The Global Entrepreneurship Index (GEI) – European dataset

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[1]Please start with version 0.1. All minor changes will lead to a new number (0.2, 0.3, 0.4 etc.). The first complete draft will get the number 1.0. Again all minor revisions will lead to a new decimal number (1.1, 1.2, 1.3 etc.). A major revision will become 2.0 etc. etc. Until there is a final version which will be called 'final'.

Content

List of Abbreviations used

In alphabetical order:

EQI	Entrepreneurial Quality Index
GEI	Global Entrepreneurship Index
GEM	Global Entrepreneurship Monitor
GDP	Gross Domestic Product
GEDI	Global Entrepreneurship and Development Index
GERD	Gross Expenditure on Research and Development
ICRG	International Country Risk Guide
KIEA	Kauffman Index of Entrepreneurial Activity
NSE	National System of Entrepreneurship
PFB	Penalty for Bottlenecks
REAI	Regional Entrepreneurship Acceleration Index
RECPI	Regional Entrepreneurship Cohort Potential Index
TEA	Total early-stage Entrepreneurial Activity

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1. Executive summary

The main purpose of this report is to present the potential public policy applicability of the Global Entrepreneurship Index (GEI) approach for the European Union and its member countries. GEI defines country level entrepreneurship as the National System of Entrepreneurship that „…is the dynamic, institutionally embedded interaction between entrepreneurial attitudes, abilities, and aspirations, by individuals, which drives the allocation of resources through the creation and operation of new ventures" (Acs et al 2014, p.479). Therefore GEI score represents the performance of the involved countries in terms of the quality of their entrepreneurship ecosystem.

GEI proposes five levels of index building as it includes the GEI super-index measuring entrepreneurship at the country level, three sub-index (attitudes, abilities and aspirations), 14 pillars, 28 variables and 49 indicators. All pillars contain an individual and an institutional variable component. A paper written by Acs and Szerb (2016) reviewed the original structure of GEI and added a couple of new variables to the former version. The crucial parts of the calculation of GEI are average adjustment of pillars and the so-called Penalty for Bottlenecks method, since these two methods enable us to apply GEI not only for analysing the quality of entrepreneurial ecosystem, but also for making policy implications regarding the pillars.

We calculated the GEI scores for 26 out of 28 member countries of the European Union for the 2006–2015 time periods. The highest values have been represented by the Northern and Western European countries particularly the Scandinavian countries, the Netherlands and the UK. Belgium, France, Germany, Luxembourg, Austria and Estonia (as the only one from the Central and Eastern European area) show above average scores. Spain, Portugal, Slovenia, Poland and Lithuania represent moderate values, while a couple of Central and Eastern European countries as well as Italy and Greece have a GEI score below the average. The EU member nations' example highlights the usefulness of the GEI method in analysing the entrepreneurial profiles of countries from a system perspective.

According to the GEI index, the EU countries differ considerably in the quality of entrepreneurial ecosystem. Moreover, even larger differences exist over the 14 pillars in the country levels. While numerous potential policy mixes exist, we analysed only one situation in which the GEDI scores were improved by all the 26 EU member countries by 5 points, about 9%. One of the most important implications of the analysis is that uniform policy does not work, and the EU member states should apply different policy mixes to reach the same improvement in the GEI.

2. Introduction

Since its initiation in 2008, the Global Entrepreneurship Index (GEI) research has addressed two important questions: (1) why an individual chooses to become an entrepreneur while others do not and (2) why entrepreneurial activities differ across countries. While academic research has mostly focused on characteristic variation across individuals there is much less evidence about measurement of entrepreneurship at the country level.

The GEI approach to entrepreneurship involves five important aspects (Acs and Szerb 2012). First, it views entrepreneurship as a concept of quality rather than quantity. Second, it considers that both institutional and individual factors are vital in measuring entrepreneurship. Third, measuring the pillars of entrepreneurship is based on a benchmark of the best five percent existing achievement for each particular pillar. Fourth, the averages of each fourteen pillar values are equalized to provide the same marginal effect. This point is particularly important from the entrepreneurship policy point of view. And fifth, it views the building blocks of entrepreneurship, the fourteen pillars, not as independent but as integrated elements of a system. The performance of the system of entrepreneurship depends on the weakest pillar, thus a good performance in one pillar can substitute only partially for a badly performing element of the system. A practical application of this theory is the Penalty for Bottlenecks (PFB) methodology.

The first version of the GEI, initially named as Global Entrepreneurship and Development Index (GEDI), was published in 2009 (Acs and Szerb 2009) and followed by yearly reports in a book format since then (Acs and Szerb 2011, 2012; Acs, Szerb and Autio 2013, 2014, 2015a, 2015b). Since its introduction the GEI has gone through many smaller changes. In 2016, the GEI has been extensively reviewed and renewed. This new structure is based on the review paper by Acs and Szerb (2016).

The rationale behind the new index structure is to include such variables that have been missing from the original version of the GEDI. In particular capturing the effect of regulation, taxation, labour market, knowledge institutions and finance so as to increase the sophistication of the GEI by the introduction of additional institutional variables.

In this report first we describe the relationship of entrepreneurship and economic development, then we provide a full description of the new GEI dataset as well as of the calculation methodology. Besides providing a formal technical description including equations we also present figures, maps, tables and list examples to offer an understanding for those who are not experts of the index building methodology.

3. Measuring entrepreneurship – theoretical background

Albeit the role of entrepreneurship in economic development is progressively becoming clearer, the understanding of policies to develop the potential of entrepreneurship remains immature. This argument is largely explained by the discrepancy between the definition and the measure of entrepreneurship. While the complex and multidimensional character of entrepreneurship is

extensively recognized (Verheul et al. 2001; Capello and Lenzi 2016), major measures of entrepreneurship are still thwarting. Over the past decades, significant progress has been made in propelling the measurement of entrepreneurship. Despite these progresses, there is a significant divide between quantity type indices of entrepreneurial activity and measures based on the quality aspects of entrepreneurship. Quantity type (or output) indicators track the incidence of business ownership (new firms) or self-employment entries within populations. In these measures, entrepreneurship is conceived of as the creation of a new business organization or an entry into self-employment. Examples of such output indicators include the Global Entrepreneurship Monitor's (GEM) Total Entrepreneurial Activity (TEA) index (Reynolds et al. 2005); the OECD-Eurostat's Entrepreneurship Indicators (Lunati, Meyer zu Schlochter and Sargsayan 2010; OECD–Eurostat 2007); World Bank's Entrepreneurship Survey (World Bank 2011); and the Flash Eurobarometer survey (Gallup 2009). Another indicator of entrepreneurship is the Kauffman Index of Entrepreneurial Activity (KIEA) which measures the adult non-business owner population who start a new business (Fairlie 2012). Examples of indices measuring population-level attitudes include the Flash Eurobarometer survey (Gallup 2009); the World Values Survey; GEM; and the International Social Survey (ISSP 1997). The use of the attitude related measures to proxy entrepreneurship is particularly ambiguous because it is not clear, what is the mechanism from moving the vaguely defined attitudes to business start-ups (Acs et al 2014).

Nevertheless, these still frequently used start-up, ownership and business density rates are problematic because these single dimensional indices do not consider the quality aspects of entrepreneurship (Acs and Szerb 2011; Shane 2009). Mann and Shideler (2015) emphasize that the problem with density type indices is that policy makers with their programmes targeting economic growth may only increase the number of firms rather than catalyse the creative destruction process. Lenihan (2011) also demonstrates that traditional one-dimensional indicators (such as jobs created or retained) are too narrow metrics to measure the impact of firm policy interventions, because these proxies focus exclusively merely on private firm impact, rather than on broader socioeconomic impacts. Thurik et al. (2013) mention a shift in entrepreneurial policy which is related to the paradigm shift from the managed economy to the entrepreneurial economy. According to their view, such policy has to be created that focus on dynamic capitalism in which entrepreneurship plays a key role, instead of promoting more new firms. In their paper Guzman and Stern (2016) focus both on the role of entrepreneurial quantity and quality. The authors calculated measures on annual basis for the fifteen states of the United States for the period 1988–2014. They created three composite indicators to measure both changes in entrepreneurial potential and ecosystem: the Entrepreneurial Quality Index (EQI, measuring the average quality level among a group of start-ups within a given cohort); the Regional Entrepreneurship Cohort Potential Index (RECPI, measuring the growth potential of firms founded within a given region and time period); and the Regional Entrepreneurship Acceleration Index (REAI, measuring the performance of a region over time in realizing the potential of firms founded there). According to their key finding, they observed a three to four-fold drop in the US entrepreneurial ecosystem performance while observing a very little drop in overall entrepreneurial potential.

The target of entrepreneurship policy has become one of the debated questions in the last decades whether promotion of entrepreneurial activity and firms in general make entrepreneurship policy successful. Fritsch and Schroeter (2009) pointed out in their investigation that the marginal effect of new business formation on the regional employment can decline as the number of start-ups increase

and this marginal effect can become even negative. Therefore, they conclude that policy efforts should promote the high-quality start-ups in order to create economic growth. Vivarelli (2012) noticed that policy-makers have to consider on the heterogeneity of entrepreneurs, and their motivation on foundation a new firm. Furthermore, entrepreneurial policies have to support firm entries that activities are based on a technological renewal and economic growth, primarily. Stam et al. (2007) found that high-growth firms have higher influence on economic growth at the macro-level than entrepreneurial activity in general. Mason and Brown (2013) stressed also the heterogeneity of high-growth firm. They claim that entrepreneurial policies have to support also the start-ups and not only high-growth firms by applying better targeted policy interventions towards high-potential new firms. It also refers on the debate in the literature which firms have to be promoted if the entrepreneurship policy would not support the firms in general.

However, one thing is clear that the quality of entrepreneurship cannot be measured by the number of firms or merely by the distinctive characteristics of entrepreneur. Meanwhile a shift of entrepreneurship policy in thinking seems to have occurred from direct intervention increasing the number of firms towards creating a more supportive environment or climate, namely an adequate ecosystem for entrepreneurs. The entrepreneurial ecosystem approach thus examines the entrepreneurial individual instead (not the company itself), as well as emphasizes the role of the entrepreneurship context.

Several studies try to identify those factors determining (allowing or restricting) the level of entrepreneurship and offer different theoretical perspectives as well as frameworks to organize a broad range of determinants explains the level of high-quality entrepreneurship, including economic, social and cultural institutions (OECD 2008; Sternberg 2009; Feld 2012; Isenberg 2011; WEF 2013; Annoni and Dijkstra 2013; Stam 2015). Freytag and Noseleit (2009) found that the better institutions a country has, the entrepreneurs' acceptance towards them higher is. The difference in acceptance among entrepreneurs and non-entrepreneurs has decreased as institutions represented higher quality. They draw the attention that small differences may also influence the institutional acceptance. Rodríguez-Pose (2013) in his paper also discussed about the importance of institutions regarding European regional economic development. He noted that the EU needs to create institutional-based regional developments strategies that are specifically tailor-made to the different local environments across European regions. However, the author also pointed out the difficulties for establishing the right mix of formal and informal institutions.

Verheul et al. (2001) in their theoretical framework distinguished the demand and supply side of entrepreneurship. Here the demand side refers to the opportunities for entrepreneurship. According to the authors' view the diversity in consumer demand is important, because a greater diversity creates more room for entrepreneurs. In the model the supply side of entrepreneurship encompasses different things: industrial structure (sector structure, networking), also influenced by technological developments; government regulations; demographic composition; culture; formal institutions. Beside environmental factors the authors consider in their model the effect of the individual risk-reward profile "represents the process of weighing alternative types of employment and is based on opportunities (environmental characteristics), resources, ability, personality traits and preferences (individual characteristics)" (Verheul et al. 2001, 9.). Audretsch and Belitski (2016) define the efficient entrepreneurial ecosystem as a complex system of interactions among individuals within the

institutional, socioeconomic and informational context. They emphasize a holistic policy approach concerning the entrepreneurial ecosystem. Acs et al. (2016a) draw the attention that the public policy question regarding entrepreneurial policy is "Does the environment allow the entrepreneur to complete the production function and fill in the missing input markets?". According to their view, the public policy interventions should promote the creation of an enabling environment. The Dutch entrepreneurial ecosystem may serve as an European example, in which four main framework conditions of the entrepreneurial ecosystem could be identified: (1) change of formal institutions in order to support labour mobility; (2) strengthen public demand for entrepreneurs by financing new knowledge creation and application; (3) promoting a culture of entrepreneurship; (4) developing physical infrastructure to upgrade knowledge circulations and networks (Stam 2014). Dilli and Elert (2016) analysed the present entrepreneurial climate across 21 EU member states and identified institutions that are potentially relevant to this climate. They highlighted the presence of varieties of entrepreneurial regimes in Europe regarding the climate. Identify a number of potentially relevant entrepreneurship indicators as well as potentially relevant formal and informal institutions their findings also suggested that there is no one-size-fits-all approach to create an entrepreneurial society in Europe.

