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QUALITY-RELATED REGIONAL DIFFERENCES IN ENTREPRENEURSHIP BASED ON THE GEDI METHODOLOGY: THE CASE OF HUNGARY*

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This paper presents a regional application of the Global Entrepreneurship and Development Index (GEDI) methodology of Acs et al. (2013) to examine the level of entrepreneurship across Hungary's seven NUTS-2 level regions between 2006 and 2012. The Regional Entrepreneurship and Development Index (REDI) has been constructed for capturing the individual efforts, and their contextual features, of entrepreneurship across regions. The REDI method builds on a Systems of Entrepreneurship Theory and provides a way to profile Regional Systems of Entrepreneurship. Important aspects of the REDI method include the Penalty for Bottleneck analysis, which helps in identifying constraining factors in Regional Systems of Entrepreneurship, and Policy Portfolio Optimisation analysis, which helps policymakers consider trade-offs between alternative policy scenarios and associated allocations of policy resources. The paper describes the entrepreneurial disparities amongst Hungarian regions and provides public policy suggestions to improve the level of entrepreneurship and to optimise resource allocation over the 14 pillars of entrepreneurship in the seven Hungarian regions.

Keywords: entrepreneurship, regional development, entrepreneurship policy, GEM, GEDI, Hungary

JEL classification indices: L26, O21, O43

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1. INTRODUCTION

Entrepreneurship as a major driver of economic development, growth, competitiveness, employment, productivity, and innovation has been gaining increasing importance over the last thirty-some years (Carree – Thurik 2003; Acs 2008; Acs et al. 2008; Braunerhjelm et al. 2009). However, the extent and the magnitude of its influence vary across countries and regions (Audretsch – Fritsch 2002; Fritsch – Schmude 2006; Acs 2010). The start-up rate of new business formations and the industry composition also influence regional growth and contribute to regional disparities (Feldman – Audretsch 1999; Feldman 2001; Audrestch – Fritsch 2002; Acs – Varga 2005; Fritsch – Mueller 2007). Start-up rates as well as post-entry firm performances are influenced by contextual institutional and regulatory features, input and product market structures, and the quality of human capital. Furthermore, agglomeration factors such as clustering, proximity to vital infrastructures, connectivity to major markets shape further the entrepreneurial climate and innovation milieu of the regions (Audretsch – Feldman 1996; Boschma – Lambooy 1999; Andersson et al. 2005).

While entrepreneurship has gained quick and ardent acceptance from practitioners in the policy agenda since its appearance, entrepreneurship policy as a quasi-independent field apart from public and small business policy has just been emerging recently (Acs – Szerb 2007; Lunström – Stevenson 2005). Not only theory, but also the availability of data constraints and influences the further evolution of entrepreneurship policy.[1] Although our knowledge about the role of entrepreneurship in economic development has been increasing, the understanding of policy influences of entrepreneurship has remained relatively underdeveloped. This controversy is, at least partially, due to the discrepancy between the definition and the measures of entrepreneurship. While the complex and multidimensional view of entrepreneurship is widely accepted (Wennekers – Thurik 1999), major measures of entrepreneurship are still one-dimensional (Iversen et al. 2008). The most frequently used start-up, ownership, and business density rates are problematic because they do not differentiate between the quality and the quantity aspects of entrepreneurship (Shane 2009; Acs – Szerb 2012). A common problem of the single-level measures is their negative correlation with the level of development

[1] Following earlier initiatives such as the Observatory of European SMEs, consistent data collection on new firm formation just started less than 15 years ago. One of the pioneers was the Global Entrepreneurship Monitor launched in 1998 (Reynolds et al. 2005). A measure of the regulatory and institutional framework of new firms is the World Bank's Ease of Doing Business Index. In the mid-2000s, OECD launched an entrepreneurship measure program based on a comprehensive, multidimensional definition of entrepreneurship (Hoffman et al. 2006).

measured by the per capita GDP (Szerb et al. 2013). The latest theoretical findings propose a shift from simple entrepreneurship measures to more complex indicators and indices reflecting the multidimensional nature of entrepreneurship and the role of entrepreneurship in economic development. Single measures also fail to identify the effect of national and contextual factors that could also be very different according to the stages of economic development (OECD 2007).

