending, government payments, non-market production and leisure) and the other for the sustainability of economic development (assessed using indicators of depletion of resources, environmental damage, etc). Although it represents a much broader indicator of economic health, it does not take into account the knowledge dimensions of the economy; let alone the "… numerous technical difficulties" it encounters (Vaury, 2003: 3).

Indicators related particularly to the knowledge economy are limited. A set of two composite indicators attempting to capture the complex multidimensional nature of knowledge-based economy comes from the European Commission's Structural Indicators exercise (see Saisana *et al*, 2005). The first indicator addresses crucial dimensions of investment in the knowledge-based economy (using measures such as R&D expenditure, number of researchers, etc), whereas the second assesses countries' performance in the transition to the knowledge-based economy (though patents and scientific publications produced). Both indicators are extremely relevant to the current research but they cover only EU-15 countries.

A particular aspect of the knowledge-based economy is innovation. Three relevant composite indices are generally acknowledged in the literature. The fist, developed by Porter and Stern (1999), is the Innovation Index which provides a quantitative benchmark of national innovative capacity for 17 OECD countries, using eight sub-indicators (including R&D expenditure and employment, expenditure on education, strength of protection of intellectual property, etc). The other is the Summary Innovation Index (SII) which is part of the European Innovation Scoreboard. SII utilises official EUROSTAT data to measure innovation capacity of the EU-25 countries. To do this it analyses 20 variables in four areas: human resources, knowledge creation, transmission and application of new knowledge and innovation finance, output and markets. The last index

in this group is the Index of Innovation Performance (IIP), provided by Freudenberg (2003) to measure innovative performance in 26 countries. IIP utilises variables in three areas: generation of new knowledge (measured by R&D performance, GDP expenditure on research, PhD holdings, etc), industry/science linkages (measured by paper publications, patents, etc) and industrial innovation (measured by the number of researchers, number of firms introducing new knowledge, etc).

Another group of composite indicators places emphasis on countries' technological advancement. The Technological Achievement Index (TAI) is designed to capture the performance in creating and diffusing technology. The index uses data from eight indicators grouped in four dimensions: technology creation (as measured by the number of patents and license granted), diffusion of recent innovations (as measured by, *inter alia*, the number of Internet hosts), diffusion of old innovations (as measured by telephones and electricity consumption) and human skills (as measured by mean years of schooling and the gross tertiary science enrolment ratio). Another composite indicator, the General Indicator of Science and Technology (GIST), is provided by the National Institute of Science and Technology Policy of Japan (1995) to grasp major trends in Japan's Science and Technology activities and to enable comprehensive international comparisons and time-series analysis. GIST consists of thirteen variables, five of which are classified as 'input' (e.g. R&D expenditure, science degrees conferred, etc) and eight as 'output' (e.g. scientific papers, paper citations, patents, technology exports, etc).

4. Operationalising knowledge-based economic dynamism: the Economic Dynamism Indicator

Having developed a framework for understanding knowledge-based economic dynamism, this section attempts to operationalise the concept providing an adequate measure. Before getting there, we briefly consider some methodological issues in the construction of composite indicators.

4.2. Methodological considerations towards the development of composite indicators

Composite indicators are increasingly recognised as useful tools in analysis and public communication. This is because they are able to capture and describe complex concepts (e.g. sustainability, competitiveness, knowledge-based economy, etc) with a simple measure that can be used to benchmark performance and to assist comparisons (both between places and across time). However, they may send misleading policy messages if they are poorly constructed or misinterpreted. The main advantages and disadvantages of using composite indicators are presented in Table 1 below.

Table 1: Pros and Cons of Composite Indicators

Pros	**Cons**
Can summarise complex or multi-dimensional issues in view of supporting decision-makers.	May send misleading policy messages if they are poorly constructed or misinterpreted.
Easier to interpret than trying to find a trend in many separate indicators.	May invite simplistic policy conclusions.
Facilitate the task of ranking countries on complex issues in a benchmarking exercise.	May be misused, e.g., to support a desired policy, if the construction process is not transparent and lacks sound statistical or conceptual principles
Can assess progress of countries over time on complex issues.	The selection of indicators and weights could be the target of political challenge
Reduce the size of a set of indicators or include more information within the existing size limit.	May disguise serious failings in some dimensions and increase the difficulty of identifying proper remedial action
Place issues of country performance and progress at the centre of the policy arena.	May lead to inappropriate policies if dimensions of performance that are difficult to measure are ignored.
Facilitate communication with general public (i.e. citizens, media, etc.) and promote accountability.	

Source: Saisana and Tarantola (2002)

For all these merits and demerits composite indicators do stir controversy. Yet, over the last years we have seen a proliferation in their use in various policy domains. Reviewing the literature (e.g. Booysen, 2002; Freudenberg, 2003) it becomes evident that there is no commonly accepted methodology on constructing composite indicators. This is due to "… the intrinsic 'vagueness' or ambiguity of composite indicators" (Saisana *et al*, 2005: 2). However, there have been some serious attempts to provide guidelines and directions

towards development of good quality composite indicators (see, for instance, Saisana and Tarantola, 2002; Booysen, 2002; Freudenberg, 2003; Saltelli *et al*, 2004; Saisana *et al*, 2005; Nardo *et al*, 2005). Succinctly, composite indexing involves five steps:

1. Developing a theoretical framework.
2. Identifying and selecting the relevant variables.
3. Standardising variables to allow aggregation.
4. Weighting variables and aggregation.
5. Validating the composite indicator.

It is important to note that this process should not necessarily be seen as a sequential one and in many occasions these steps are taken concurrently (Booysen, 2002).

Theoretical framework

Since a composite indicator is in essence a summary of a phenomenon, the starting point for indexing should be the adoption of a theoretical framework that enables understanding of the phenomenon under study. Ideally, this framework should provide a clear definition of what it is that is being measured and indicate what kind of individual measures should be sought and weighted in a manner that reflects the dimensions of the concept under study.

Variables selection

A composite indicator is the sum of its parts. As such, its quality depends largely on the quality of its constituent variables. Ideally, variables should be selected on the basis of their analytical soundness, measurability and relevance to the phenomenon under indexation, and not exclusively on the availability of data series. In practise, however, the lack of required data is the norm. Statistics may be not available either because a certain phenomenon cannot be measured or just because nobody has attempted to measure it. Proxy measures can be used in this case; a solution which should be adopted even when problems of cross-country comparability arise (Nardo *et al*, 2005).

Because there is no single definitive set of indicators for any given purpose, the choice of which variables should be selected in the indicator remains an inherently subjective exercise. Different variables can be selected to monitor progress in the same performance or policy area. Selection, however, requires a balance between simplification and complication which arises as a result of the tendency to keep on adding variables and components (Booysen, 2002). Although capturing the full essence of the phenomenon under measure is significant, simplicity should be not undervalued. Finally, to have an objective comparison across countries of different size, scaling variables by an appropriate size measure (e.g. population, income, land area, etc) is required.

Standardisation

Since all variables are not measured in the same units or scales, they need to be put into a common basis to avoid problems of mixing different measurement units (avoid adding 'apples' with 'oranges'). This is known as standardisation or normalisation process. There are many techniques that can be used in this respect. Commonly used methods include[3]:

1. Standard deviation from the mean, which imposes a standard normal distribution (i.e. a mean of zero and a standard deviation of one). Thus, positive (negative) values for a given country indicate above (below)-average performance.
2. Distance from the group leader, which assigns 100 to the leading country and other countries are ranked as percentage points away from the leader.
3. Distance from the mean, where the mean value is given 100, and countries receive scores depending on their distance from the mean.
4. Distance from the best and worst performers, where positioning is in relation to the sample's maximum and minimum and the index takes values between zero (laggard) and a hundred (leader)

[3] Details of each method can be found in Booysen (2002), Freudenberg (2003), Saisana *et al* (2005) and Nardo *et al* (2005).