The phenomenon of entrepreneurship has been extensively studied at both the individual and contextual levels but they do not provide insight into how individuals interact with their systemic contexts, the complex recursive relationships between the two levels have not received much attention. We propose that a major shortcoming in policy thinking is the insufficient recognition that entrepreneurship, at a country level, is a systemic phenomenon and should be approached as such. To address this gap, we introduce the concept of National Systems of Entrepreneurship that recognizes the systemic character of country-level entrepreneurship, and also, recognizes that although embedded in a country-level context, entrepreneurial processes are fundamentally driven by individuals (Acs et al. 2014). We then explain how the GEI methodology is designed to profile National Systems of Entrepreneurship. Finally, using the European Union member countries, we illustrate how the GEI method enables policy-makers to develop a better understanding of the systemic characteristics of country-level entrepreneurship and identify priority areas for national and EU level of entrepreneurship policy.

4. The methodological background of GEI

4.1. The structure of Global Entrepreneurship Index

Based on the inconsistencies about the definition, the measurement, and the policy domain of entrepreneurship, Acs and Szerb (2011, 2012) and Acs et al (2014) developed the Global Entrepreneurship Index (GEI) that serves to measure country level entrepreneurship.[2] The GEI takes into account that

- entrepreneurship is a multifaceted phenomenon that requires a complex measure;

[2]The GEI formerly was named as GEDI, Globl Entrepreneurship and Development Index.

- instead of a quantity approach a proper measure should consider the quality aspects of entrepreneurship;
- both the individual efforts/capabilities and the environmental/institutional aspects of entrepreneurship are important;
- the different aspects/components of the entrepreneurship constitute a system where the interrelation of the elements is vital;
- entrepreneurship policy should be formulated from a system perspective by providing a tailor-made policy mix that fits to a particular country's entrepreneurial profile rather than providing a one size fits to all universal suggestions.

GEI defines country level entrepreneurship as the National System of Entrepreneurship that „…is the dynamic, institutionally embedded interaction between entrepreneurial attitudes, abilities, and aspirations, by individuals, which drives the allocation of resources through the creation and operation of new ventures" (Acs et al 2014, p.479). GEI proposes five levels of index building as it includes the GEI super-index measuring entrepreneurship at the country level, three sub-index (attitudes, abilities and aspirations), 14 pillars, 28 variables and 49 indicators. All pillars contain an individual and an institutional variable component. Viewing from the system perspective, GEI takes into account the connection between the individual and the institutional factors as interacting variables. More recently, the institutional components of the GEI have been reviewed and changed. In this paper we present the amended, new version of GEI as presented in Table 1.

Table 1: The structure of the Global Entrepreneurship Index (GEI)

	Sub-indexes	Pillars	Variables (individual/institutional)
GLOBAL ENTREPRENEURSHIP INDEX	ATTITUDES SUB-INDEX	OPPORTUNITY PERCEPTION	*OPPORTUNITY RECOGNITION*
			FREEDOM AND PROPERTY
		STARTUP SKILLS	*SKILL PERCEPTION*
			EDUCATION
		RISK ACCEPTANCE	*RISK PERCEPTION*
			COUNTRY RISK
		NETWORKING	*KNOW ENTREPRENEURS (KNOWENT)*
			CONNECTIVITY
		CULTURAL SUPPORT	*CARRIER STATUS (CARSTAT)*
			CORRUPTION
	ABILITIES SUB-INDEX	OPPORTUNITY STARTUP	*OPPORTUNITY MOTIVATION*
			TAXGOVERN
		TECHNOLOGY ABSORPTION	*TECHNOLOGY LEVEL (TECHSECT)*
			TECHNOLOGY ABSORPTION
		HUMAN CAPITAL	*HIGH EDUCATION*
			LABOUR MARKET
		COMPETITION	*COMPETITORS*
			COMPETITIVENESS AND REGULATION
	ASPIRATIONS SUB-INDEX	PRODUCT INNOVATION	*NEW PRODUCT*
			TECHNOLOGY TRANSFER
		PROCESS INNOVATION	*NEW TECHNOLOGY*
			SCIENCE
		HIGH GROWTH	*GAZELLE*
			FINANCE AND STRATEGY

		INTERNATIONALIZATION	*EXPORT*
			ECONOMIC COMPLEXITY
		RISK CAPITAL	*INFORMAL INVESTMENT*
			DEPTH OF CAPITAL MARKET

Note: Individual variables are coloured with white background, while institutional ones with grey background.
Source: Authors' edition

Entrepreneurial attitudes reflect the people's attitudes toward entrepreneurship. It involves opportunity recognition, start-up skills, risk perception, networking, and cultural supports of entrepreneurs. Institutional embedding is expressed as the property rights and economic freedom, the quality of the education, the riskiness of the country, the connectivity potential, and the prevalence of corruption.

Entrepreneurial abilities include some important characteristics of the entrepreneur that determine the extent to which new start-ups will have potential for growth, such as motivation based on opportunity as opposed to necessity, the potential technology-intensity of the start-up, the entrepreneur's level of education, and the level of competition. These individual factors coincide with the proper institutional factors of taxation and the efficiency of government operation (Taxgovern), technology absorption capability, the freedom of the labour market and the extent of staff training (Labour Market), and the dominance of powerful business groups as well as the effectiveness of antimonopoly regulation (Competitiveness and Regulation).

Entrepreneurial aspirations refer to the distinctive, qualitative, strategy-related nature of entrepreneurial activity. The individual and institutional factors of product and process innovation such as technology transfer, the applied research potential of science, high-growth expectations, venture capital availability and strategy sophistication (Finance and Strategy), internationalization and the availability of risk financing constitute entrepreneurial aspirations (Acs et al 2014). For more details and description of the variables see the Appendices.

4.2. The calculation of GEI

The GEI scores for all the countries are calculated according to the following eight points. Note that we calculate the GEI scores for all the 101 countries for the 2006–2015 time period resulting 554 observations. The European Union dataset including 26 EU member countries is a subset of the whole dataset containing 197 units of observation.

1. ***The selection of variables:*** We start with the variables that come directly from the original sources for each country involved in the analysis. The variables can be at the individual level (personal or business) that are coming from the GEM Adult Population Survey or the institutional/environmental level that are coming from various other sources. Altogether we use 16 individual and 15 institutional variables. Some variables are complex creatures themselves. The description and the calculation of the individual variables are described in Appendix 2 and that of the institutional variables is in Appendix 3. Individual data are calculated from the 2006–2015 years, using the two year moving average principle. In the lack of proper data, single year value is applied. In the case of the institutional variables we applied single year data. This result 554 total observation for 101 countries.

2. ***The construction of the pillars:*** We calculate all pillars from the variables using the interaction variable method; that is, by multiplying the individual variable with the proper institutional variable. The notion behind this technique is going back to Baumol's (1990) idea that the value of entrepreneurship depends both on the individual effort and the institutional context. This multiplication results pillar values for all the 554 observations.

$$z_{i,j} = IND_{i,j} * INS_{i,j} \qquad (1)$$

For all j = 1, ..., k the number of individual and institutional variables
$IND_{i,j}$ is the original score value for country *i* and variable *j* individual variable
$INS_{i,j}$ is the original score value for country *i* and variable *j* institutional variable
$z_{i,j}$ is the original pillar value for country i and pillar *j*

3. ***Normalization:*** pillars values were first normalized to a range from 0 to 1, using the distance method, according to equation 2:

$$x_{i,j} = \frac{z_{i,j}}{\max z_{i,j}} \qquad (2)$$

For all j = 1, ..., k the number of pillars, where
$x_{i,j}$ is the normalized score value for country i and pillar j
$z_{i,j}$ is the original pillar value for country i and pillar j
$max\ z_{i,j}$ is the maximum value for pillar j

This normalization technique relates the performance of a country to the best performing country. Hence, it provides a proper benchmark to evaluate performance of a particular country in a certain pillar to the best available practice. The disadvantage of the min-max methodology is that it assigns value one to best country and zero to the worth one could exaggerates small differences. Another popular normalization method, the "z-score" approach guarantees normal distribution but results a variable range of the scores. Since we require that country scores should be strictly in the [0;1] range, we cannot use this approach.

4. ***Capping:*** All index building is based on a benchmarking principle. In our case we selected the 95 percentile score adjustment meaning that any observed values higher than the 95 percentile is lowered to the 95 percentile. For the 26 EU countries we use the benchmarks values from the full data set that contains all the countries and all the years resulting 554 observations over the 2006–2015 time period. This capping method has two advantages. First, it makes possible to get rid of the outliers. Second, it provides a reasonable and reachable benchmark for the other countries. Without capping the best country benchmark value of a certain pillar could be extremely high resulting unreasonably lower normalized scores for the other countries.

Table 2 shows the result of the capping of the pillars. Beside the pillar averages and standard deviations we also report the skewness values that measure the asymmetry of the pillars. Following Annoni and Kozovska (2010), we consider skewness scores to be acceptable in the [-1;1] range.

Table 2: The normalized GEI pillar averages, standard deviations and skewness values before and after capping

Pillar name	Non-capped pillar values			Capped pillar values		
	Mean	Std. Dev.	Skewness	Mean	Std. Dev.	Skewness
Opportunity Perception	0.27	0.20	1.22	0.40	0.27	0.83
Start-up Skills	0.38	0.21	0.44	0.49	0.26	0.21
Risk Acceptance	0.54	0.23	-0.29	0.62	0.26	-0.37

Networking	0.33	0.15	1.01	0.52	0.21	0.42
Cultural Support	0.52	0.19	0.47	0.60	0.22	0.35
Opportunity Startup	0.42	0.23	0.57	0.49	0.27	0.49
Technology Absorption	0.25	0.20	0.89	0.41	0.30	0.54
Human Capital	0.23	0.16	1.27	0.40	0.27	0.85
Competition	0.40	0.19	0.84	0.52	0.24	0.63
Product Innovation	0.46	0.20	0.15	0.59	0.24	-0.05
Process Innovation	0.15	0.15	1.61	0.33	0.31	0.85
High Growth	0.20	0.15	1.66	0.40	0.26	0.72
Internationalization	0.39	0.23	0.29	0.49	0.28	0.15
Risk Capital	0.20	0.22	1.25	0.29	0.30	1.06
Average	*0.34*			*0.47*		

Source: authors' edition

According to Table 2, the pillar averages increased from 0.34 to 0.47 as a result of capping; just reinforcing the existence of outliers in the dataset. Before adjustment the skewness values exceeded one in six cases out of fourteen. After adjustment all the skewness values of the pillars have been reduced to the acceptable the [-1;1] range

5. ***Average pillar adjustment:*** The different averages of the normalized values of the indicators imply that reaching the same indicator values require different effort and resources. Since we want to apply GEI for public policy purposes, the additional resources for the same marginal improvement of the pillar values should be the same for all pillars. However, the marginal effects could be different depending on the level of the pillar values. Country variations in the marginal effects are also possible occurrences. Calculating all the marginal effects for all the countries would mean a cumbersome task. So, we suggest a simpler solution that is to equalize the marginal effects of the components only on the average pillar values of all the countries. This technique reduces but does not fully diminish the distortion in calculating the marginal effects. Equation 3 shows the calculation of the average value of pillar *j*:

$$x_j^W = \frac{\sum_{i=1}^{n} x_{i,j}}{n} \qquad (3)$$

We want to transform the $x_{i,j}$ values such that the potential minimum value is 0 and the maximum value is 1:

$$y_{i,j} = x_{i,j}^k \qquad (4)$$

Where $y_{i,j}$ is the average adjusted pillar values for country *i* and pillar *j;*
k is the "strength of adjustment", the *k*-th moment of x_j is exactly the needed average, $\bar{y}_j$.

We have to find the root of the following equation for *k:*

$$\sum_{i=1}^{n} x_{i,j}^k - n\bar{y}_j = 0 \qquad (5)$$

It is easy to see based on previous conditions and derivatives that the function is decreasing and convex which means it can be quickly solved using the well-known Newton-Raphson method with an initial guess of 0. After obtaining *k*, the computations are straightforward. Note that if

$$\begin{aligned} \bar{x}_j < \bar{y}_j \qquad & k < 1 \\ \bar{x}_j = \bar{y}_j \qquad & k = 1 \\ \bar{x}_j > \bar{y}_j \qquad & k > 1 \end{aligned}$$

that is *k* be thought of as the strength (and direction) of adjustment.

The average marginal rate of compensation (AMRC) for any two average pillars *i* and *j* is the same:

$$AMRC_{i,j} = \frac{d\bar{y}_i}{d\bar{y}_j} \qquad (6)$$

The adjusted pillar values are calculated for all the 2006-2015 time period including all the 554 observation. Table 3 shows the average pillar values before and after the equalization procedure:

Table 3: GEI pillar averages before and after average pillar adjustment

Pillar name	Average pillar values before equalization	Average pillar values after equalization
Opportunity Perception	0.40	0.47
Start-up Skills	0.49	0.47
Risk Acceptance	0.62	0.47
Networking	0.52	0.47
Cultural Support	0.60	0.47
Opportunity Startup	0.49	0.47
Technology Absorption	0.41	0.47
Human Capital	0.40	0.47
Competition	0.52	0.47
Product Innovation	0.59	0.47
Process Innovation	0.33	0.47
High Growth	0.40	0.47
Internationalization	0.49	0.47
Risk Capital	0.29	0.47
Average	*0.47*	*0.47*

Source: Authors' calculation

6. ***Penalizing:*** After these transformations, the Penalty for Bottleneck (PFB) methodology was used to create pillar-adjusted PFB values. A bottleneck is defined as the worst performing link or a binding constraint in a particular country's system of entrepreneurship. Here, bottleneck means a shortage or the lowest level of a particular pillar, relative to other pillars. This notion of a bottleneck is important for policy purposes. Our model suggests that pillars interact; if they are out of balance, entrepreneurship is inhibited. The pillar values should be adjusted in a way that takes into account this notion of balance. After equalizing the pillar averages, the value of each pillar of a country is penalized by linking it to the score of the pillar with the weakest scores in that country. This simulates the notion of a bottleneck; if the weakest pillar were improved, the whole GEI would show a significant improvement.