The *Global Entrepreneurship and Development Index* (GEDI) project was designed to provide a suitable measure of entrepreneurship based on the multidimensional definition of entrepreneurship and to present a useful platform for policy analysis and outreach. The salient features of GEDI are (1) the contextualisation of individual-level data by a country's institutional conditions; (2) the use of 14 context-weighted measures of entrepreneurial attitudes, abilities and aspirations; (3) the recognition that different pillars combine to produce system-level performance; and (4) the consequent recognition that national entrepreneurial performance may be held back by bottleneck factors – i.e. poorly performing pillars constrain system performance (Acs et al. 2013).

As the first attempt to adapt the GEDI methodology to measure regional entrepreneurship, the *Regional Entrepreneurship and Development Index* (REDI) was constructed for capturing the contextual features of entrepreneurship across NUTS-2 level Spanish regions (Acs et al. 2014). In this paper, we provide a further development of the GEDI and REDI methodologies for measuring regional-level entrepreneurship in seven NUTS-2 level Hungarian regions. As a result of the original GEDI methodology improvement, the amended technique makes it possible to balance out and optimise the resource allocation of the 14 pillars of entrepreneurship. Similarly to the Spanish regional analysis, this version is also capable of providing tailor-made policy suggestions for the seven Hungarian regions by identifying the bottlenecks of the regional entrepreneurial climate and individual endowments.

The structure of the paper is the following: the next section of the paper focuses on the regional adaption of the GEDI methodology, including a new improvement. Section 3, the main part of the paper, contains the analysis and the policy discussion. Finally, in Section 4, the paper concludes with a summary.

2. THE GLOBAL ENTREPRENEURSHIP AND DEVELOPMENT INDEX (GEDI) METHODOLOGY AND ITS REGIONAL ADAPTATION

The GEDI views entrepreneurship from the system perspective (Acs et al. 2014). As such, entrepreneurship occurs in response to the dynamic, institutionally embedded interaction between entrepreneurial attitudes, abilities, and aspirations,