5. Categorical scale, where each variable is assigned a score (either numerical or qualitative in ordinal scale) depending on whether its value is above or below a given threshold.

Each method has its advantages and disadvantages. Different, however, methods will produce different results. The selection, therefore, of the appropriate method is not trivial and requires special attention. It should take into account the properties of data and the objectives of the composite indicator. Booysen (2002) argues that the most important criterion in selecting a scaling technique is to achieve a balance between the width of the range and the spread of index scores.

Weighting

Variables that are used for the construction of a composite indicator have to be weighted to reflect the significance, reliability or other characteristics of the underlying data. The weights that are given to different variables may substantial alter the outcomes of the composite indicator. For this reason, weights ideally should reflect the underlying theoretical framework adopted. However, it is sometimes quite difficult to provide weights based on theoretical grounds. As such, the most common practice is to give equal weights to all variables used, largely for reasons of simplicity. This implies, however, that all indicators in the composite have equal importance, which may not be the case.

Another way to identify appropriate weights is through empirical analysis, particularly using methods based on correlations among the variables used (e.g. regression analysis, principal components analysis, factor analysis etc; for details see Saisana *et al*, 2005). However, it is not certain that the correlations will correspond to the real-world links between the phenomena being measured (Freudenberg, 2003). Alternatively, weights can be established in co-operation with various stakeholders (e.g. experts, policy makers, etc) on the condition that they understand the strengths, weaknesses and particularities of the data within a given theoretical framework. Yet, another approach is to attach weights in

accordance to the quality and availability of data; an attempt that partially corrects for data problems.

Since different weighting techniques can produce quite different results, no weighting approach is above criticism. It is for this reason that Babbie (1995) argues that equal weighting should be the norm. Booysen (2002) seems to embrace such a view on the basis of simplicity in terms of composite construction and interpretation.

Validation

As seen, several judgements are made with regard to selecting, weighting, standardising and aggregating variables into a composite indicator. Outcomes may depend largely on the approach selected. For this reason, sensitivity tests should be conducted to analyse the impact of including or excluding various variables, changing weights, using different standardisation techniques, etc, on the results of the composite indicator. A combination of uncertainty and sensitivity analyses can be used to assess the robustness of the composite indicator and to improve quality. Uncertainty analysis examines how uncertainty in the input factors propagates through the structure of the composite indicator and affects its values, whereas sensitivity analysis evaluates the contribution of the individual source of uncertainty to the output variance.

Composite indicators usually measure phenomena that are linked to well-known and measurable concepts (e.g. economic growth). These links can be used to test the explanatory power of a composite. Simple cross-plots provide a good means to illustrate such links. Correlation analysis is equally useful for validation, where high correlation indicates a composite indicator of high quality.

4.3. The Economic Dynamism Indicator

Having examined some key methodological issues in the construction of composite indicators, the paper now turns to formulate such an indicator that measures knowledge-driven economic dynamism called Economic Dynamism Indicator (EDI).

As discussed, the first step in the construction of any indicator is to specify an appropriate theoretical framework which clearly defines the phenomenon to be measured and outlines its dimensions. This framework has been elaborated in Section 2. On the bases of this, knowledge-driven economic dynamism has been defined as the potential an area has for generating and maintaining high rates of economic performance due to its knowledge capacity. Four fundamental dimensions of the concept had been identified: human capital, innovation ability, information access and last, but not least, economic performance. These four dimensions constitute the four components of the EDI.

The next step is to select appropriate variables that reflect the four components just described. The goal of the EDI is to provide a current assessment of economic dynamism for all countries in the globe. In order to ensure data consistency, we decided to obtain data from one, but reliable, source, that is the World Bank. On these grounds the variables that have been selected to reflect EDI's components are:

Human capital

EDU: Gross enrollment ratio in tertiary education

LIT: Literacy rate as a percentage of adult population

Innovation ability

RD: R&D expenditure as a percentage of GDP

RE: Researchers in R&D per million inhabitants

PT: Patents per million inhabitants

Information access

W: Internet users per thousand inhabitants

Economic performance

Y: Real GDP per capita in PPP (constant at 2000, measured in international dollars)

g: Real GDP per capita annual growth (PPP, constant at 2000, international dollars)

These variables were selected because internationally comparable data were available for a large number of countries. However, there were quite a lot of missing values. In order to improve the geographical coverage and reliability of data, instead of the value of the last year, we used the average of the last four years available for each country. This has also a 'smoothing' effect on the data (since it reduced the influence of extreme values) improving their quality and reliability. The following table indicates the coverage of the variables finally achieved.

Table 2: Indicators used and sample size

Variables (x_i)	No of countries with available data	Year of available data
EDU	104	1991, 2000-2004
LIT	104	1990, 1995, 1999
RD	101	1996-2004
RE	87	1996-2004
PT	116	1990-2004
W	197	1995-2004
Y	171	1990-2004
g	171	1990-2004

The variables selected for the EDI are expressed in various units (e.g. the RD is a percentage of GDP, the PT are patents per million people). The 'minimum-maximum' method is used here to normalize or standardize the variables. This method transforms actual values into a number that ranges between 0 (laggard with minimum value) and 1 (leader with maximum value). For a given country, the index expresses their distance from the overall best and the worst performing countries:

$$SV = \frac{x_i - x_{\min}}{x_{\max} - x_{\min}},$$

where SV is the standardised value, x_i is the actual value, x_{max} is the maximum value and x_{min} is the minimum value.

The normalisation method does not affect the country rankings for individual indicators (since any normalisation method is just a simple transformation of the initial values). In

contrast, it can affect the overall findings of a composite indicator, since individual indicators are not only normalised, but also aggregated into a composite.

Whereas the influence of the standardisation method on the results of composite indicators seems limited, the weights attached to individual indicators in contrast strongly influence the overall index. The weighting used in this study reflects the idea that knowledge-driven economic dynamism is a result of economic and knowledge characteristics. Or to put it differently it is the compound effect of a 'hard economic' dynamism and a 'soft' dynamism stemming from the knowledge elements of the economy. However, there is an important asymmetry here: knowledge economy is a recent phenomenon whereas conventional economic dynamics have shaped a country's development path for a much longer time. On these grounds, we assert that knowledge-driven economic dynamism should primarily reflect current economic performance which has to be adjusted for the knowledge characteristics of the economy. These four knowledge dimensions of dynamism are given equal weight.

On the basis of the above, the formula for calculating the EDI is as follows:

$$\mathrm{EDI} = \mathrm{EP} * \left(1 + SV \sum_{i=1}^{n} SVx_{\mathrm{i}} \right), \qquad (1)$$

where x_i is the actual value of the sub-indicator i, SV is its standardised value and EP is a measure of economic performance.

Before we move to unveil the different forms of the EDI, it is necessary to make an important note here. As it might have been noticed, economic performance refers to the whole first part of the product in the equation presented above (EP), and also constitutes an element of its second part (x_i). This is because two different aspects of the economy are taken into account: the one regards the economic conditions which are currently exhibited in a country and the other points to the subsequent effects of past economic dynamism or economic growth (i.e. the momentum of the past performance). Accordingly, two forms of the EDI can be envisaged, one (described by equation 2.a) which places higher value on the growth dynamics of the economy (i.e. g is the fist part

of the product of the equation), and the other (described by equation 2.b) which gives emphasis on the current economic performance.

$$\mathrm{EDI}_{\mathrm{a}} = \mathrm{g} * \left(1 + SV \sum_{i=1}^{n} SV(Y, x_{\mathrm{i}})\right) \qquad (2.a)$$

$$\mathrm{EDI}_{\mathrm{b}} = \mathrm{Y} * \left(1 + SV \sum_{i=1}^{n} SV(g, x_{\mathrm{i}})\right) \qquad (2.b)$$

The combination of different variables gives eleven EDI's for each one of the EDI forms. Table 3 below presents their descriptive statistics. As can be seen, correlations between the EDIs and conventional measures of economic dynamism (i.e. Y and g) are quite high, which is an indication of the high quality of the EDIs. However, the quality of the indicators, in terms of the number of countries that data are available, reduces with the number of variables added. Thus, the EDI which combines all the variables that the theory has addressed maintains with only 40 observations; which means that only 40 countries (of the 218 in the world) avail data on all the variables used. As a result, this indicator, though valuable, provides a limited picture of the phenomenon – more than 80% of the countries have no value.