We define our penalty function following as:

$$h_{(i),j} = min\, y_{(i),j} + \mathrm{a}(1 - e^{-\mathrm{b}(y_{(i)j} - min\, y_{(i),j})}) \qquad (7)$$

where $h_{i,j}$ is the modified, post-penalty value of pillar j in country i
$y_{i,j}$ is the normalized value of index component j in country i
y_{min} is the lowest value of $y_{i,j}$ for country i
i = 1, 2, …, n = the number of countries
j= 1, 2, …, m = the number of pillars
0 ≤a, b ≤ 1 are the penalty parameters, the basic setup is a=b=1

The penalty function also reflects to the compensation of the loss of one pillar for a gain in another pillar. Let us define the Marginal Rate of Compensation (MRC) as follows:

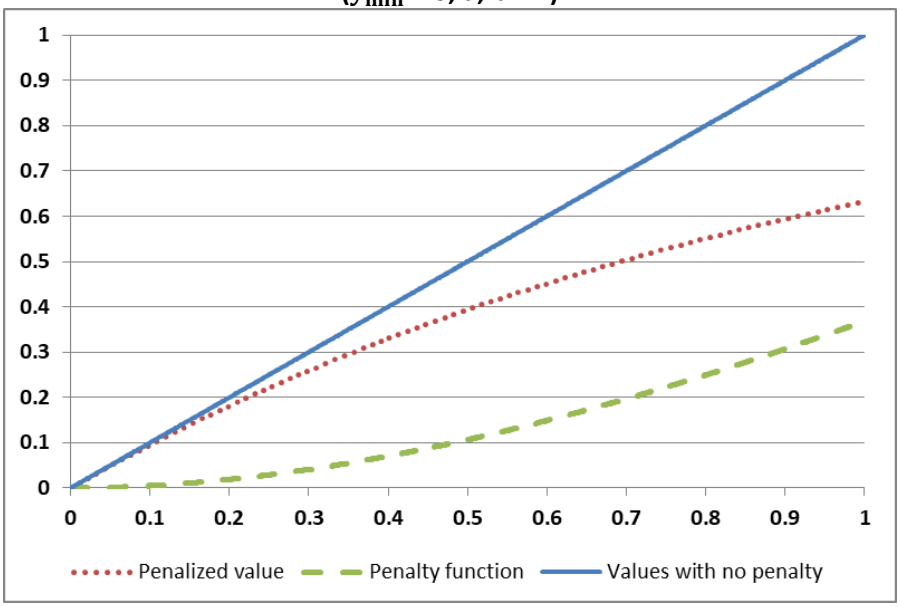
$$MRC_{i,j} = \frac{dy_i}{dy_j} \qquad (8)$$

Full compensability means that a loss in one pillar can be compensated by the same increase in another pillar. However, this is not realistic. The MRC is the same concept as the Marginal Rate of Substitution for goods and to the Marginal Rate of Technical Substitution of inputs (Casadio Tarabusi and Palazzi 2012), that are reflected to the law of diminishing return. Therefore, the effect of the change of the penalty is not proportional. It means that higher compensation is necessary for the loss in one pillar if the difference between another pillar value and the particular pillar is higher as compared to lower differences between the pillars. The required positive value of the second derivative means that the pillars just only partially and not fully compensable with each other meaning that the penalty increases in an increasing rate:

$$\frac{dMRC_{i,j}}{dy_j} > 0 \qquad (9)$$

Figure 1 is picturing the size of the penalty when the minimum pillar value is 0.

Figure 1: Penalty function, the penalized values and the pillar values with no penalty (y_{min} = 0; a, b = 1)



Source: Authors' edition

Note that we do not know the size of penalty. To the best of our knowledge, no objective method exists to define the penalty function exactly. According to Figure 1, the maximum penalty is 0.368. This maximum penalty that is around a third loss of the original value looks reasonable. Larger penalty values rearrange the ranking of the countries considerably. As a result, the average decrease of the GEI points is 9.8%, from 47.1 to 42.5.

Table 4 shows the change of the pillar scores and the size of penalty using one country, Ireland 2015 scores, as an example.

Table 4: Average adjusted pillar scores, penalized scores and penalty in the case of Ireland 2015 values

Pillar name	Average adjusted scores	Penalized scores	Penalty scores	Penalty (%)
Opportunity Perception	0.664	0.630	0.034	5.1%
Start-up Skills	0.904	0.792	0.112	12.4%
Risk Acceptance	0.738	0.684	0.054	7.3%
Networking	0.391	0.391	0.000	0.0%
Cultural Support	0.743	0.688	0.055	7.5%
Opportunity Startup	0.907	0.794	0.113	12.4%
Technology Absorption	0.801	0.728	0.074	9.2%
Human Capital	0.926	0.805	0.121	13.0%
Competition	0.920	0.802	0.118	12.9%
Product Innovation	0.842	0.754	0.088	10.4%
Process Innovation	0.756	0.697	0.059	7.8%
High Growth	0.833	0.748	0.085	10.2%
Internationalization	0.827	0.745	0.083	10.0%
Risk Capital	0.630	0.604	0.026	4.2%
Average	0.777	0.704	0.073	8.7%

Source: Authors' calculation and edition; Legend: Red letter is the bottleneck pillar

Ireland's bottleneck pillar is "Networking" with 0.391 average adjusted pillar score. The bottleneck pillar is not penalized. The second lowest pillar is "Opportunity Perception" with 0.664 score. From the system perspective Ireland cannot fully capitalize from the higher "Opportunity Perception" performance since the bottleneck pillar is holding back. The size of the penalty is 0.034, around 5.1%. Ireland's best pillar is "Human Capital" (0.926). Since the difference between the bottleneck "Networking" pillar and "Human Capital" is larger than between "Networking" and "Opportunity Perception", the size of penalty is higher both in absolute value and proportionally, resulting 0.121 (13%) of penalty. All the other penalties are between these two extremes. On the average, Ireland is losing 8.7% of its entrepreneurial resources because of the imbalances in its system of entrepreneurship.

There are some important policy related consequences of the PFB methodology. First, the different pillars cannot be fully substituted with each other. In other words, the performance of the better performing pillar just only partially compensates for the bad performance of the bottleneck pillar. Second, the overall GEI index score can be improved the most by increasing the bottleneck pillar. The magnitude of the enhancement depends on the relative size of the bottleneck as compared to the other pillars. Third, for policy makers it means that the enhancement of the worst performing bottleneck pillar is the most important priority for entrepreneurship policy.

7. ***Sub-index calculation***: The pillars are the basic building blocks of the entrepreneurial attitudes (ATT), entrepreneurial abilities (ABT), and entrepreneurial aspirations (ASP) sub-indexes. The value of a sub-index for any country is the arithmetic average of its PFB-adjusted pillars for that sub-index multiplied by a 100 (Eq. 10a, 10b and 10c). The maximum value of the sub-indices is 100 and the potential minimum is 0, both of which reflect the relative position of a country in a particular sub-index.

$$ATT_i = 100 \sum_{j=1}^{5} h_j \qquad (10a)$$

$$ABT_i = 100 \sum_{j=6}^{9} h_j \qquad (10b)$$

$$ASP_i = 100 \sum_{j=10}^{14} h_j \qquad (10c)$$

where $h_{i,j}$ is the modified, post-penalty value of pillar j in country i
i = 1, 2, …, n = the number of countries
j= 1, 2, …, 14 = the number of pillars

8. **The Global Entrepreneurship Index calculation.** The super-index, the Global Entrepreneurship Index, is simply the average of the three sub-indices (Eq. 11). Since 100 represents the theoretically available limit the GEI points can also be interpreted as a measure of efficiency of the entrepreneurship resources.

$$GEI_i = \frac{1}{3}(ATT_i + ABT_i + ASP_i) \qquad (11)$$

where i = 1, 2, …, n = the number of countries

While the holistic view of entrepreneurship has had a long history (Audretsch and Belitski 2016; Hofer and Bygrave 1992; Park 2005) the identification and the interrelation of the elements of the system of entrepreneurship is less elaborated. For example, the recent development in the entrepreneurship ecosystem literature (Isenberg 2011; Mason and Brown 2014; Stam 2015; Stangler and Bell-Masterson 2015) focus on identifying the elements of the system but neglects to examine the connection amongst these elements. As reflecting to this gap, Acs et al (2014) developed the Penalty for Bottleneck (PFB) methodology that views the 14 pillars of entrepreneurship in interaction with one another. Following Miller's configuration theory (Miller 1986, 1996), we assert that performance of entrepreneurial ecosystem is more a function of the harmonization of the pillars than it is of the strength of individual pillars themselves. Thus, optimal performance of entrepreneurial ecosystem requires that the normalized and adjusted values of the 14 pillars be equal.

5. Measuring and comparing the level of entrepreneurship in the European Union member states

Finally we have calculated the GEI index scores for all the countries participating in the GEM survey in the 2006–2015 time periods and selected the European Union countries. We have no data on Cyprus and Malta at all. For other four countries, Austria, Bulgaria, Czech Republic, and Luxemburg data are available on for only a few years (1–3 years). The request form FIRES was to calculate the index, sub-index and pillar scores for as many EU countries as possible for the 2006–2015 time period. Unfortunately, the ten years data are available only for nine EU countries. To increase data availability we estimated some missing country individual pillar scores. It resulted a doubling of the number of countries to eighteen. For a shorter five years' time period (2011–2015), we can provide data for 22 EU member countries. Table 5 presents the countries and years of data availability including estimated scores for all 26 EU nations.

Table 5: Data availability for the 26 EU countries, 2006-2015*

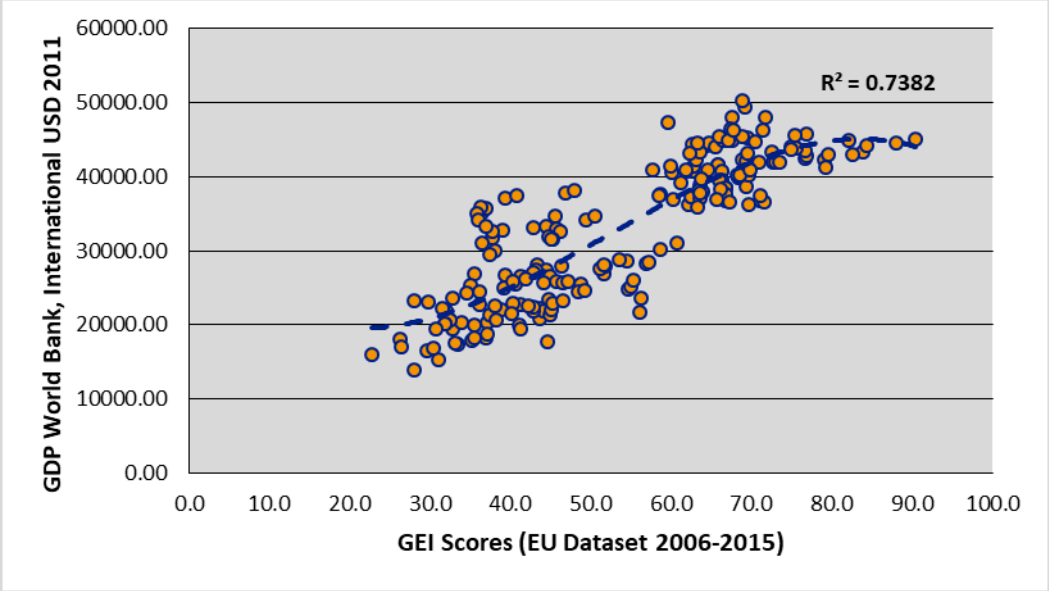
Country\year	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	Number of years	Number of est. years
Austria		x					x		x		3	0
Belgium	x	x	x	x	x	x	x	x	x	x	10	0

Bulgaria										x	1	0
Croatia	x	x	x	x	x	x	x	x	x	x	10	0
Czech Rep.	x					x		x			3	0
Denmark	x	x	x	x	x	x	x	est.	x	est.	10	2
Estonia						est.	x	x	x	x	5	0
Finland	x	x	x	x	x	x	x	x	x	x	10	0
France	x	x	x	x	x	x	x	x	x	est.	10	1
Germany	x	est.	x	x	x	x	x	x	x	x	10	1
Greece	x	x	x	x	x	x	x	x	x	x	10	0
Hungary	x	x	x	x	x	x	x	x	x	x	10	0
Ireland	x	x	x	est.	x	x	x	x	x	x	10	1
Italy	x	x	x	x	x	est.	x	x	x	x	10	1
Latvia	x	x	x	x	x	x	x	x	est.	x	10	1
Lithuania						x	x	x	x	est.	5	1
Luxembourg								x	x	x	3	0
Netherlands	x	x	x	x	x	x	x	x	x	x	10	0
Poland						x	x	x	x	x	5	0
Portugal	est.	x	est.	est.	x	x	x	x	x	x	10	3
Romania	est.	x	x	x	x	x	x	x	x	x	10	1
Slovakia						x	x	x	x	x	5	0
Slovenia	x	x	x	x	x	x	x	x	x	x	10	0
Spain	x	x	x	x	x	x	x	x	x	x	10	0
Sweden	x	x	est.	est.	x	x	x	x	x	x	10	1
United Kingdom	x	x	x	x	x	x	x	x	x	x	10	0

Note: Data with estimated individual value scores are reported by grey background; Source: Authors' edition

Any estimation is risky since it means creating non-existent data. Here, we estimated data points from one year up to three years (Portugal). It is important to note that we estimated only the individual variables (half of the variables); institutional variables are all valid, original data points. For estimation we used two techniques: For the end points (2006 and 2015) we used the closest two year average values and for intermediate points we used a linear interpolation technique. We think that estimating one year data is not a real problem, it results probably very minimal distortion. This is the case for Estonia (2011), France (2015), Germany (2007), Ireland (2009), Italy (2011), Latvia (2014), Lithuania (2015), and Romania (2006). In the case of Denmark and Sweden we estimated two years individual data points; still and acceptable solution. The case of Portugal is riskier because we estimated three data points that are in the 2006–2009 time period. There is no clear rule what should we do in this case, we would suggest to include Portugal in the data set, however, it is only the authors' view.