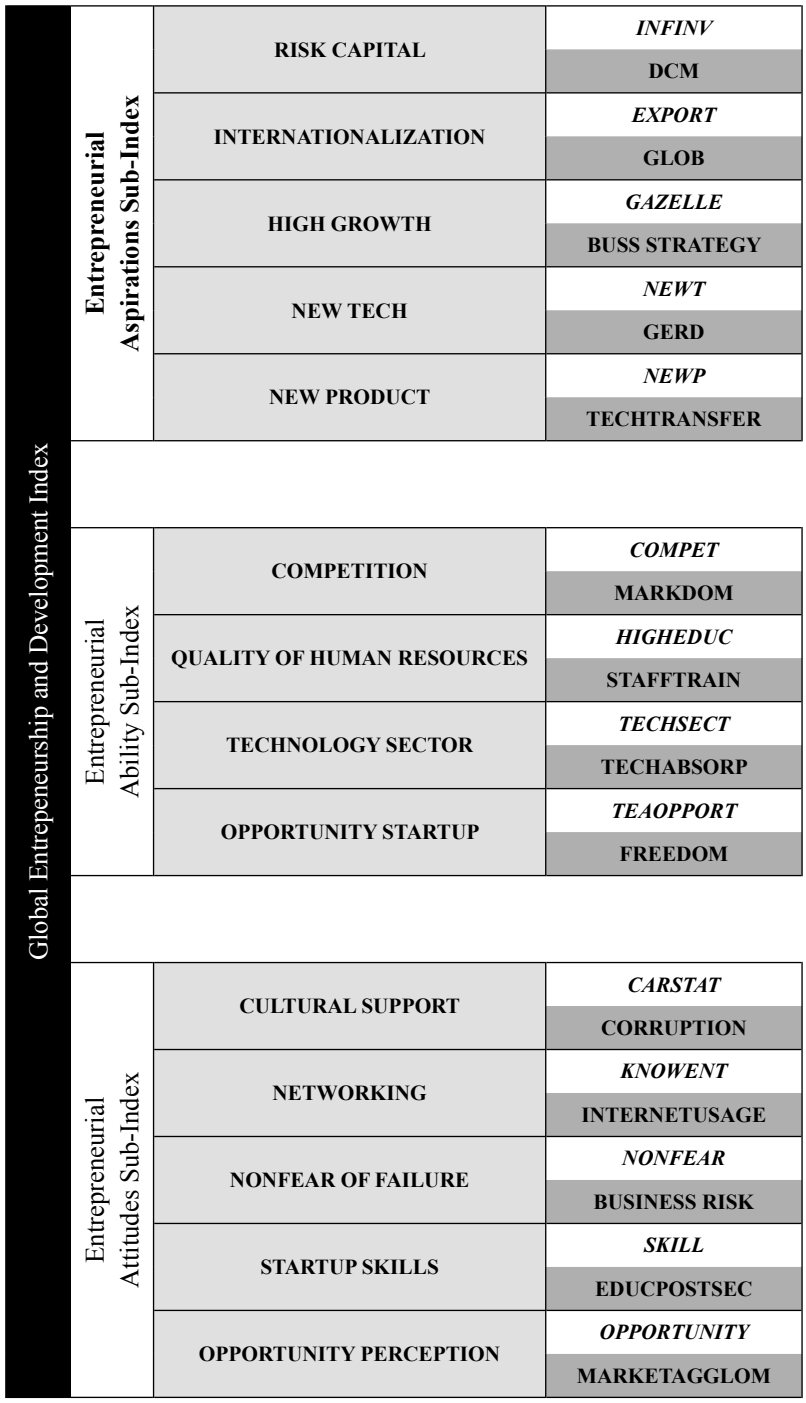

Figure 1. Structure of the Global Entrepeneurship and Development Index

Note: The GEDI is a super-index made up of three sub-indexes, each of which is composed of several pillars. Each pillar consists of an institutional variable (denoted in **bold**) and an individual variable (denoted in ***bold italic***). The data values for each variable are gathered from wide-ranging sources.

Source: Global Entrepreneurship and the United States, by Acs – Szerb (U.S. Small Business Administration, Office of Advocacy, September 2010). www.sba.gov/advo/research/rs____tot.pdf

by individuals, which drives the allocation of resources through the creation and operation of new ventures.

The GEDI is based on 28 variables that make up 14 pillars further divided into three sub-indices: Attitudes (ATT), Abilities (ABT), and Aspiration (ASP). The abilities and aspiration sub-indices capture the quality of actual entrepreneurship activities as they relate to nascent and start-up businesses, while the entrepreneurial attitude sub-index identifies the attitudes of a country's population as they relate to entrepreneurship. Each of the fourteen pillars contains an individual and an institutional variable.[2] The whole structure of the index is depicted in *Figure 1*. A detailed description of the pillars and its components can be found in *Appendix A* and *B*.

The GEDI index also applies the novel *Penalty for Bottleneck* (PFB) methodology, which measures and quantifies the interactions between the individual and institutional components, and facilitates the identification of bottlenecks relevant for policy development.[3] Bottleneck is defined as the worst performing weakest link, or binding constraint in the system. With respect to entrepreneurship, by "bottleneck" we mean a shortage or the lowest level of a particular entrepreneurial pillar as compared to other pillars that differs country and regional levels. This notion of bottleneck is important for policy purposes. Our model suggests that attitudes, ability, and aspiration interact; if they are out of balance, entrepreneurship is inhibited.

The sub-indices are composed of four or five components, defined as pillars that should be adjusted in a way that takes this notion of balance into account. After normalising the scores of all the pillars, the value of each pillar in a country is penalised by linking it to the score of the indicator with the weakest performance in that country. This simulates the notion of bottleneck; if the weakest indicator were improved, the whole GEDI would show a significant improvement. Moreover, the penalty should be higher if differences are higher. Looking from either the configuration or the weakest link perspective, it implies that stable and efficient sub-index configurations are those that are balanced (have about the same level) in all pillars.

Mathematically, we model the penalty for bottlenecks by modifying Tarabusi – Palazzi's (2004) original function for our purposes. The penalty function is defined as:

$$h_{i,j} = y_{\min} + (1 - e^{-(y_{i,j} - y_{min})}) \tag{1}$$

[2] See *Appendix A*, *B* and *C* for the complete GEDI framework.