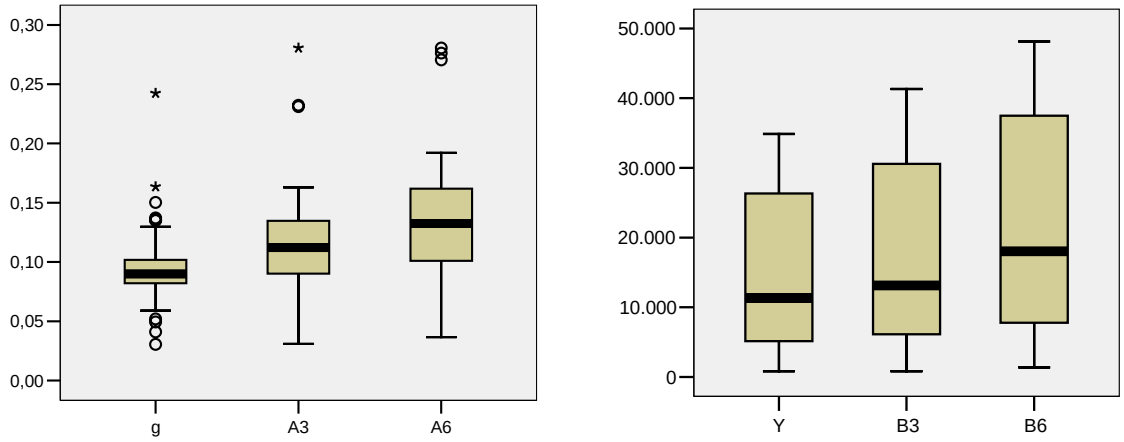
However, the situation improves significantly when two EDI facets are considered. The first concerns indicators A6 and B6, which give emphasis on human capital and retain the highest number of observations (120). The second concerns indicators A3 and B3 which stress the innovation aspect of EDI and provides observations for 91 countries. We decide to focus on these four EDIs (which highlight different but complementary sides of the knowledge-driven economic dynamism) and to explore further their qualities.

Table 3: Descriptive statistics of the developed EDIs

EDI's form	EDI	x_i	N	max	min	variance	standard deviation	mean	CV	correlation with Y	correlation with g
	Y		171	59880,27	568,25	99092573,7	9954,52	9469,33	105,12%		
	g		171	1,476	0,030	0,012	0,111	0,102	109,12%		
g(1+SVΣSVx)	A1	Y,RD,RE,PT,EDU,W,LIT	40	0,2663	0,0627	0,0015	0,0389	0,1302	29,89%		0,56
	A2	Y,RD,RE,PT	70	0,2778	0,0593	0,0017	0,0410	0,1246	32,90%		0,61
	A3	Y,RD,PT	91	0,2806	0,0310	0,0016	0,0403	0,1163	34,63%		0,60
	A4	Y,RD	99	0,2985	0,0307	0,0020	0,0448	0,1237	36,18%		0,68
	A5	Y,EDU,W,LIT	82	0,2626	0,0398	0,0015	0,0391	0,1240	31,51%		0,56
	A6	Y,EDU,W	120	0,2806	0,0366	0,0020	0,0452	0,1219	37,05%		0,64
	A7	Y,RD,RE,PT,EDU,W	61	0,2784	0,0589	0,0018	0,0422	0,1334	31,62%		0,55
	A8	Y,RD,PT,EDU,W,LIT	54	0,2672	0,0482	0,0015	0,0391	0,1266	30,86%		0,53
	A9	Y,RD,PT,EDU,W	80	0,2800	0,0342	0,0019	0,0433	0,1261	34,30%		0,59
	A10	Y,RD,EDU,W,LIT	55	0,2673	0,0483	0,0015	0,0389	0,1268	30,65%		0,53
	A11	Y,RD,EDU,W	83	0,2839	0,0344	0,0019	0,0431	0,1278	33,73%		0,61
Y(1+SVΣSVx)	B1	g,RD,RE,PT,EDU,W,LIT	40	61777,84	847,66	328152237,83	18114,97	19775,39	91,60%	0,99	
	B2	g,RD,RE,PT	71	85281,49	793,77	321925697,16	17942,29	20088,37	89,32%	0,98	
	B3	g,RD,PT	89	76445,78	797,82	252036544,53	15875,66	16395,49	96,83%	0,98	
	B4	g,RD	97	84712,56	803,62	282796113,96	16816,54	16816,06	100,00%	0,98	
	B5	g,EDU,W,LIT	82	66163,37	621,95	258232326,99	16069,61	13155,13	122,15%	0,99	
	B6	g,EDU,W	120	64892,07	569,04	277461421,35	16657,17	14303,26	116,46%	0,99	
	B7	g,RD,RE,PT,EDU,W	61	63909,55	789,67	337174796,03	18362,32	22127,87	82,98%	0,98	
	B8	g,RD,PT,EDU,W,LIT	54	61288,52	867,15	285882491,61	16908,06	16178,26	104,51%	0,99	
	B9	g,RD,PT,EDU,W	79	62458,00	789,67	302702571,63	17398,35	18448,63	94,31%	0,99	
	B10	g,RD,EDU,W,LIT	55	61249,24	870,53	284381197,84	16863,61	15948,36	105,74%	0,99	
	B11	g,RD,EDU,W	82	64311,94	789,67	317832111,58	17827,85	18603,47	95,83%	0,99	

Figure 1 below presents the boxplots of the four EDIs. These are seen in comparison to the conventional measures of economic dynamism to which they are linked (i.e. A3 and A6 are related to g, and B3 and B6 are related to Y). As can be observed, the new composite indicators show a greater dispersion, compared to g and Y, and on these grounds we can argue that the former are able to magnify and highlight the differences between countries

Figure 1: Boxplots of EDIs



The same is also evident when we plot the one indicator against the other (see Figures 2a, 2b). What becomes clear is that the higher the conventional measure (Y or g) the greater the dispersion of the EDI is, indicating the ability to EDI to provide better assessments of the phenomenon under study.