Figure 2: The relationship of the GEI scores of European countries for 2006–2015 and GDP per Capita values (measured in International USD 2011 by World Bank)

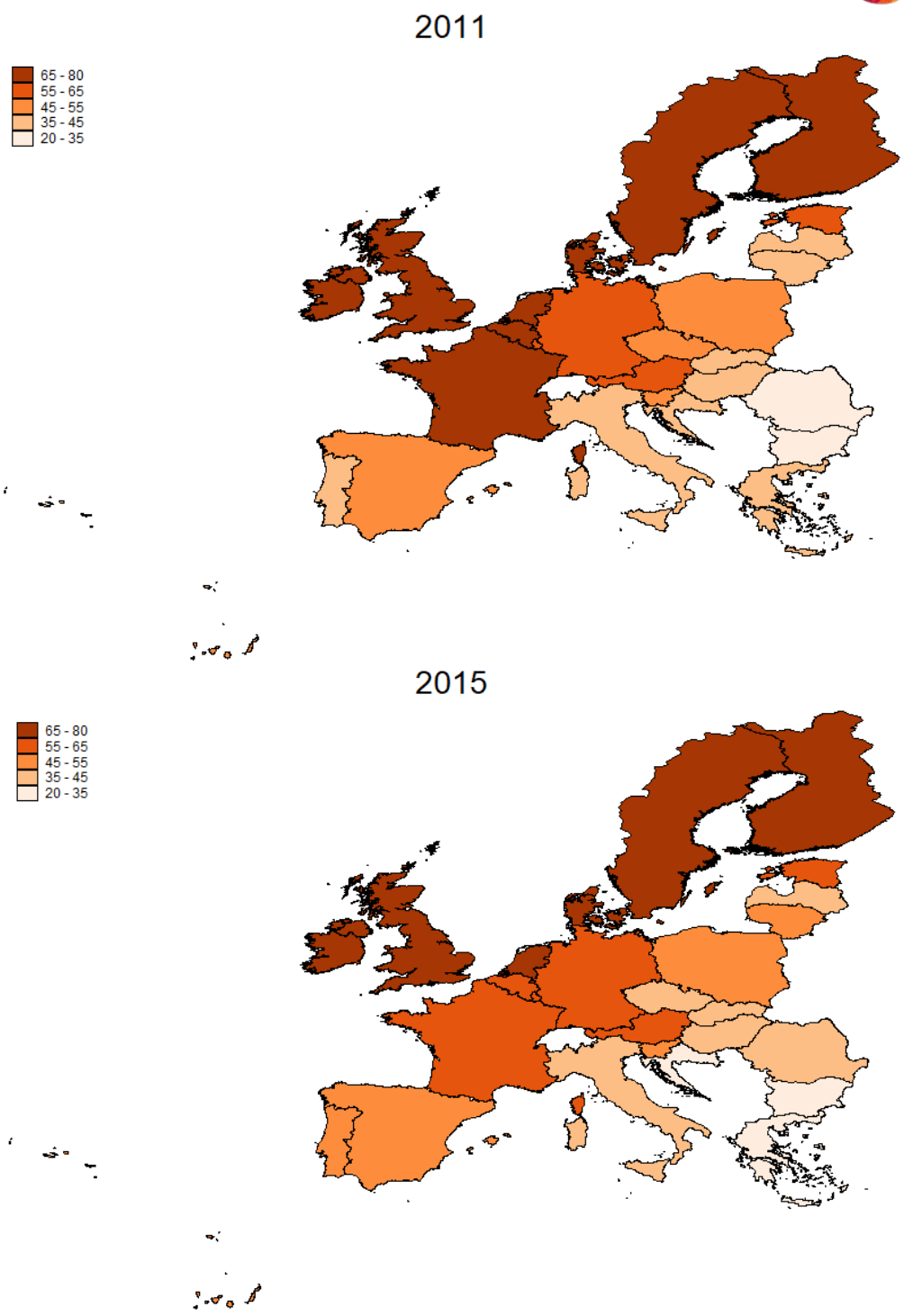


Source: Authors' edition

As the relationship of economic development (measured by GDP per Capita) and GEI Scores has been investigated, it can be concluded that there is a strong correlation among these measures. It is confirmed be the R-Square value among these items, as GEI Scores explain the variance of GDP by about 74% (Figure 2). The graph refers also on the distinction among more developed Northern and Western European, and less developed Central and Eastern European countries. It can be observed as a trend that the more developed countries has relatively higher GEI scores compared to the less developed economies.

In order to demonstrate this difference among EU countries, we created two maps (Figure 3a and 3b). Both in 2011 and 2015 the best values have been represented by the Northern and Western European countries particularly the Scandinavian countries, the Netherlands and the UK. The scores of France and Belgium decreased slightly from 2011 to 2015, but they show above average scores altogether with Germany, Luxembourg, Austria and Estonia (as the only one from the Central and Eastern European area). Spain, Portugal, Slovenia, Poland and Lithuania represent moderate values, while a couple of Central and Eastern European countries as well as Italy have a GEI score below the average. According to the values for 2011, the lowest score had Romania, but their performance has slightly improved by 2015. Therefore Bulgaria and Greece showed the lowest performance for 2015.

Figure 3a and 3b: The GEI scores in 26 EU countries for 2011 (3a) and 2015 (3b)

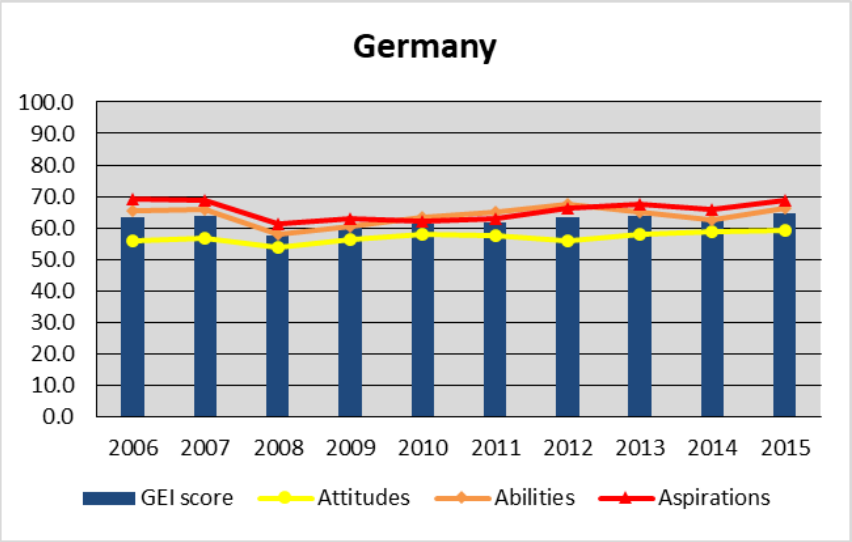


Note: For 2011 map, scores from different years have been used in the case of Austria (2012), Bulgaria (2015), and Luxembourg (2013). For 2015 map, scores from different years have been used in the case of Austria (2014) and Czech Republic (2013).
Source: Authors' edition

In order to examine these differences in details, we have chosen four countries[3] (Germany, Hungary, Italy and the United Kingdom) with different level of economic development and their GEI as well as sub-index (ATT, ABT and ASP) scores have been compared to each other (Figure 4a–4d).

The GEI scores (dark blue bars) are significantly higher in Germany and the UK compared to Hungary and Italy. Concerning the time series, the German values seems to be the most stable and German sub-index scores (yellow, orange and red lines) represent relatively small differences around the GEI score. The effect of economic crisis can be observed on abilities and aspirations values in case of Germany (Figure 4a). Both of them fell significantly from 2007 to 2008, then their trend represented a slow increase.

Figure 4a: Time series of GEI and its sub-index scores on Germany for 2006–2015

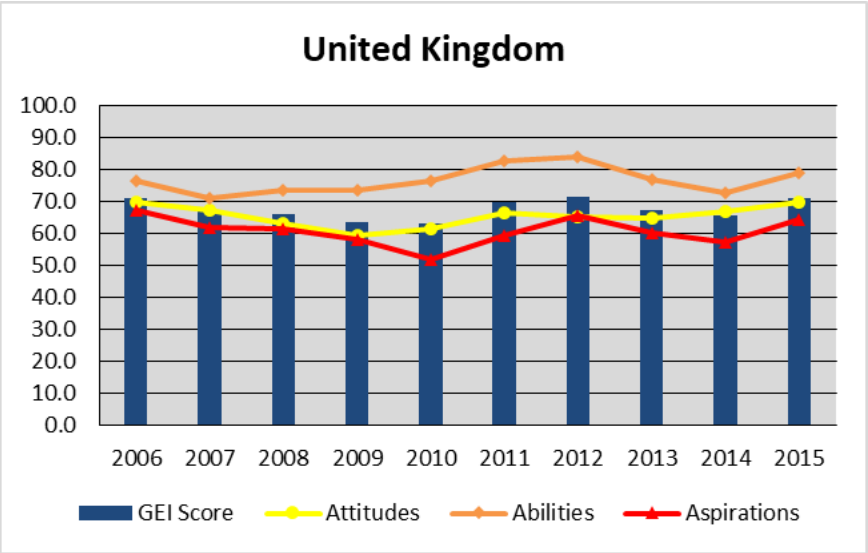


Source: Authors' edition

A relatively bigger differences can be observed among GEI index and sub-indexes scores in the case of UK (Figure 4b). While abilities show almost the highest performance in Europe, attitude scores are less stable than in the German case, but they are still more stable than in the case of Italy or Hungary. The highest variability can be seen in the case of aspirations sub-index scores in the UK. Its trend showed decline from 2006 to 2010. After reaching a turning point, it has risen from 2010 to 2012, then the score represented a shorter waving trend among 2012 and 2015.

Figure 4b: Time series of GEI and its sub-index scores on the United Kingdom for 2006–2015

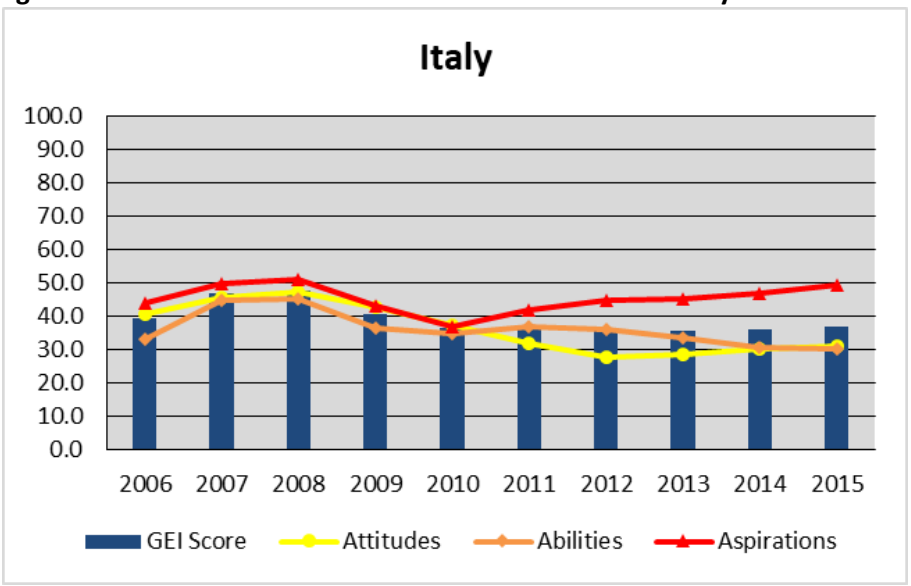
[3] We have chosen Germany, Hungary, Italy and the UK, since related investigations within the FIRES project analyse these countries as well.



Source: Authors' edition

Italy has moderate GEI scores during the investigated time period, but its trend also represents the impact of economic decline from 2008 to 2012 (Figure 4c). The sub-index scores represent similar trends compared to each other as well as to the GEI score. However a divergence can be observed after 2010, that is particularly observable among the values of aspirations (an increasing trend) and the two other sub-index scores (rather decreasing trend).