[3] For the description of the full methodology, see Acs – Szerb (2011). For the newest development, see Acs et al. (2013).

where $h_{i,j}$ is the modified, post-penalty value of index component j in country i,
$y_{i,j}$ is the normalised value of index component j in country i,
y_{min} is the lowest value of $y_{i,j}$ for country i,
$i = 1, 2, \ldots\ldots m$ = the number of countries, and
$j = 1, 2, \ldots\ldots n$ = the number of index components.

We suggest that this dynamic index construction is particularly useful for enhancing entrepreneurship in a particular country. There are two potential drawbacks of the PFB method. One is the arbitrary selection of the magnitude of the penalty. The other problem is that we cannot exclude fully the potential that a particularly good feature can have a positive effect on the weaker performing features. While this could also happen, most of the entrepreneurship policy experts hold that policy should focus on improving the weakest link in the system. Altogether, we claim that the PFB methodology is theoretically better than the arithmetic average calculation since it benchmarks the best country pillar scores and not the average. However, the PFB adjusted GEDI is not necessarliy an optimal solution since the magnitude of the penalty is unknown.

To be able to apply the GEDI index for a regional analysis, the applied data and variables should be adapted to reflect regional conditions. The first attempt for such an adaption has been done by using NUTS-2 level regional data for Spain. In this paper, we follow Acs et al. (2014) in the creation of the 14 pillars, but use an improved version of the GEDI methodology that equalises the individual pillar averages before penalising them.

The main concern for the applied individual variables is the availability of a representative sample size for each of the seven Hungarian NUTS-2 regions.[4] However, the adaption of institutional variables, that is a key for the regional-level index construction, is more complicated. Ideally, we would use the same variables for the regional analyses as we do for the country-level analysis. Unfortunately, we posses only four out of the fourteen cases of such institutional variables. As a second best solution, we applied closely related regional proxies to substitute for a missing variable (five pillars).[5] The calculation of the proxies

[4] While it was not a problem for Spain that had a regionally representative sample, we had to use a pooled data set of the GEM 2008–2012 Adult Population Survey reaching a sample of 10,000, in total. For a detailed discussion regarding the methodology used for GEDI country analyses, see Acs et al. (2012).

[5] Over the last decades, there has been an increasing movement in the European Union to collect institutional variables not only at the country, but also at the regional levels (NUTS-1, NUTS-2 and NUTS-3). This increasing data collection activity provides a unique opportunity to construct an entrepreneurship index similar to the national GEDI. See the Eurostat regional database: http://epp.eurostat.ec.europa.eu

can be found in *Appendix C*. The third possibility is to simply employ the same country-level institutional variables for all regions. In these five cases, the pillar-level values for all seven regions would correspond entirely to the variations of the individual variable component. As a consequence, real Hungarian regional differences may be higher than our analysis shows.

The overall regional-level entrepreneurship and development index (REDI) for the Hungarian regions are calculated as benchmarking pillars determined by the whole data set containing 355 data points over the 2006–2012 time period. While this combined methodology makes it possible to contrast the entrepreneurial performance of the Hungarian regions to other countries, it is more appropriate to compare the regions to one another. For calculating the country and the regional-level index values, we apply the following steps.

First, after handling the outliers we normalise the pillar values:

$$x_{i,j} = \frac{z_{i,j}}{\max_i z_{i,j}} \tag{2}$$

for all $j = 1,..m$ the number of pillars,
where $x_{i,j}$ is the normalised score value for country or region i and pillar j,
$z_{i,j}$ is the original pillar value for country and region i and pillar j, and
$\max_i z_{i,j}$ is the maximum value for pillar j.

Before applying the penalty principle (equation 1) for the unbalance of the 14 pillars on a regional and country level, we should make another adjustment that considers the differences in the 14 pillar averages. Since different pillar averages reflect different marginal rates of substitutions, we should handle for this distortion and equate marginal differences. The equalisation of the pillar average methodology equalises the 14 pillar averages, hence equalises the marginal effect of improvement. Let us calculate the average of each of the 14 pillars as

$$\bar{x}_j = \sum_{i=1}^{n} \frac{x_{i,j}}{n} \text{ for all } j \tag{3}$$

where x_i is the normalised score for country or region i for a particular pillar,
$\bar{x}_j$ is the arithmetic average of the pillar j for number n countries and regions

We want to transform the $x_{i,j}$ values so that the potential values be in the [0,1] range.