Figure 2a: Plotting EDIs against conventional measures of economic dynamism

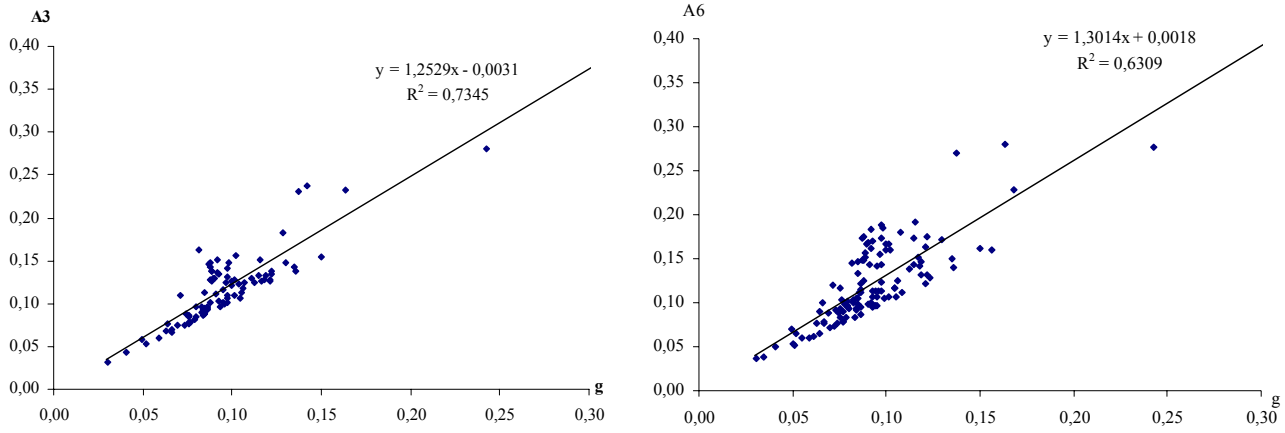
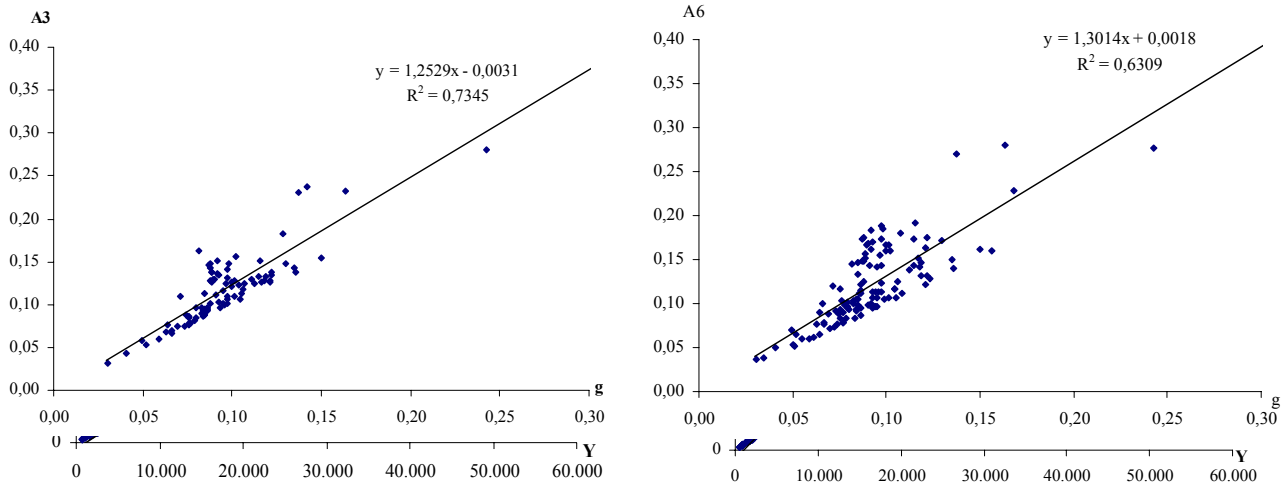


Figure 2b: Plotting EDIs against conventional measures of economic dynamism



Having established the quality and validity of the new indicator the following tables provide the ranking of the countries in terms of EDIs (Tables 4a and 4). To improve readability, these figures are plotted in graphs and in maps which follow.

Table 4a: Ranking of countries

		g(1+SVΣSVx)			
g		**A3**		**A6**	
Equatorial Guinea	1,48	China	0,28	Ireland	0,28
Bosnia	0,37	Luxembourg	0,24	China	0,28
China	0,24	Ireland	0,23	Korea Rep	0,27
Lebanon	0,17	Korea Rep	0,23	Lebanon	0,23
Ireland	0,16	Singapore	0,18	Slovenia	0,19
Cambodia	0,16	Japan	0,16	Australia	0,19
Bermuda	0,15	Denmark	0,16	Norway	0,19
Viet Nam	0,15	Viet Nam	0,15	United States	0,18
Puerto Rico	0,14	Slovenia	0,15	Estonia	0,18
Luxembourg	0,14	United States	0,15	Malaysia	0,17
Samoa (American)	0,14	Israel	0,15	Finland	0,17
Korea Rep	0,14	Chile	0,15	New Zealand	0,17
Lesotho	0,14	Norway	0,15	Sweden	0,17
Azerbaijan	0,14	Sweden	0,15	Poland	0,17
Chile	0,13	Finland	0,14	Chile	0,17
Singapore	0,13	Azerbaijan	0,14	United Kingdom	0,17
Barbados	0,13	Australia	0,14	Netherlands	0,17
Lao	0,12	Iceland	0,14	Hong Kong	0,17
India	0,12	Germany	0,14	Czech	0,17
Malaysia	0,12	Malaysia	0,14	Canada	0,17
Sri Lanka	0,12	Lesotho	0,14	Kuwait	0,16
Chad	0,12	Austria	0,14	Austria	0,16

Mozambique	0,12	United Kingdom	0,14	Viet Nam	0,16
Kuwait	0,12	India	0,13	Cambodia	0,16
Saint Kitts and Nevis	0,12	Maurutius	0,13	Greece	0,16
Maurutius	0,12	Poland	0,13	Denmark	0,16
Bostwana	0,12	New Zealand	0,13	Belgium	0,16
Trinidad and Tobago	0,12	Malta	0,13	Spain	0,15
Belize	0,12	Netherlands	0,13	Thailand	0,15
Thailand	0,12	Canada	0,13	Germany	0,15
Sudan	0,12	France	0,13	Azerbaijan	0,15
Slovenia	0,12	Trinidad and Tobago	0,13	Israel	0,15
Poland	0,11	Mozambique	0,13	France	0,15
Dominican Republic	0,11	Hong Kong	0,13	Italy	0,15
Tunisia	0,11	Belgium	0,13	Maurutius	0,15
Malta	0,11	Sri Lanka	0,13	Japan	0,14
Uganda	0,11	Czech	0,13	Dominican Republic	0,14
Cape Verde	0,11	Thailand	0,13	Argentina	0,14
Estonia	0,11	Estonia	0,13	Portugal	0,14
Iran	0,11	Spain	0,12	Hungary	0,14
Eritrea	0,11	Tunisia	0,12	Trinidad and Tobago	0,14
Panama	0,11	Cyprus	0,12	Lesotho	0,14
French Polynesia	0,10	Greece	0,12	Tunisia	0,14
Indonesia	0,10	Iran	0,12	Latvia	0,13
Albania	0,10	Hungary	0,12	India	0,13
Cyprus	0,10	Panama	0,11	Bostwana	0,13
Denmark	0,10	Italy	0,11	Lao	0,13
Bangladesh	0,10	Portugal	0,11	Iran	0,13
Hong Kong	0,10	Argentina	0,11	Slovakia	0,12
Greece	0,10	Switzerland	0,11	Papua New Ginea	0,12
Czech	0,10	Bangladesh	0,11	Mozambique	0,12
Macao (China)	0,10	Costa Rica	0,11	Belarus	0,12
Yemen	0,10	Indonesia	0,11	Switzerland	0,12
Norway	0,10	Turkey	0,10	Indonesia	0,12
Tonga	0,10	Slovakia	0,10	Lithuania	0,12
Papua New Ginea	0,10	Nepal	0,10	Albania	0,12
Australia	0,10	Peru	0,10	Uruguay	0,11
New Zealand	0,10	Egypt	0,10	Egypt	0,11
Peru	0,10	Belarus	0,10	Turkey	0,11
Costa Rica	0,10	Pakistan	0,10	Oman	0,11
Argentina	0,10	Croatia	0,10	Costa Rica	0,11
Spain	0,10	Brazil	0,10	Uganda	0,11
Fiji	0,10	Latvia	0,09	Kazakhstan	0,11
Egypt	0,10	Uruguay	0,09	Romania	0,11
Hungary	0,10	Romania	0,09	El Salvador	0,11
Grenada	0,10	Mexico	0,09	Nepal	0,11
Mali	0,10	Kazakhstan	0,09	Eritrea	0,11
Nepal	0,09	Morocco	0,09	Bangladesh	0,11
Ghana	0,09	Antigua and Barbuda	0,09	Bolivia	0,11
Oman	0,09	Armenia	0,09	Mexico	0,10
Pakistan	0,09	Bolivia	0,09	Yemen	0,10
Syria	0,09	South Africa	0,09	Jordan	0,10