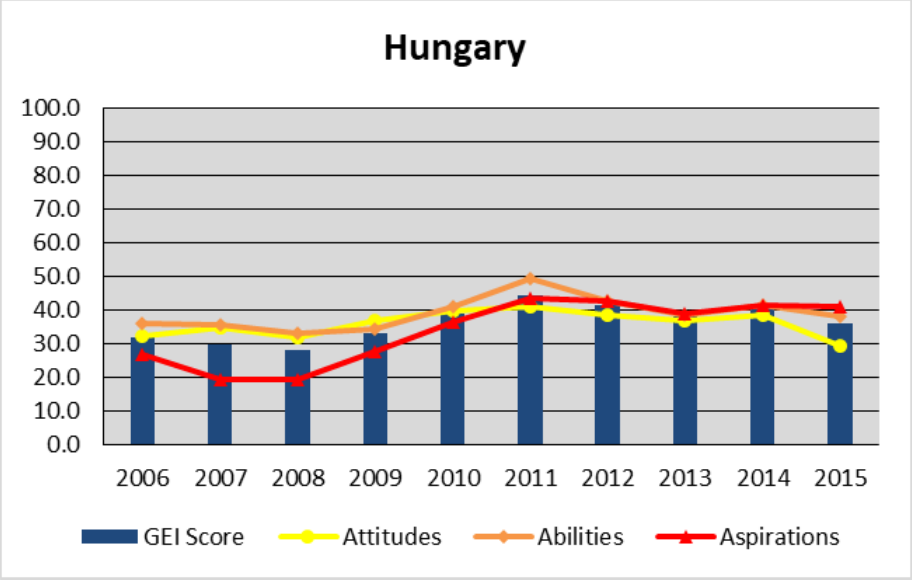
Figure 4c: Time series of GEI and its sub-index scores on Italy for 2006–2015



Source: Authors' edition

The trend Hungarian GEI score also represents a waving trend (Figure 4d). After a slow decline in the first years of the investigated period, a relatively strong rising trend can be observed among 2008 and 2012. Later the country's score remained more or less on this level. The position of sub-index scores have also changed, as attitudes and abilities have relatively high scores during the first phase of the investigated period, but later aspirations received a leading role beside the abilities.

Figure 4d: Time series of GEI and its sub-index scores on Hungary for 2006–2015



Source: Authors' edition

In order to analyse the strengths and weakness of the EU countries, we need to decompose the GEI index. While it is possible to investigate entrepreneurship related to the three sub-indexes and the GEI scores, here we focus on the analysis of the 14 pillars. Table 6 shows the 14 pillar, the three sub-index and the GEI values for each of the 26 European Union member states and the US, as a benchmarking country.

The EU average GEI is 52.39 while the US represent a significantly higher value (83.25). Dividing the EU-member countries into the Old (pre-2004 members) and the New (the countries that joined in 2004 and 2007), there is a significant difference in the performance of entrepreneurial ecosystem: The Old members' GEI average is 61.26 while the New member states' GEI average is only 41.77. EU member countries seem to score high in the aspiration related pillars of "Internationalization", "Process Innovation" and "Risk Capital" and of ability related pillars of "Opportunity Startup" and "Technology Absorption". EU countries score relatively low in the attitudes related pillars like "Networking", "Opportunity Perception", "Risk Acceptance" and "Cultural Support".

The US outperforms the old EU member states in twelve out of the 14 pillars. The old EU member countries are better than the US only in "Networking" and "Opportunity Startup". The dominance of the US is clear by comparing the new EU member states to the US; the US outperforms the old EU member states in each of the fourteen pillars. The whole EU is considerably behind the US that is perhaps a reason behind the increasing differences between the US and the EU. Comparing the old and the new EU member states, new member states are better than the old ones only in two pillars ("High Growth" and "Internationalization"). Out of the remaining twelve pillars, the differences are the largest in "Opportunity Perception" and "Competition" (Table 6).

Table 6: The average adjusted score values of the 14 pillar, the three sub-indexes and the GEI scores of entrepreneurship in the European Union member countries and the US (latest available scores)

Country	1	2	3	4	5	6	7	8	9	10	11	12	13	14	ATT	ABT	ASP	GEI
Austria	0.78	0.88	0.69	0.59	0.63	0.82	0.88	0.53	0.82	0.72	0.70	0.31	0.84	0.59	64.04	66.78	57.27	62.70
Belgium	0.70	0.59	0.55	0.35	0.56	0.56	0.87	0.81	0.85	0.86	0.92	0.51	0.88	0.61	52.51	68.75	67.36	62.87
Bulgaria	0.13	0.38	0.19	0.40	0.28	0.28	0.29	0.24	0.16	0.05	0.46	0.18	0.25	0.20	24.70	22.56	20.82	22.69
Croatia	0.18	0.42	0.10	0.22	0.29	0.38	0.41	0.18	0.31	0.16	0.53	0.49	0.89	0.37	22.66	29.52	40.03	30.74
Czech Republic	0.34	0.46	0.74	0.31	0.14	0.45	0.62	0.35	0.38	0.60	0.80	0.57	1.00	0.42	35.33	40.16	54.43	43.31
Denmark	*1.00*	*0.64*	*0.73*	*0.67*	*0.92*	*1.00*	*1.00*	*1.00*	*0.99*	*1.00*	*0.74*	*0.56*	*0.41*	*0.98*	*72.26*	*85.57*	*66.98*	*74.94*
Estonia	0.87	0.67	0.58	0.53	0.57	0.59	0.50	0.52	0.61	0.58	0.74	0.56	0.71	0.31	59.15	52.64	54.02	55.27
Finland	0.89	0.95	0.75	0.98	0.91	1.00	0.60	0.46	0.38	0.79	0.87	0.65	0.68	0.59	77.95	56.19	66.09	66.74
France	*0.50*	*0.45*	*0.66*	*0.64*	*0.67*	*0.60*	*0.93*	*0.51*	*0.73*	*0.76*	*0.85*	*0.63*	*0.70*	*0.69*	*57.16*	*65.56*	*68.87*	*63.87*
Germany	0.75	0.57	0.62	0.38	0.83	0.76	0.78	0.45	0.92	0.76	0.84	0.61	0.78	0.76	59.28	66.43	68.69	64.80
Greece	0.19	0.73	0.24	0.32	0.32	0.45	0.30	0.49	0.32	0.27	0.47	0.13	0.56	0.60	32.11	35.62	35.81	34.51
Hungary	0.32	0.33	0.16	0.36	0.34	0.44	0.49	0.48	0.25	0.30	0.44	0.48	0.76	0.31	29.14	38.16	40.95	36.09
Ireland	0.66	0.91	0.74	0.39	0.74	0.90	0.80	0.92	0.92	0.84	0.75	0.84	0.83	0.63	63.67	78.04	71.03	70.91
Italy	0.33	0.33	0.36	0.25	0.33	0.37	0.40	0.20	0.29	0.88	0.67	0.17	0.55	0.66	30.96	30.47	49.29	36.90
Latvia	0.42	0.58	0.18	0.38	0.38	0.60	0.64	0.49	0.40	0.38	0.27	0.70	0.64	0.51	36.38	47.64	44.47	42.83
Lithuania	*0.44*	*0.50*	*0.33*	*0.43*	*0.49*	*0.49*	*0.61*	*0.73*	*0.33*	*0.39*	*0.46*	*0.68*	*0.74*	*0.60*	*43.02*	*50.94*	*53.85*	*49.27*
Luxembourg	0.73	0.16	0.56	0.73	0.65	1.00	0.81	0.58	0.98	1.00	0.62	0.50	1.00	0.87	47.60	64.52	61.86	57.99
Netherlands	0.85	0.91	0.82	0.76	1.00	0.96	0.76	0.38	0.80	0.67	0.79	0.51	0.61	0.66	76.45	65.63	60.99	67.69
Poland	0.39	0.69	0.39	0.37	0.47	0.42	0.38	0.51	0.37	0.61	0.37	0.48	0.70	0.58	45.07	41.87	52.72	46.55
Portugal	0.45	0.66	0.63	0.37	0.53	0.57	0.47	0.33	0.45	0.32	0.64	0.34	0.75	0.42	50.34	44.27	46.86	47.15
Romania	0.30	0.38	0.23	0.19	0.42	0.29	0.47	0.45	0.29	0.30	0.30	0.58	0.69	0.73	29.57	35.59	45.99	37.05
Slovakia	0.29	0.37	0.69	0.34	0.30	0.38	0.55	0.40	0.24	0.50	0.53	0.63	1.00	0.57	37.82	37.92	56.49	44.08
Slovenia	0.30	0.84	0.79	0.33	0.48	0.59	0.65	0.51	0.41	0.59	0.73	0.36	0.85	0.40	50.25	51.00	53.49	51.58
Spain	0.40	0.68	0.66	0.62	0.33	0.54	0.74	0.40	0.41	0.32	0.55	0.27	0.26	0.56	49.54	48.31	37.39	45.08
Sweden	1.00	0.51	0.75	0.74	0.90	0.94	1.00	0.63	0.82	0.81	1.00	0.61	0.87	0.62	73.46	78.96	73.92	75.45
United Kingdom	0.82	0.58	0.85	0.51	0.91	0.89	0.98	0.75	0.76	0.65	0.71	0.75	0.63	0.56	69.94	78.92	64.60	71.16
Old EU Member States	0.69	0.63	0.64	0.55	0.71	0.77	0.76	0.57	0.71	0.74	0.75	0.51	0.72	0.66	59.12	63.26	61.40	61.26
New EU Member States	0.36	0.51	0.40	0.35	0.38	0.45	0.51	0.44	0.34	0.41	0.51	0.52	0.75	0.46	37.55	40.73	47.02	41.77
EU Member States	0.54	0.58	0.54	0.47	0.55	0.63	0.65	0.51	0.55	0.58	0.64	0.50	0.71	0.57	49.63	53.15	54.40	52.39
United States	0.83	1.00	0.99	0.53	0.88	0.76	0.81	1.00	0.97	0.91	0.93	1.00	1.00	1.00	78.91	82.43	88.40	83.25

Note: Scores for 2015, except Austria (2014) and the Czech Republic (2013); Rows written italics mark estimated data.

Legend (columns): 1. Opportunity Perception (ATT), 2. Start-up Skills (ATT), 3. Risk Acceptance (ATT), 4. Networking (ATT), 5. Cultural Support (ATT), 6. Opportunity Startup (ABT), 7. Technology Absorption (ABT), 8.Human Capital (ABT), 9. Competition (ABT), 10. Product Innovation (ASP), 11. Process Innovation (ASP), 12. High Growth (ASP), 13. Internationalization (ASP), 14. Risk Capital (ASP); Source: Authors' calculation and edition

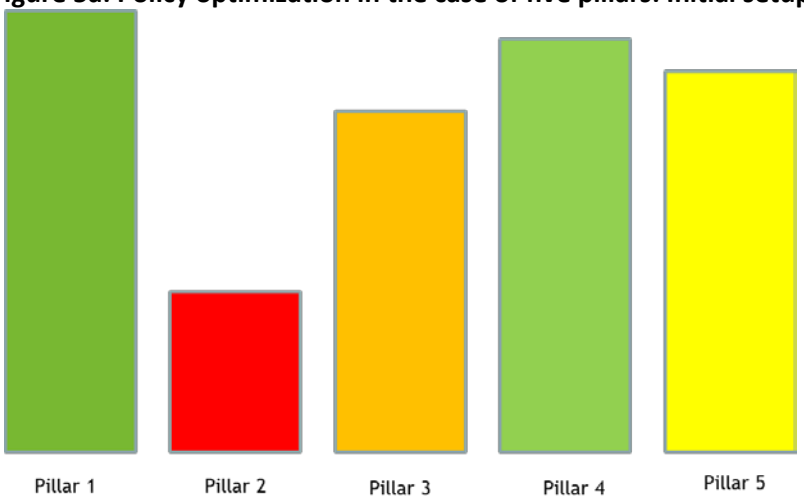
6. The policy application of the GEI methodology

6.1. Bottleneck sensitivity analysis

An important implication of the GEI analysis is the best way to increase the GEI is to reduce the differences between the pillars by enhancing the weakest GEI pillar. However, another pillar may become the weakest link constraining the performance in entrepreneurship. This system dynamics leads to the problem of "optimal" allocation of the additional resources. In other words, if a particular country were to allocate additional resources to improving its GEI Index scores, how should this additional effort be allocated to achieve an "optimal"[4] outcome?

Let's assume that we would like to increase the average GEI index score by 5. The PFB method calculation implies that the greatest improvement can be achieved by alleviating the weakest performing pillar. Once the binding constraint has been eliminated then the further available resources should be distributed to improve the next most binding pillar and so on, until the additional resources are exhausted. Figures 5a–5d show this situation in the case of five pillars and four steps.