Turkey	0,09
Bahrain	0,09
New Caledonia	0,09
El Salvador	0,09
United Kingdom	0,09
Mauritania	0,09
Uzbekistan	0,09
Austria	0,09
United States	0,09
Saint Vincent and the Grenadines	0,09
Portugal	0,09
Netherlands	0,09
Djibouti	0,09
Namibia	0,09
Canada	0,09
Belgium	0,09
Germany	0,09
Iceland	0,09
Finland	0,09
Israel	0,09
Slovakia	0,09
France	0,09
Sweden	0,09
Burkina Faso	0,09
Uruguay	0,09
Belarus	0,09
Kazakhstan	0,09
Seychelles	0,09
Nigeria	0,09
Romania	0,09
Bolivia	0,08
Guyana French	0,08
Latvia	0,08
Italy	0,08
Armenia	0,08
Guatemala	0,08
Mexico	0,08
Morocco	0,08
Nicaragua	0,08
Benin	0,08
Vanuatu	0,08
Malawi	0,08
Dominica	0,08
Tanzania	0,08
Antigua and Barbuda	0,08
Brazil	0,08
Jordan	0,08
Japan	0,08
Algeria	0,08
Bahamas	0,08

Lithuania	0,09
Nicaragua	0,09
Colombia	0,08
Bulgaria	0,08
Philippines	0,08
Mongolia	0,08
Ecuador	0,08
Russia	0,08
Honduras	0,08
Jamaica	0,08
Venezuela	0,07
Paraguay	0,07
FYROM	0,07
Zambia	0,07
Madagascar	0,06
Ukraine	0,06
Kyrgyzstan	0,05
Georgia	0,04
Moldova	0,03

Bulgaria	0,10
Croatia	0,10
Uzbekistan	0,10
United Arab Emirates	0,10
Brazil	0,10
Armenia	0,10
Saudi Arabia	0,10
Namibia	0,10
Pakistan	0,10
Ghana	0,10
Philippines	0,10
Mali	0,10
Nigeria	0,10
Mauritania	0,09
Colombia	0,09
Nicaragua	0,09
Mongolia	0,09
Guatemala	0,09
Algeria	0,09
Jamaica	0,09
Morocco	0,09
Russia	0,09
Swaziland	0,09
Venezuela	0,09
South Africa	0,09
Burkina Faso	0,09
Honduras	0,08
Malawi	0,08
Senegal	0,08
Paraguay	0,08
Guinea	0,08
Ethiopia	0,08
Cameroon	0,08
FYROM	0,08
Congo, Republic of	0,08
Rwanda	0,07
Gambia	0,07
Ukraine	0,07
Angola	0,07
Kyrgyzstan	0,06
Niger	0,06
Madagascar	0,06
Sierra Leone	0,06
Zimbabwe	0,05
Burundi	0,05
Georgia	0,05
Tajikistan	0,04
Moldova	0,04

Colombia	0,08
Croatia	0,08
Philippines	0,08
Senegal	0,08
Saudi Arabia	0,08
Saint Lucia	0,08
Ethiopia	0,08
Guinea	0,08
Swaziland	0,08
Ecuador	0,08
Bulgaria	0,08
Honduras	0,08
Lithuania	0,08
Mongolia	0,08
South Africa	0,07
Cameroon	0,07
Jamaica	0,07
Rwanda	0,07
Switzerland	0,07
Gabon	0,07
Gambia	0,07
Venezuela	0,07
Turkmenistan	0,07
Congo, Republic of	0,07
Paraguay	0,07
Zambia	0,07
United Arab Emirates	0,07
Kenya	0,07
Comoros	0,07
Angola	0,06
Togo	0,06
Russia	0,06
FYROM	0,06
Niger	0,06
Central African Republic	0,06
Madagascar	0,06
Cote d Ivoire	0,06
Sierra Leone	0,06
Solomon	0,05
Guinea-Bissau	0,05
Kyrgyzstan	0,05
Burundi	0,05
Zimbabwe	0,05
Ukraine	0,05
Haiti	0,05
Georgia	0,04
Tajikistan	0,03
Moldova	0,03
Congo Dem Rep	0,03

Table 4b: Ranking of countries

Y		Y(1+SVΣSVx) D3		D6	
Luxembourg	59.880,27	Luxembourg	76.445,78	United States	64.892,07
United States	34.871,74	Japan	52.590,33	Norway	59.935,34
Norway	34.716,20	United States	51.592,93	Ireland	52.847,73
Ireland	33.735,39	Norway	44.629,24	Sweden	50.909,27
Switzerland	30.617,10	Switzerland	42.293,42	Netherlands	50.816,37
Austria	29.257,73	Sweden	42.100,44	Finland	50.402,68
Iceland	29.119,10	Ireland	41.565,02	Australia	49.397,01
Netherlands	29.041,25	Iceland	41.533,05	Canada	49.201,64
Denmark	28.927,46	Finland	40.355,05	Austria	47.841,49
Canada	27.998,96	Denmark	40.332,08	United Kingdom	47.522,56
Belgium	27.692,81	Austria	38.809,12	Switzerland	46.697,06
United Kingdom	27.254,74	Israel	37.368,66	Belgium	45.640,42
Australia	26.634,59	Germany	37.326,74	Japan	43.902,28
Hong Kong	26.619,96	Netherlands	36.961,99	Italy	41.742,41
Sweden	26.441,65	Canada	36.119,46	France	41.533,10
France	26.356,55	United Kingdom	35.956,56	Germany	41.293,18
Finland	26.305,06	Belgium	35.242,56	Denmark	40.924,72
Japan	26.295,16	France	35.197,95	Hong Kong	40.872,78
Germany	25.746,13	Australia	34.781,24	Israel	36.320,64
Italy	25.487,49	Singapore	31.903,41	New Zealand	35.919,48
French Polynesia	24.275,13	Korea Rep	30.306,20	Korea Rep	35.342,70
Singapore	24.170,76	Italy	29.982,17	Spain	33.815,05
Bermuda	23.463,35	Hong Kong	28.887,31	United Arab Em.	30.153,36
Puerto Rico	23.004,84	Spain	25.771,40	Slovenia	29.336,79
Israel	22.573,64	New Zealand	25.687,38	Greece	29.158,32
Spain	22.364,66	Slovenia	22.325,01	Portugal	27.411,63
New Caledonia	22.016,02	Cyprus	21.795,14	Czech	27.334,51
United Arab Emirates	21.275,64	Greece	20.785,99	Kuwait	22.910,30
Cyprus	20.659,50	Portugal	20.224,35	Hungary	20.631,54
New Zealand	20.603,17	Czech	19.590,01	Estonia	19.452,33
Greece	18.894,02	Malta	18.503,84	Slovakia	17.033,70
Macao (China)	18.453,34	Hungary	16.169,04	Argentina	16.897,65
Portugal	18.173,56	Slovakia	13.417,14	Poland	16.752,39
Kuwait	18.089,56	Estonia	12.790,79	Lithuania	15.812,54
Slovenia	17.962,83	Argentina	12.390,51	Oman	15.189,73
Korea Rep	17.671,35	Poland	12.242,68	Latvia	14.891,39
Bahrain	17.488,64	Croatia	12.129,19	Saudi Arabia	14.814,00
Malta	17.381,19	Lithuania	11.245,23	Malaysia	12.949,93
Seychelles	16.917,82	South Africa	11.153,43	Croatia	12.915,43
Bahamas	16.579,73	Maurutius	10.914,71	Chile	12.710,12
Czech	16.572,34	Chile	10.690,25	Maurutius	12.297,87
Barbados	14.941,34	Trinidad and Tobago	10.458,21	Trinidad and Tobago	11.744,87
Equatorial Guinea	14.920,09	Latvia	9.989,93	Russia	11.254,62
Hungary	14.139,54	Malaysia	9.856,23	South Africa	11.204,81

Oman	13.525,44
Saudi Arabia	12.301,73
Slovakia	12.288,45
Saint Kitts and Nevis	11.639,40
Argentina	11.592,62
Estonia	11.463,62
Poland	11.054,50
Croatia	10.405,89
Lithuania	10.296,25
Maurutius	10.235,30
Antigua and Barbuda	10.226,87
Trinidad and Tobago	10.103,82
South Africa	9.890,89
Chile	9.688,95
Latvia	9.348,32
Malaysia	8.977,76
Mexico	8.895,50
Costa Rica	8.490,38
Bostwana	8.455,89
Uruguay	8.229,57
Russia	7.982,04
Grenada	7.433,89
Brazil	7.376,19
Tonga	6.833,60
Romania	6.831,16
Thailand	6.754,31
Bulgaria	6.687,79
Tunisia	6.636,79
Dominican Republic	6.628,75
Turkey	6.549,04
Colombia	6.398,49
Belize	6.343,29
Namibia	6.337,81
Iran	6.309,52
Panama	6.240,14
Gabon	6.122,79
FYROM	5.930,45
Bosnia	5.754,90
Kazakhstan	5.683,19
Algeria	5.660,08
Saint Vincent and the Grenadines	5.482,27
Belarus	5.480,30
Saint Lucia	5.440,57
Venezuela	5.411,70
Dominica	5.375,90
Samoa (American)	5.289,66
Cape Verde	5.029,14
Fiji	4.986,79
Lebanon	4.890,17
Ukraine	4.881,24

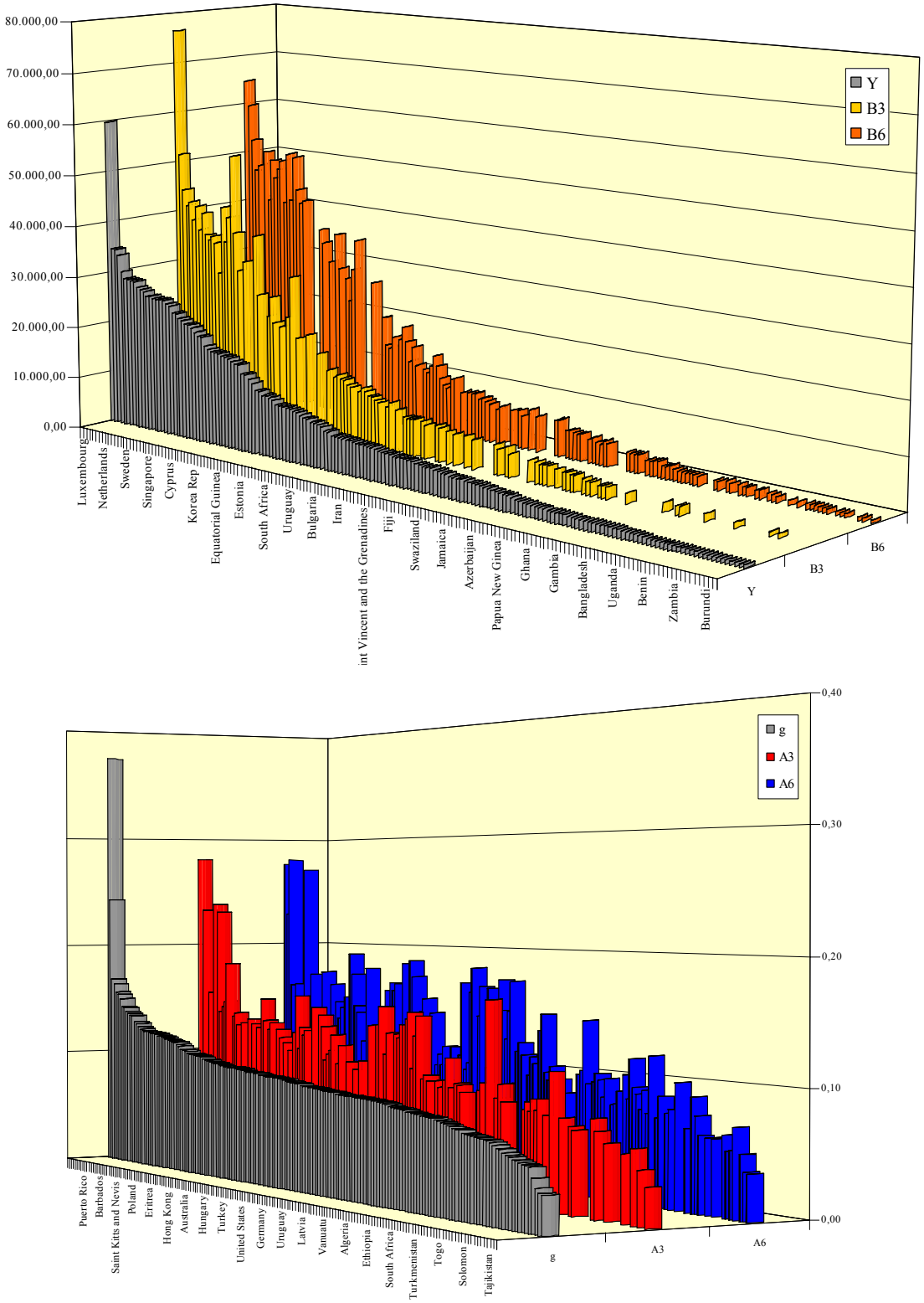
Russia	9.433,25
Mexico	9.392,24
Costa Rica	9.016,66
Uruguay	8.564,65
Brazil	8.370,61
Romania	7.280,92
Tunisia	7.214,36
Turkey	7.178,48
Bulgaria	7.172,74
Thailand	7.116,26
Iran	6.949,60
Panama	6.623,80
Colombia	6.562,90
FYROM	6.197,60
Belarus	6.105,46
Kazakhstan	5.988,43
Ukraine	5.725,41
China	5.696,77
Venezuela	5.671,54
Peru	4.991,84
Paraguay	4.496,39
Philippines	4.152,51
Morocco	4.123,33
Egypt	3.859,52
Sri Lanka	3.843,51
Jamaica	3.811,86
Ecuador	3.535,76
Azerbaijan	3.385,13
Nicaragua	3.335,98
Armenia	3.235,37
Indonesia	3.193,87
India	2.960,58
Honduras	2.576,02
Bolivia	2.533,69
Viet Nam	2.398,03
Lesotho	2.355,81
Georgia	2.295,93
Pakistan	2.024,19
Mongolia	1.773,82
Bangladesh	1.767,00
Kyrgyzstan	1.665,81
Nepal	1.479,46
Mozambique	1.114,49
Zambia	817,77
Madagascar	797,82

Uruguay	10.804,80
Mexico	10.741,73
Costa Rica	9.557,33
Bulgaria	9.066,58
Bostwana	9.064,10
Thailand	8.849,34
Romania	8.841,55
Brazil	8.704,83
Dominican Republic	8.353,19
Tunisia	8.096,55
Turkey	7.929,13
Belarus	7.892,53
Colombia	7.461,96
Iran	7.427,11
Kazakhstan	7.401,28
FYROM	7.085,71
Ukraine	7.081,36
Lebanon	6.922,80
Venezuela	6.894,48
Namibia	6.685,53
Algeria	6.399,52
China	5.486,22
El Salvador	5.330,10
Jordan	5.281,39
Paraguay	5.237,95
Swaziland	5.125,09
Philippines	5.031,30
Jamaica	4.807,53
Albania	4.541,74
Egypt	4.473,02
Guatemala	4.313,22
Morocco	4.085,06
Nicaragua	3.687,33
Armenia	3.647,68
Azerbaijan	3.567,50
Indonesia	3.526,02
Papua New Ginea	3.103,64
Bolivia	3.084,04
India	2.863,21
Honduras	2.835,23
Georgia	2.781,21
Viet Nam	2.493,78
Lesotho	2.396,31
Zimbabwe	2.263,58
Mongolia	2.150,71
Cambodia	2.115,08
Kyrgyzstan	2.050,95
Pakistan	2.041,44
Guinea	2.032,09
Ghana	2.027,89