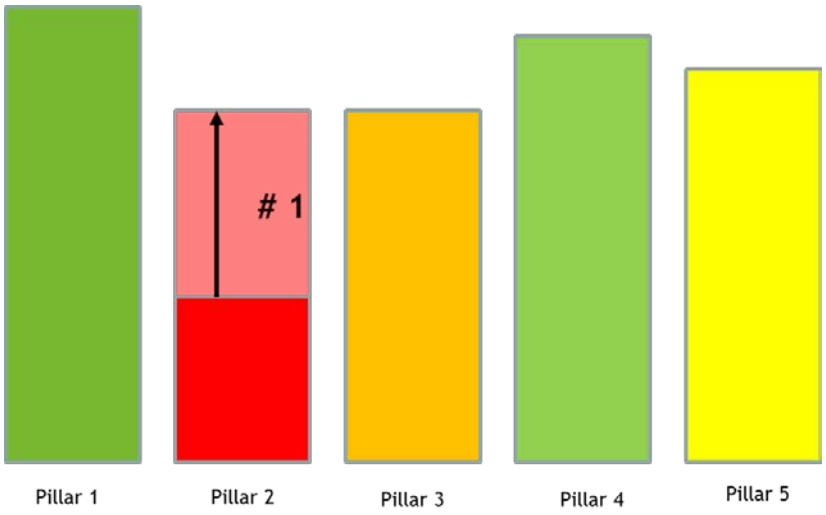
Figure 5a: Policy optimization in the case of five pillars: Initial setup



According to Figure 5a, the bottleneck pillar is Pillar 2, the second lowest is pillar 3 followed by pillar 5. First, Pillar 2 score should increase to the level of Pillar 3. We increase Pillar 2 scores in small steps checking out how fare we are from the desired goal to reach a 5 point increase of GEI. According to Figure 5b we could raise Pillar to up to the level of Pillar 3, the second lowest pillar.

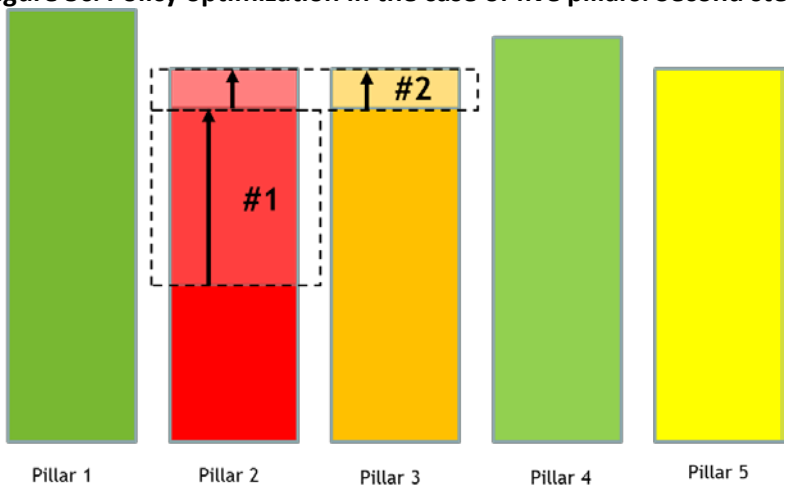
Figure 5b: Policy optimization in the case of five pillars: First step

[4] Optimal in the sense of maximizing the GEI.



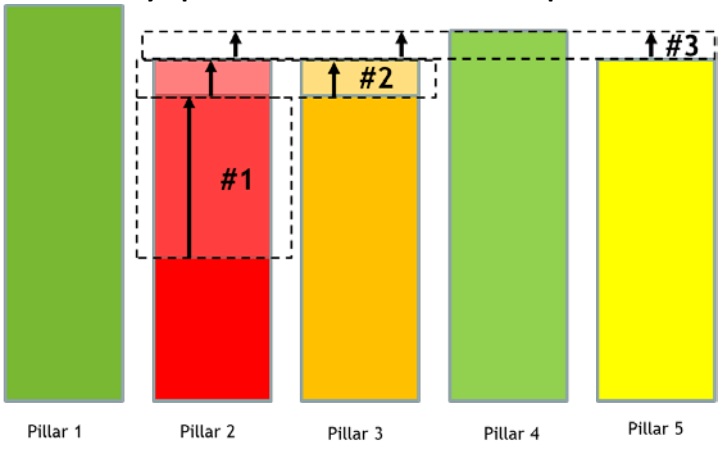
In the second step we should increase the scores of Pillar 2 and Pillar 3 together until we reach the following bottleneck pillar that is Pillar 5 (Figure 5c).

Figure 5c: Policy optimization in the case of five pillars: Second step



Finally in the third step we should increase Pillar 2, Pillar 3 and Pillar 5 scores together until we reach the following bottleneck pillar that is Pillar 4.

Figure 5d: Policy optimization in the case of five pillars: Third step



Once we have reached the desired goal of 5 point increase in GEI we should stop to add further resources. Table 7 presents a practical application of the policy optimization with two countries: Hungary and The Netherlands

Table 7: Simulation of "optimal" policy allocation to increase the GEI score by 5 in Hungary and the Netherlands

	Hungary				The Netherlands			
Pillar	**1**	**2**	**3**	**4**	**1**	**2**	**3**	**4**
Opportunity Perception	0.32	0.03	8%	0.34	0.87	0.00	0%	0.87
Start-up Skills	0.33	0.02	5%	0.35	0.90	0.00	0%	0.90
Risk Acceptance	0.17	0.18	46%	0.34	0.82	0.00	0%	0.82
Networking	0.36	0.00	0%	0.36	0.77	0.00	0%	0.77
Cultural Support	0.34	0.00	0%	0.34	1.00	0.00	0%	1.00
Opportunity Startup	0.44	0.00	0%	0.44	0.96	0.00	0%	0.96
Technology Absorption	0.50	0.00	0%	0.50	0.76	0.00	0%	0.76
Human Capital	0.48	0.00	0%	0.48	0.38	0.15	88%	0.53
Competition	0.25	0.09	23%	0.34	0.81	0.00	0%	0.81
Product Innovation	0.30	0.04	10%	0.34	0.67	0.00	0%	0.67
Process Innovation	0.44	0.00	0%	0.44	0.79	0.00	0%	0.79
High Growth	0.48	0.00	0%	0.48	0.51	0.02	12%	0.53
Internationalisation	0.76	0.00	0%	0.76	0.61	0.00	0%	0.61
Risk Capital	0.32	0.03	8%	0.34	0.66	0.00	0%	0.66
Sum of changes		0.39	7.1%			0.17	1.6%	
Number of pillars changed		6				2		
GEI score	36.3			41.3	67.8			72.8

Source: Authors' calculation. Legend (column): 1 – The situation before the improvement has taken place; 2 – The required increase in the particular pillars in absolute values; 3 – The required increase in the particular pillars in percentages; 4 – The improved pillar values after adjustment.

Hungary has a relatively low GEI scores with several bottlenecks. Hungary's bottleneck is "Risk Acceptance" with 0.17 pillar score, followed by "Competition" (0.25), "Product Innovation" (0.30), "Opportunity Perception" (0.32), "Risk Capital" (0.32) and "Startup Skills" (0.33). Hungary should raise all these six pillars to 0.34 (up to the level of "Cultural Support") to reach the desired goal of five point GEI increase. Altogether, seven percent of the resources need to alleviate the six binding constraints. Note that the amount of these additional resources is relatively high, so this entrepreneurship ecosystem improvement is probably expensive and time consuming task for Hungary.

The Netherlands has only two bottlenecks that are "Human Capital" and "High Growth". The former one is so binding that it requires 88% of the additional resources. The Netherlands needs to turn relatively little new resources – only 1.6% of existing resources – to improve its GEI score by 5 from 67.8 to 72.8.

6.2. Improving entrepreneurship in the European Union: A simulation

In Section 5 we described and analysed the performance of entrepreneurial ecosystems of the European Union compared to its main competitor and benchmark country the United States. On the one hand, it is clear that the US outperforms the EU member countries. In this sense GEI just reinforces what other researchers have already found. However, the GEI analysis has pointed to the significant differences in the quality of entrepreneurial ecosystems across the EU member countries. There are

considerable deviations among the Old EU member states and the New EU member states and among the Nordic countries and the Southern European countries. At the same time, the main administrative and decision-making bodies of the EU have been trying to provide general, uniform policies and guidelines to its member states. According to the GEI, one size does not fit all, and we need tailor-made policies according to the specific needs of each country.

An important note is that the following simulation has a limited potential for interpreting as a policy recommendation, because it relies on important assumptions restraining its practical application. First, the applied 14 pillars of GEI only partially reflect the national system of entrepreneurship. Consequently, maximizing the GEI index of a particular country does not mean maximizing the whole NSE of a particular country. Second, we assume that all GEI pillars require roughly the same effort to improve by the same magnitude, which might well not be realistic. Third, we assume that the costs of the resources to improve the 14 pillars are about the same. In fact, these costs may vary significantly over pillars (Acs et al 2014). Fourth, we set aside the differences in country size by presuming that the same effort is necessary to improve the GEI over the 26 EU countries. Of course, the cost of an improvement of a pillar in larger country like Germany could be considerable higher than in a smaller country like Slovenia.

In the following, we simulate a situation in which each of the investigated EU member countries increase its allocation of entrepreneurship policy resources in an effort to gain a 5 points improvement in the GEI Index. As described earlier, the PFB method calculation implies that the greatest improvement can be achieved by alleviating the weakest performing pillar. Once the binding constraint has been eliminated then the further available resources should be distributed to improve the next most binding pillar. We iterated this procedure until an overall GEI Index performance of 5 points in every country had been achieved. The result of the simulation is shown in Table 8.

Table 8a: Simulation of "optimal" policy allocation to increase the GEI score by 5 points in the EU member countries

Country		1	2	3	4	5	6	7	8	9	10	11	12	13	14	Total Effort
Austria	A	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.16	0.00	0.00	0.16
	B	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	100%	0%	0%	1.6%
Belgium	A	0.00	0.00	0.02	0.19	0.03	0.00	0.00	0.00	0.00	0.00	0.00	0.10	0.00	0.00	0.34
	B	0%	0%	6%	56%	9%	0%	0%	0%	0%	0%	0%	29%	0%	0%	3.6%
Denmark	A	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.15	0.00	0.15
	B	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	100%	0%	1.3%
Finland	A	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.15	0.03	0.00	0.00	0.00	0.00	0.02	0.20
	B	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.75	0.15	0.00	0.00	0.00	0.00	0.10	0.02
France	A	0.05	0.18	0.00	0.00	0.00	0.00	0.00	0.07	0.00	0.00	0.00	0.03	0.00	0.00	0.33
	B	15%	55%	0%	0%	0%	0%	0%	21%	0%	0%	0%	9%	0%	0%	3.4%
Germany	A	0.00	0.05	0.00	0.14	0.00	0.00	0.00	0.14	0.00	0.00	0.00	0.00	0.00	0.00	0.33
	B	0%	15%	0%	42%	0%	0%	0%	42%	0%	0%	0%	0%	0%	0%	3.5%
Greece	A	0.12	0.00	0.07	0.00	0.03	0.00	0.00	0.00	0.00	0.01	0.00	0.15	0.00	0.00	0.38
	B	32%	0%	18%	0%	8%	0%	0%	0%	0%	3%	0%	39%	0%	0%	6.8%
Ireland	A	0.00	0.00	0.00	0.18	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.19
	B	0%	0%	0%	95%	0%	0%	0%	0%	0%	0%	0%	0%	0%	5%	1.8%
Italy	A	0.03	0.00	0.00	0.09	0.00	0.00	0.00	0.14	0.00	0.00	0.00	0.14	0.00	0.00	0.40
	B	8%	0%	0%	23%	0%	0%	0%	35%	0%	0%	0%	35%	0%	0%	7.0%
Luxembourg	A	0.00	0.11	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.11
	B	0%	100%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	1.1%
Netherlands	A	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.15	0.00	0.00	0.00	0.10	0.03	0.00	0.28
	B	0%	0%	0%	0%	0%	0%	0%	54%	0%	0%	0%	36%	11%	0%	2.7%
Portugal	A	0.06	0.00	0.00	0.08	0.00	0.00	0.00	0.14	0.03	0.07	0.00	0.08	0.00	0.00	0.46
	B	13%	0%	0%	17%	0%	0%	0%	30%	7%	15%	0%	17%	0%	0%	6.7%
Spain	A	0.07	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.08	0.00	0.14	0.14	0.00	0.43
	B	16%	0%	0%	0%	0%	0%	0%	0%	0%	19%	0%	33%	33%	0%	6.3%
Sweden	A	0.00	0.12	0.00	0.00	0.00	0.00	0.00	0.12	0.00	0.00	0.00	0.14	0.00	0.06	0.44
	B	0%	27%	0%	0%	0%	0%	0%	27%	0%	0%	0%	32%	0%	14%	3.9%
United Kingdom	A	0.00	0.10	0.00	0.16	0.00	0.00	0.00	0.00	0.00	0.02	0.00	0.02	0.03	0.12	0.45
	B	0%	22%	0%	36%	0%	0%	0%	0%	0%	4%	0%	4%	7%	27%	4.4%

Table 8b: Simulation of "optimal" policy allocation to increase the GEI score by 5 points in the EU member countries (continued)

Country		1	2	3	4	5	6	7	8	9	10	11	12	13	14	Total Effort
Bulgaria	A	0.10	0.00	0.04	0.00	0.00	0.00	0.00	0.00	0.07	0.17	0.00	0.05	0.00	0.03	0.46
	B	22%	0%	9%	0%	0%	0%	0%	0%	15%	37%	0%	11%	0%	7%	13.2%
Croatia	A	0.08	0.00	0.15	0.01	0.00	0.00	0.00	0.05	0.00	0.07	0.00	0.00	0.00	0.00	0.36
	B	22%	0%	42%	3%	0%	0%	0%	14%	0%	19%	0%	0%	0%	0%	7.0%
Czech Republic	A	0.00	0.00	0.00	0.00	0.16	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.16
	B	0%	0%	0%	0%	100%	0%	0%	0%	0%	0%	0%	0%	0%	0%	2.2%
Estonia	A	0.00	0.00	0.00	0.02	0.01	0.00	0.00	0.06	0.00	0.00	0.00	0.00	0.00	0.21	0.30
	B	0%	0%	0%	7%	3%	0%	0%	20%	0%	0%	0%	0%	0%	70%	3.6%
Hungary	A	0.12	0.06	0.00	0.06	0.04	0.00	0.00	0.00	0.12	0.11	0.00	0.00	0.00	0.09	0.60
	B	20%	10%	0%	10%	7%	0%	0%	0%	20%	18%	0%	0%	0%	15%	10.3%
Latvia	A	0.00	0.00	0.18	0.00	0.03	0.00	0.00	0.00	0.00	0.00	0.07	0.00	0.00	0.00	0.28
	B	0%	0%	64%	0%	11%	0%	0%	0%	0%	0%	25%	0%	0%	0%	4.4%
Lithuania	A	0.00	0.00	0.17	0.01	0.00	0.00	0.00	0.00	0.12	0.07	0.00	0.00	0.00	0.00	0.37
	B	0%	0%	46%	3%	0%	0%	0%	0%	32%	19%	0%	0%	0%	0%	5.6%
Poland	A	0.10	0.00	0.07	0.10	0.00	0.09	0.07	0.03	0.05	0.00	0.07	0.00	0.00	0.00	0.58
	B	17%	0%	12%	17%	0%	16%	12%	5%	9%	0%	12%	0%	0%	0%	8.8%
Romania	A	0.02	0.00	0.13	0.16	0.00	0.10	0.00	0.00	0.01	0.01	0.00	0.00	0.00	0.00	0.43
	B	5%	0%	30%	37%	0%	23%	0%	0%	2%	2%	0%	0%	0%	0%	8.1%
Slovakia	A	0.13	0.01	0.00	0.05	0.11	0.02	0.00	0.03	0.12	0.00	0.00	0.00	0.00	0.00	0.47
	B	28%	2%	0%	11%	23%	4%	0%	6%	26%	0%	0%	0%	0%	0%	7.3%
Slovenia	A	0.16	0.00	0.00	0.09	0.00	0.00	0.00	0.03	0.02	0.00	0.00	0.05	0.00	0.00	0.35
	B	46%	0%	0%	26%	0%	0%	0%	9%	6%	0%	0%	14%	0%	0%	4.4%
European Union	A	0.08	0.01	0.08	0.12	0.07	0.00	0.00	0.10	0.05	0.04	0.00	0.08	0.00	0.00	0.63
	B	13%	2%	13%	19%	11%	0%	0%	16%	8%	6%	0%	13%	0%	0%	7.9%

Source: Authors' calculation;

Legend: A: Required increase in pillar; B: Percentage of total effort;

Pillars: 1. Opportunity Perception (ATT), 2. Startup Skills (ATT), 3. Risk Acceptance (ATT), 4. Networking (ATT), 5. Cultural Support (ATT), 6. Opportunity Startup (ABT), 7. Technology Absorption (ABT), 8.Human Capital (ABT), 9. Competition (ABT), 10. Product Innovation (ASP), 11. Process Innovation (ASP), 12. High Growth (ASP), 13. Internationalization (ASP), 14. Risk Capital (ASP)

We can see that to improve the EU average GEDI index score by 5 points, an “optimal” effort allocation would call for a 19% improvement in the Networking pillar, a 16% in the Human Capital pillar, and a 13% in the Opportunity Recognition, Risk Acceptance and the High Growth pillars. Of the remaining effort, our simulation suggests that 8% should be allocated to Competition, 6% to Product Innovation, and 2% to Startup Skills. It is important to note that there is a distinction among the content of Human Capital and Startup Skills pillars. The former one reflects on educational level of entrepreneurs and firm’s investments into training and employee development. The latter one identify the presence of skills concerning starting a new business in the whole population of a certain country.

However, looking at Table 9 it is apparent that the “optimal” policy mix is different for the 26 EU member countries. There are not even two EU member countries having the same policy mix to improve the GEDI score by 5. Old EU member states seem to be relatively weak in High Growth, except Denmark, Finland, Germany, Ireland and Luxemburg. Human capital is also a weak pillar in many developed EU countries. New EU member states are particularly fragile in the attitude related pillars of Opportunity Perception and Risk Acceptance. These weaknesses perhaps are related to the heritage of the socialist system.

Countries also differ in the amount of the required additional new resources: For Luxemburg there are only 0.11 (1.1%) new resources necessary while Hungary requires 0.60 (10.3%). All the other EU countries are between these two extremes. It is relatively easier to improve the GEI score if the country has only one weak pillar (Luxemburg, Austria, Denmark, Czech Republic) as compared to those countries that have a more balanced entrepreneurial profile and require more pillars to improve their GEI score: Poland needs to enhance eight pillars, Hungary, Slovakia seven pillars, Bulgaria, Slovakia, Romania and the UK six pillars. All these finding underlie the importance of differentiated entrepreneurship policy in the EU member states.

Conclusion

The main purpose of this report is to present the potential public policy applicability of the Global Entrepreneurship Index approach for the European Union and its member countries. Based on the multidimensional view of entrepreneurship, we introduced the concept of the National System of Entrepreneurship. While previous entrepreneurship measures incorporated only individual data, the GEI combined individual data with contextual institutional factors. GEI also holds that the building blocks, called pillars, of the NSE interact with one another. Acs et al. (2018) have proved that NSE has positive and significant relation with economic growth. Their results proposed that the investigation of entrepreneurial ecosystems could support the understanding of cross-country differences within economic growth rates. Lafuente et al. (2016) suggested that policy makers should focus on the development of NSE and policies that support the application of knowledge in order to create innovations and promote economic growth in the long-run.

We applied the GEI approach to examine the quality of entrepreneurial ecosystems within 26 out of 28 EU member countries. The outcome of the analysis is underlined by three factors. First, the EU has been lagging behind its main competitor, the US, in all aspects of entrepreneurship. Second, the relatively low level of entrepreneurship is one of the main reasons for the relative stagnation of the EU. The less entrepreneurial Southern European countries struggle and suffer the most. Third, the EU recognized its lagging position but these ambitious aims described in the 2000 Lisbon Agenda seem not to be fulfilled. On the contrary, the differences between the EU and the US have increased, calling for agenda new approach.

The EU member nations' example highlights the usefulness of the GEI method in analysing the entrepreneurial profiles of countries from a system perspective. According to the GEI index, the EU countries differ considerably in the quality of entrepreneurial ecosystems. Moreover, even larger differences exist over the 14 pillars in the country levels. In addition to highlighting the most binding bottleneck factors of entrepreneurial ecosystem, the GEI methodology also provides rough indications on how much a country should invest to alleviate a given bottleneck.

The Penalty for Bottleneck methodology quantified the system view by stating that the performance of the NSE is determined by the country's worst performing pillar. In addition, the PFB also assumes the partial substitutability of the pillars of entrepreneurship. However, the exact size and magnitude of the substitution is not known. The unique feature of GEI's Penalty for Bottleneck methodology is that, it is possible to begin simulating alternative policy scenarios and their possible effects at the system level. While numerous potential policy mixes exist, we analysed only one situation in which the GEDI scores were improved by all the 26 EU member countries by 5, about 9%. This simplest simulation is based on four important binding assumptions that limit the practical applicability of the results. One of the most important implications of the analysis is that uniform policy does not work, and the EU member states should apply different policy mixes to reach the same improvement in the GEI. Despite that the GEI framework does not offer a panacea for policy makers, it does provide a useful learning device as a starting point for further policy analysis.

Although GEI serves as an adequate basis for discovering country's entrepreneurial ecosystem, it has to be noted that the GEI three sub-indexes of attitudes, abilities and aspiration, their 14 pillars, 28

variables and 49 indicators only partially capture the National System of Entrepreneurship that limits its general use for policy purposes. Beside the analysis with the application of GEI, further case studies and empirical research might be useful in order to investigate in details those strengths and weaknesses that has been identified previously (see also Acs et al. (2014)).

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Appendix

Appendix 1: The description of the GEI index pillars

Pillar name	Description
Opportunity Perception	Opportunity Perception refers to the entrepreneurial opportunity perception potential of the population and weights this against the freedom of the country and property rights
Start-up Skills	Start-up Skill captures the perception of start-up skills in the population and weights this aspect with the quality of education
Risk Acceptance	Risk Acceptance captures the inhibiting effect of fear of failure of the population on entrepreneurial action combined with a measure of the country's risk.
Networking	This pillar combines two aspects of Networking: (1) a proxy of the ability of potential and active entrepreneurs to access and mobilize opportunities and resources and (2) the ease of access to reach each other.
Cultural Support	The Cultural Support pillar combines how positively a given country's inhabitants view entrepreneurs in terms of status and career choice and how the level of corruption in that country affects this view.
Opportunity Startup	The Opportunity Startup pillar captures the prevalence of individuals who pursue potentially better quality opportunity-driven start-ups (as opposed to necessity-driven start-ups) weighted with the combined effect of taxation and government quality of services.
Technology Absorption	The Technology Absorption pillar reflects the technology-intensity of a country's start-up activity combined with a country's capacity for firm-level technology absorption.
Human Capital	The Human Capital pillar captures the quality of entrepreneurs as weighing the percentage of start-ups founded by individuals with higher than secondary education with a qualitative measure of the propensity of firms in a given country to train their staff combined with the freedom of the labor market.
Competition	The Competition pillar measures the level of the product or market uniqueness of start-ups combined with the market power of existing businesses and business groups as well as with the effectiveness of competitive regulation.
Product Innovation	The Product Innovation pillar captures the tendency of entrepreneurial firms to create new products weighted by the technology transfer capacity of a country.
Process Innovation	The Process Innovation pillar captures the use of new technologies by start-ups combined with the Gross Domestic Expenditure on Research and Development (GERD) and the potential of a country to conduct applied research.
High Growth	The High Growth pillar is a combined measure of (1) the percentage of high-growth businesses that intend to employ at least ten people and plan to grow more than 50 percent in five years (2) the availability of venture capital and (3) business strategy sophistication.
Internationalization	The Internationalization pillar captures the degree to which a country's entrepreneurs are internationalized, as measured by businesses' exporting potential weighted by the level of economic complexity of the country.
Risk Capital	The Risk Capital pillar combines two measures of finance: informal investment in start-ups and a measure of the depth of the capital market. Availability of risk capital is to fulfill growth aspirations.

Source: Own creation

Appendix 2: The description of the individual variables used in the GEI

Individual variable	Description
Opportunity Recognition	The percentage of the 18-64 aged population recognizing good conditions to start business next 6 months in area he/she lives,
Skill Perception	The percentage of the 18-64 aged population claiming to posses the required knowledge/skills to start business
Risk Acceptance	The percentage of the 18-64 aged population stating that the fear of failure would not prevent starting a business
Know Entrepreneurs	The percentage of the 18-64 aged population knowing someone who started a business in the past 2 years
Carrier	The percentage of the 18-64 aged population saying that people consider starting business as good carrier choice
Status	The percentage of the 18-64 aged population thinking that people attach high status to successful entrepreneurs
Career Status	The status and respect of entrepreneurs calculated as the average of Carrier and Status
Opportunity Motivation	Percentage of the TEA businesses initiated because of opportunity start-up motive
Technology Level	Percentage of the TEA businesses that are active in technology sectors (high or medium)
Educational Level	Percentage of the TEA businesses owner/managers having participated over secondary education
Competitors	Percentage of the TEA businesses started in those markets where not many businesses offer the same product
New Product	Percentage of the TEA businesses offering products that are new to at least some of the customers
New Tech	Percentage of the TEA businesses using new technology that is less than 5 years old average (including 1 year)
Gazelle	Percentage of the TEA businesses having high job expectation average (over 10 more employees and 50% in 5 years)
Export	Percentage of the TEA businesses where at least some customers are outside country (over 1%)
Informal Investment Mean	The mean amount of 3 year informal investment
Business Angel	The percentage of the 18-64 aged population who provided funds for new business in past 3 years excluding stocks & funds, average
Informal Investment	The amount of informal investment calculated as INFINVMEAN* BUSANG

Appendix 3: The description and source of the institutional variables used in the GEDI