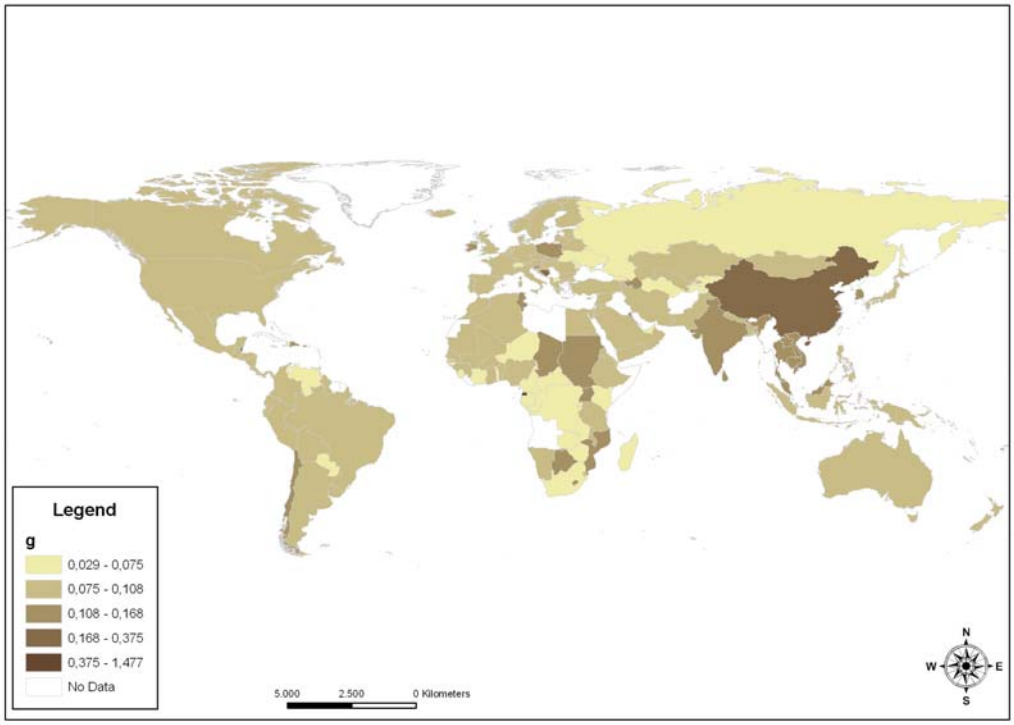
Peru	4.871,02
El Salvador	4.627,77
China	4.622,85
Paraguay	4.447,79
Swaziland	4.438,87
Jordan	4.177,47
Guyana French	4.137,47
Albania	4.090,94
Philippines	4.079,16
Guatemala	3.968,44
Morocco	3.782,15
Jamaica	3.775,23
Egypt	3.724,86
Sri Lanka	3.693,98
Turkmenistan	3.608,52
Ecuador	3.498,57
Syria	3.338,50
Nicaragua	3.297,65
Azerbaijan	3.155,99
Indonesia	3.124,32
Armenia	3.091,84
Vanuatu	2.886,12
India	2.620,68
Honduras	2.554,27
Bolivia	2.429,30
Papua New Ginea	2.398,98
Lesotho	2.290,81
Viet Nam	2.267,14
Georgia	2.232,28
Zimbabwe	2.188,91
Cambodia	2.022,19
Guinea	2.008,57
Ghana	1.972,38
Pakistan	1.962,22
Cameroon	1.932,00
Angola	1.877,56
Djibouti	1.849,96
Comoros	1.779,14
Sudan	1.746,31
Gambia	1.741,67
Mauritania	1.724,12
Haiti	1.722,00
Mongolia	1.696,67
Lao	1.682,47
Solomon	1.679,74
Kyrgyzstan	1.634,37
Bangladesh	1.606,67
Uzbekistan	1.603,94
Cote d Ivoire	1.489,98
Senegal	1.481,85
Cameroon	1.990,33
Angola	1.881,12
Uzbekistan	1.772,95
Lao	1.770,67
Gambia	1.769,85
Mauritania	1.764,74
Moldova	1.743,98
Bangladesh	1.686,26
Senegal	1.568,95
Nepal	1.542,93
Uganda	1.347,70
Rwanda	1.128,82
Congo, Republic of	1.074,84
Nigeria	1.066,27
Burkina Faso	1.049,19
Tajikistan	1.038,89
Mozambique	1.038,65
Eritrea	942,99
Mali	898,84
Yemen	882,93
Ethiopia	811,61
Madagascar	798,38
Niger	719,97
Sierra Leone	660,55
Burundi	601,60
Malawi	569,04

Moldova	1.445,63
Togo	1.407,67
Nepal	1.351,77
Uganda	1.293,89
Rwanda	1.106,55
Chad	1.091,59
Central African Republic	1.090,66
Burkina Faso	1.040,28
Kenya	1.031,68
Mozambique	1.017,18
Benin	985,87
Nigeria	947,12
Tajikistan	946,88
Congo, Republic of	936,32
Eritrea	927,44
Mali	883,28
Yemen	829,22
Zambia	817,77
Ethiopia	803,71
Madagascar	789,67
Niger	719,97
Guinea-Bissau	709,96
Congo Dem Rep	639,69
Sierra Leone	603,39
Burundi	601,10
Tanzania	569,20
Malawi	568,25

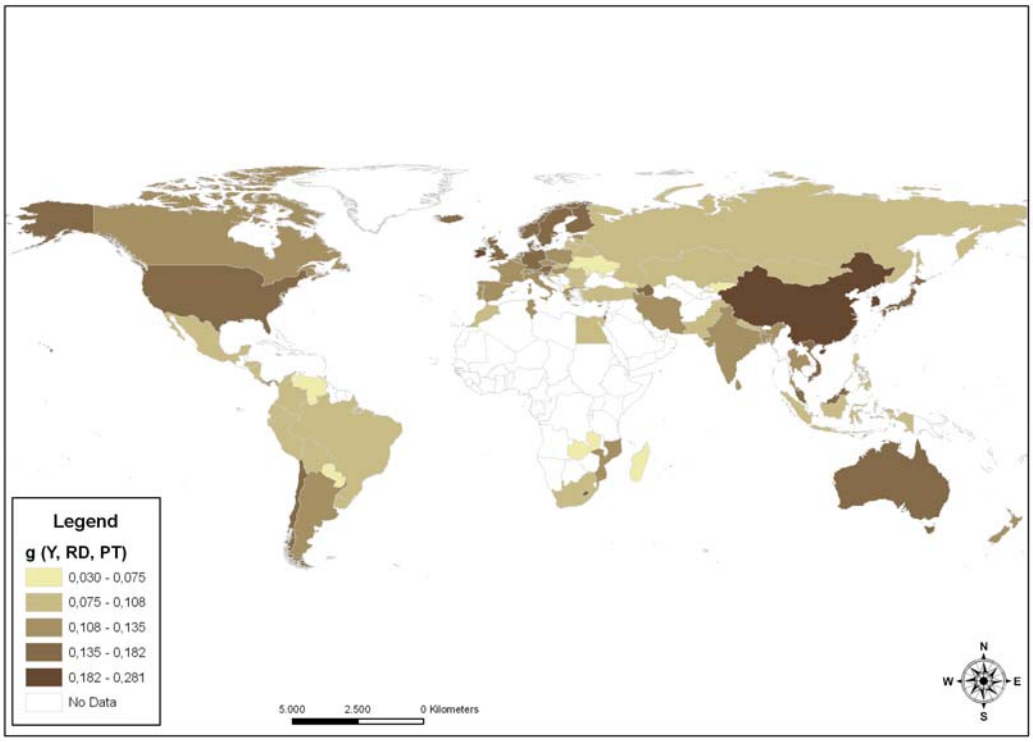
Graph 1: Ranking of countries in terms of EDIs in comparison to conventional assessments of economic dynamism



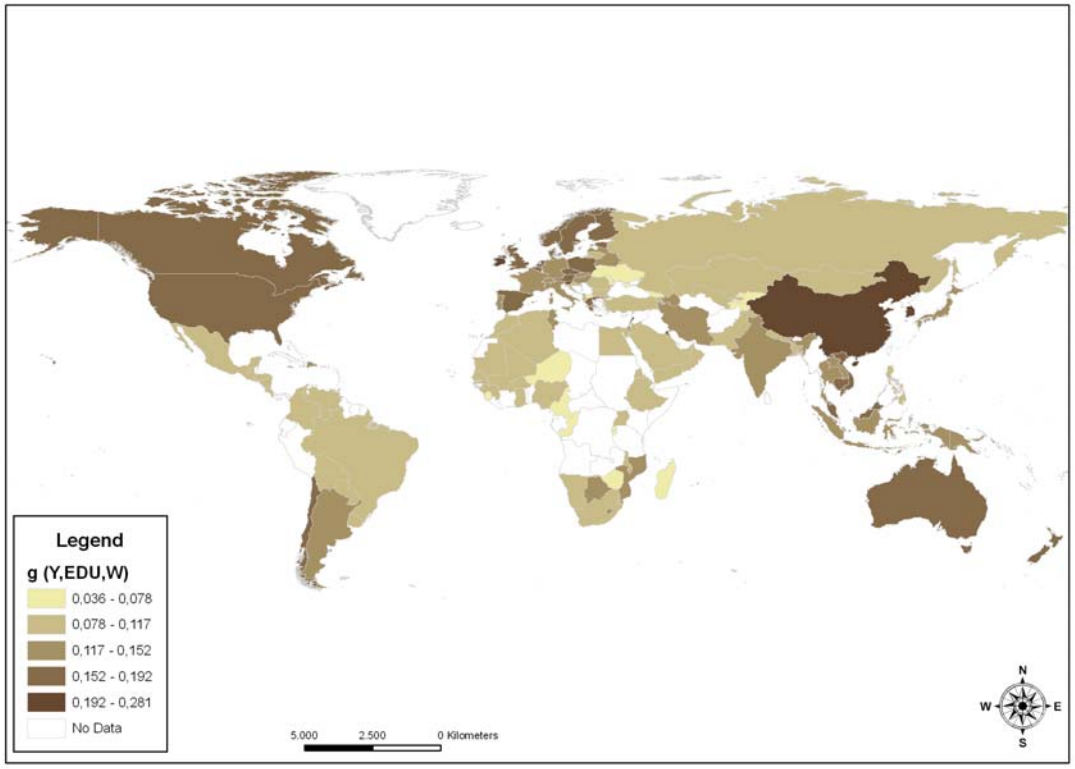
Map 1: Economic growth in the world



Map 2: Knowledge-driven economic dynamism in the world: the aspect of innovation



Map 2: Knowledge-driven economic dynamism in the world: the aspect of human capital



Finally, Tables 5 and 6 provide the top and bottom ends of the country-rankings.

Table 5a: Top/bottom countries

		g		A3	g(1+SVΣSVx)	A6	
top 10	**1**	Equatorial Guinea	1,48	China	0,28	Ireland	0,28
	2	Bosnia	0,37	Luxembourg	0,24	China	0,28
	3	China	0,24	Ireland	0,23	Korea Rep	0,27
	4	Lebanon	0,17	Korea Rep	0,23	Lebanon	0,23
	5	Ireland	0,16	Singapore	0,18	Slovenia	0,19
	6	Cambodia	0,16	Japan	0,16	Australia	0,19
	7	Bermuda	0,15	Denmark	0,16	Norway	0,19
	8	Viet Nam	0,15	Viet Nam	0,15	United States	0,18
	9	Puerto Rico	0,14	Slovenia	0,15	Estonia	0,18
	10	Luxembourg	0,14	United States	0,15	Malaysia	0,17
	10	Guinea-Bissau	0,05	Jamaica	0,08	Angola	0,07
	9	Kyrgyzstan	0,05	Venezuela	0,07	Kyrgyzstan	0,06
	8	Burundi	0,05	Paraguay	0,07	Niger	0,06
	7	Zimbabwe	0,05	FYROM	0,07	Madagascar	0,06
	6	Ukraine	0,05	Zambia	0,07	Sierra Leone	0,06
	5	Haiti	0,05	Madagascar	0,06	Zimbabwe	0,05
	4	Georgia	0,04	Ukraine	0,06	Burundi	0,05
	3	Tajikistan	0,03	Kyrgyzstan	0,05	Georgia	0,05
	2	Moldova	0,03	Georgia	0,04	Tajikistan	0,04
bottom 10	**1**	Congo Dem Rep	0,03	Moldova	0,03	Moldova	0,04

Table 5b: Top/bottom countries

		Y		D3	Y(1+SVΣSVx)	D6	
top 10	**1**	Luxembourg	59.880,27	Luxembourg	76.445,78	United States	64.892,07
	2	United States	34.871,74	Japan	52.590,33	Norway	59.935,34
	3	Norway	34.716,20	United States	51.592,93	Ireland	52.847,73
	4	Ireland	33.735,39	Norway	44.629,24	Sweden	50.909,27
	5	Switzerland	30.617,10	Switzerland	42.293,42	Netherlands	50.816,37
	6	Austria	29.257,73	Sweden	42.100,44	Finland	50.402,68
	7	Iceland	29.119,10	Ireland	41.565,02	Australia	49.397,01
	8	Netherlands	29.041,25	Iceland	41.533,05	Canada	49.201,64
	9	Denmark	28.927,46	Finland	40.355,05	Austria	47.841,49
	10	Canada	27.998,96	Denmark	40.332,08	UK	47.522,56
	10	Zambia	817,77	Lesotho	2.355,81	Mozambique	1.038,65
	9	Ethiopia	803,71	Georgia	2.295,93	Eritrea	942,99
	8	Madagascar	789,67	Pakistan	2.024,19	Mali	898,84
	7	Niger	719,97	Mongolia	1.773,82	Yemen	882,93
	6	Guinea-Bissau	709,96	Bangladesh	1.767,00	Ethiopia	811,61
	5	Congo Dem Rep	639,69	Kyrgyzstan	1.665,81	Madagascar	798,38
	4	Sierra Leone	603,39	Nepal	1.479,46	Niger	719,97
	3	Burundi	601,10	Mozambique	1.114,49	Sierra Leone	660,55
	2	Tanzania	569,20	Zambia	817,77	Burundi	601,60
bottom 10	**1**	Malawi	568,25	Madagascar	797,82	Malawi	569,04

5. Conclusions

With the spread of modern and efficient information and communication technologies, the world economy has become more competitive as well as interdependent. As such, economic survival made it essential to have knowledge creation and use play a focal point in long-term developmental strategies. In other words, it is critical for countries to make the transition to the knowledge economy.

This paper presented a framework of knowledge-driven economic dynamism, which asserts that investments in education and training, innovation and technological adoption, the information infrastructure, and a sound economic structure are necessary for sustained creation, adoption, adaptation and use of knowledge in economic production, which will consequently result in higher economic potential. Building upon this framework it also attempted to construct an indicator, called Economic Dynamism Indicator (EDI), which is able to assess the quality of a country's economic dynamism which stems from its knowledge economy. Although further research is required along this front there are indications that EDI can provide a robust basis for measuring economic dynamism of this short.

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