Institutional variable	Description	Source of data	Data availability
Economic Freedom	"Business freedom is a quantitative measure of the ability to start, operate, and close a business that represents the overall burden of regulation, as well as the efficiency of government in the regulatory process. The business freedom score for each country is a number between 0 and 100, with 100 equaling the freest business environment. The score is based on 10 factors, all weighted equally, using data from the World Bank's *Doing Business* study". (http://www.heritage.org/Index/pdf/Index09_Methodology.pdf). Data are collected from 2015.	Heritage Foundation/ World Bank	http://www.heritage.org/index/explore.aspx
Property Rights	"The property rights component is an assessment of the ability of individuals to accumulate private property, secured by clear laws that are fully enforced by the state. It measures the degree to which a country's laws protect private property rights and the degree to which its government enforces those laws. It also assesses the likelihood that private property will be expropriated and analyzes the independence of the judiciary, the existence of corruption within the judiciary, and the ability of individuals and businesses to enforce contracts." (http://www.heritage.org/index/property-rights)	Heritage Foundation/ World Bank	http://www.heritage.org/index/explore.aspx
Freedom and Property	Economic Freedom * Property Rights	Own calculation	
Tertiary Education	Gross enrolment ratio in tertiary education, 2015 or latest available data.	World Bank	http://data.worldbank.org/indicator/SE.TER.ENRR
Quality of Education	Answers to the question: "In your country, how do you assess the quality of math and science education? [1 = extremely poor—among the worst in the world; 7 = excellent—among the best in the world]"		The Global Competitiveness Report 2015-2016, p. 377
Education	Tertiary Education * Quality of Education	Own calculation	
Country Risk	The country risk classifications are meant to reflect country risk. Under the Participants' system, country risk is composed of transfer and convertibility risk (i.e. the risk a government imposes capital or exchange controls that prevent an entity from converting local currency into foreign currency and/or transferring funds to creditors located outside the country) and cases of force majeure (e.g. war, expropriation, revolution, civil disturbance, floods, earthquakes).	OECD	http://www.oecd.org/tad/xcred/crc.htmx
Urbanization	Urbanization that is the percentage of the population living in urban areas, data are from the Population Division of the United Nations, 2010 estimate	United Nations	http://data.worldbank.org/indicator/SP.URB.TOTL.IN.ZS
Infrastructure	Pillar 2, Infrastructure and connectivity in the World Competitiveness Report: „.. in addition to assessing the quality of the transport infrastructure, the pillar also measures the quality of domestic and international transport networks."	World Economic Forum	The Global Competitiveness Report 2015-2016, p. 47
Connectivity	Urbanization * Infrastructure	Own calculation	
Corruption	The Corruption Perceptions Index (CPI) measures the perceived level of public-sector corruption in a country. "The CPI is a "survey of surveys", based on 13 different expert and business surveys." (http://www.transparency.org/policy_research/surveys_indi	Transparency International	http://files.transparency.org/content/download/702/3015/file/CPI2013_DataBundle.zip

	ces/cpi/2009) Overall performance is measured on a ten point Likert scale. Data are collected over the last 24 months.		
Taxation	Paying taxes scores, "..addresses the taxes and mandatory contributions that a medium-size company must pay or withhold in a given year, as well as measures the administrative burden in paying taxes." (http://www.doingbusiness.org/data/exploretopics/paying-taxes)	World Bank	http://www.doingbusiness.org/data/distance-to-frontier
Good Governance	The effectiveness of the government "the capacity of the government to effectively formulate and implement sound policies" (http://info.worldbank.org/governance/wgi/#home)	World Bank	http://qog.pol.gu.se/data/datadownloads/qogbasicdata
Taxgovern	Measures the effectiveness of using the taxes by combining together the level of the tax by the quality of government services, Taxation* Good Governance	Own calculation	
Tech Absorption	Firm level technology absorption capability: "Companies in your country are (1 = not able to absorb new technology, 7 = aggressive in absorbing new technology)".	World Economic Forum	The Global Competitiveness Report 2015-2016–. p. 379
Labor Freedom	Measures the freedom of the labor as "..that considers various aspects of the legal and regulatory framework of a country's labor market, including regulations concerning minimum wages, laws inhibiting layoffs, severance requirements, and measurable regulatory restraints on hiring and hours worked." (http://www.heritage.org/index/labor-freedom)	Heritage Foundation	http://www.heritage.org/index/download
Staff Training	The extent of staff training: "To what extent do companies in your country invest in training and employee development? (1 = hardly at all; 7 = to a great extent)".	World Economic Forum	The Global Competitiveness Report 2015-2016, p. 377
Labor Market	Labor Freedom * Staff Training		
Regulation	Effectiveness of anti-monopoly policy, answering to the question: " In your country, how effective are anti-monopoly policies at ensuring fair competition? [1 = not effective at all; 7 = extremely effective] "	World Economic Forum	The Global Competitiveness Report 2015-2016, p. 395
Market Dominance	Extent of market dominance: "Corporate activity in your country is (1 = dominated by a few business groups, 7 = spread among many firms)".	World Economic Forum	The Global Competitiveness Report 2015-2016, p. 471
Compregulation	Regulation * Market Dominance		
Technology Transfer	These are the innovation index points from GCI: a complex measure of innovation including investment in research and development (R&D) by the private sector, the presence of high-quality scientific research institutions, the collaboration in research between universities and industry, and the protection of intellectual property.	World Economic Forum	The Global Competitiveness Report 2015-2016, p. 22
GERD	Gross domestic expenditure on Research & Development (GERD) as a percentage of GDP, year 2014 or latest available data Puerto Rico, Dominican Republic, and United Arab Emirates are estimated	UNESCO	http://stats.uis.unesco.org/unesco/TableViewer/tableView.aspx?ReportId=2656
Scientific Institutions	Quality of scientific research institutions. Answering to the question: "In your country, how do you assess the quality of scientific research institutions? [1 = extremely poor—among the worst in the world; 7 = extremely good—among the best in the world] "	World Economic Forum	The Global Competitiveness Report 2015-2016, p. 381
Availability of Scientist	Availability of scientists and engineers. Answering to the question: " In your country, to what extent are scientists and engineers available? [1 = not at all; 7 = widely available] "	World Economic Forum	The Global Competitiveness Report 2015-2016, p. 381

Science	GERD* Average of Scientific Institutions and Availability of Scientist	Own calcuation	
Venture Capital	Venture capital availability. Answering to the question: " In your country, how easy is it for start-up entrepreneurs with innovative but risky projects to obtain equity funding? [1 = extremely difficult; 7 = extremely easy]"	World Economic Forum	The Global Competitiveness Report 2015-2016, p. 379
Business Strategy	Refers to the ability of companies to pursue distinctive strategies, which involves differentiated positioning and innovative means of production and service delivery.	World Economic Forum	The Global Competitiveness Report 2015-2016, p. 22
Finance and Strategy	Venture Capital Business Strategy	Own calculation	
Economic complexity	"The complexity of an economy is related to the multiplicity of useful knowledge embedded in it. Because individuals are limited in what they know, the only way societies can expand their knowledge base is by facilitating the interaction of individuals in increasingly complex networks in order to make products. We can measure economic complexity by the mix of these products that countries are able to make." (http://atlas.media.mit.edu/en/resources/economic_complexity/)	Observatory of Economic Complexity	http://atlas.media.mit.edu/en/resources/data/
Depth of Capital Market*	The Depth of Capital Market is one of the six sub-indices of the Venture Capital and Private Equity index. This variable is a complex measure of the size and liquidity of the stock market, level of IPO, M&A and debt and credit market activity. Note that there were some methodological changes over the 2006-2015 time period so previous years comparison is not perfect.	EMLYON Business School France and IESE Business School, Barcelona, Spain	http://blog.iese.edu/vcpeindex/files/2013/08/VCPE-Index-2013-Annual-HD.pdf

Appendix 4: The Global Entrepreneurship Index of European countries for 2006–2015

Country	Year	GEI	Country	Year	GEI	Country	Year	GEI
Austria	2007	68.8	Greece	2006	38.1	Poland	2011	45.0
Austria	2012	64.4	Greece	2007	37.7	Poland	2012	45.1
Austria	2014	62.7	Greece	2008	39.1	Poland	2013	42.2
Belgium	2006	68.4	Greece	2009	37.7	Poland	2014	45.3
Belgium	2007	62.7	Greece	2010	36.5	Poland	2015	46.6
Belgium	2008	65.8	Greece	2011	37.5	Portugal	2006	41.8
Belgium	2009	65.8	Greece	2012	35.6	Portugal	2007	39.4
Belgium	2010	68.2	Greece	2013	35.1	Portugal	2008	44.5
Belgium	2011	66.3	Greece	2014	36.1	Portugal	2009	43.2
Belgium	2012	64.6	Greece	2015	34.5	Portugal	2010	41.3
Belgium	2013	61.8	Hungary	2006	31.5	Portugal	2011	42.8
Belgium	2014	60.2	Hungary	2007	29.7	Portugal	2012	45.0
Belgium	2015	62.9	Hungary	2008	28.0	Portugal	2013	45.7
Bulgaria	2015	22.7	Hungary	2009	32.9	Portugal	2014	46.5
Croatia	2006	32.8	Hungary	2010	38.8	Portugal	2015	47.2
Croatia	2007	37.1	Hungary	2011	44.3	Romania	2006	27.9
Croatia	2008	37.5	Hungary	2012	41.3	Romania	2007	31.1
Croatia	2009	32.0	Hungary	2013	38.1	Romania	2008	29.7
Croatia	2010	33.9	Hungary	2014	40.3	Romania	2009	26.2
Croatia	2011	35.6	Hungary	2015	36.1	Romania	2010	26.4
Croatia	2012	32.5	Ireland	2006	71.8	Romania	2011	30.4
Croatia	2013	31.8	Ireland	2007	69.1	Romania	2012	33.4
Croatia	2014	31.9	Ireland	2008	68.8	Romania	2013	33.1
Croatia	2015	30.7	Ireland	2009	67.6	Romania	2014	35.5
Czech Rep.	2006	48.8	Ireland	2010	63.2	Romania	2015	37.1
Czech Rep.	2011	46.4	Ireland	2011	65.6	Slovakia	2011	39.2
Czech Rep.	2013	43.3	Ireland	2012	69.6	Slovakia	2012	40.6
Denmark	2006	83.9	Ireland	2013	66.5	Slovakia	2013	40.3
Denmark	2007	82.1	Ireland	2014	67.5	Slovakia	2014	42.0
Denmark	2008	90.5	Ireland	2015	70.9	Slovakia	2015	44.1
Denmark	2009	87.9	Italy	2006	39.3	Slovenia	2006	51.6
Denmark	2010	72.7	Italy	2007	46.8	Slovenia	2007	57.0
Denmark	2011	76.7	Italy	2008	47.9	Slovenia	2008	58.7
Denmark	2012	76.9	Italy	2009	40.8	Slovenia	2009	60.7
Denmark	2013	79.1	Italy	2010	36.4	Slovenia	2010	57.3
Denmark	2014	73.1	Italy	2011	36.9	Slovenia	2011	54.5
Denmark	2015	74.9	Italy	2012	36.3	Slovenia	2012	53.5
Estonia	2011	56.1	Italy	2013	35.9	Slovenia	2013	51.8
Estonia	2012	56.2	Italy	2014	36.1	Slovenia	2014	51.1
Estonia	2013	54.7	Italy	2015	36.9	Slovenia	2015	51.6
Estonia	2014	55.0	Latvia	2006	44.6	Spain	2006	44.4
Estonia	2015	55.3	Latvia	2007	41.1	Spain	2007	49.5
Finland	2006	69.3	Latvia	2008	43.7	Spain	2008	50.6
Finland	2007	69.6	Latvia	2009	40.2	Spain	2009	45.6
Finland	2008	73.5	Latvia	2010	35.2	Spain	2010	42.8
Finland	2009	69.3	Latvia	2011	37.0	Spain	2011	45.7
Finland	2010	66.8	Latvia	2012	41.3	Spain	2012	46.2
Finland	2011	66.3	Latvia	2013	43.7	Spain	2013	44.7
Finland	2012	68.6	Latvia	2014	44.1	Spain	2014	45.3
Finland	2013	66.1	Latvia	2015	42.8	Spain	2015	45.1
Finland	2014	63.7	Lithuania	2011	38.2	Sweden	2006	79.2
Finland	2015	66.7	Lithuania	2012	42.9	Sweden	2007	82.7
France	2006	62.9	Lithuania	2013	44.8	Sweden	2008	84.3

France	2007	60.2	Lithuania	2014	48.5	Sweden	2009	76.7
France	2008	58.6	Lithuania	2015	49.3	Sweden	2010	69.8
France	2009	58.4	Luxembourg	2013	58.1	Sweden	2011	79.5
France	2010	62.2	Luxembourg	2014	58.9	Sweden	2012	75.6
France	2011	66.8	Luxembourg	2015	58.0	Sweden	2013	72.5
France	2012	66.3	Netherlands	2006	69.5	Sweden	2014	74.9
France	2013	62.5	Netherlands	2007	70.5	Sweden	2015	75.4
France	2014	63.6	Netherlands	2008	67.5	UK	2006	71.2
France	2015	63.9	Netherlands	2009	59.6	UK	2007	66.8
Germany	2006	63.5	Netherlands	2010	68.9	UK	2008	66.2
Germany	2007	63.7	Netherlands	2011	76.9	UK	2009	63.7
Germany	2008	57.7	Netherlands	2012	71.4	UK	2010	63.3
Germany	2009	59.9	Netherlands	2013	66.1	UK	2011	69.6
Germany	2010	61.1	Netherlands	2014	67.1	UK	2012	71.5
Germany	2011	61.9	Netherlands	2015	67.7	UK	2013	67.4
Germany	2012	63.2				UK	2014	65.6
Germany	2013	63.6				UK	2015	71.2
Germany	2014	62.4						
Germany	2015	64.8						