$$y_{i,j} = x_{i,j}^{k} \tag{4}$$

where k is the "strength of adjustment", the k^{th} moment of x_j is exactly the needed average, . We have to find the root of the following equation for k:

$$\sum_{i=1}^{n} x_{i,j}^{k} - n\overline{y}_j = 0 \tag{5}$$

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

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

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

After the equalisation of pillar averages, we calculate the penalised pillar values according to equation 1. We calculate the sub-index scores that are the arithmetic averages of its PFB-adjusted pillars for that sub-index multiplied by 100. 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 or region in a particular sub-index.

$$ATT_i = 100 \sum_{j=1}^{5} h_j \tag{6a}$$

$$ABT_i = 100 \sum_{j=6}^{10} h_j \tag{6b}$$

$$ASP_i = 100 \sum_{j=11}^{14} h_j \tag{6c}$$

where h_{ij} is the modified, post-penalty value of pillar *j* in region *i,*

i = 1, 2,……*n* = the number of regions, and

j= 1, 2,…….14 = the number of pillars.

The super-index, the Global Entrepreneurship and Development Index, is simply the average of the three sub-indices.

$$GEDI_i = \frac{1}{3ATT_i + ABT_i + ASP_i} \tag{F7}$$

where *i* = 1, 2,……*n* = the number of countries and regions.

3. REGIONAL DIFFERENCES IN THE SEVEN NUTS-2 HUNGARIAN REGIONS, COMPARED

Table 1 shows the relative rankings of Hungary's seven regions based on their aggregate GEDI scores as compared to 83 other countries. These 83 countries participated in the GEDI 2011 report (Acs et al. 2012). We also report Hungary's overall GEDI scores for two years, 2010 and 2011, in addition to the GEDI score calculated from the 2008–2012 pooled data. It seems that Hungary, as a country, improved its GEDI scores over the 2008–2012 time period. According to *Table 1*, NUTS-2 level regional differences are quite significant: the ranking, with the scores ranging from the high end of 47.7 for Central Hungary, ranking 31st, to 36.1 at the low end for the Southern Great Plain, ranking 63rd. In terms of country comparisons, Central Hungary has a position in the neighbourhood of Latvia and Turkey, while the Southern Great Plain's ranking is similar to the Dominican Republic and Panama. Comparing Hungary's GEDI score (2008–2012) with other former socialist countries, we can determine that except for Serbia, all other post-socialist countries have a better position (Slovenia: 23, Poland: 24, Czech Republic: 26, Croatia: 39, Slovakia: 41, Romania: 44).

The GEDI rankings of the Hungarian regions reflect roughly their well-known ranking relating to regional development, except for Central Transdanubia. Based on the per capita GDP, Central Transdanubia enjoys a better position, usually coming directly after Western Transdanubia. However, according to the latest report of the Hungarian Central Statistical Office (HCSO 2012), Central Transdanubia's position has worsened lately. For example, both the FDI and the attracted overall domestic investment to Central Transdanubia seriously decreased in 2011.

To provide a better understanding of the overall ranking, we present Hungary's regional rankings for the three GEDI sub-indices, namely Entrepreneurial Attitudes (ATT), Entrepreneurial Abilities (ABT), and Entrepreneurial Aspirations (ASP) *(Table 2)*. These three sub-indices make up the overall GEDI score and reflect the three aspects of entrepreneurship development. As shown in *Table 2,* regional differences are the highest for entrepreneurial attitudes. Looking at the 3 top-ranking regions for all three sub-indices, we find that Central Hungary (including the capital, Budapest), Western Transdanubia and Southern Transdanubia hold the leading positions for Entrepreneurial Attitudes (ATT) and for Entrepreneurial Abilities (ABT). In the case of Entrepreneurial Aspirations (ASP), Central Hungary (including Budapest) takes the first place, while Northern Hungary ranks second and Southern Transdanubia is number three.

In the following, we focus on the pillar-level analysis. *Table 3* shows all the 14 pillar values for Hungary's regions and includes two additional useful benchmarks: the average pillar values for the most advanced innovation driven econo-

Table 1

The GEDI 2006–2011 ranking: Countries and Hungary's regions compared

Rank	Country/Region	Per capita GDP (PPP)	GEDI	Rank	Country/Region	Per capita GDP (PPP)	GEDI
1	United States	47 184	78.7	47	Greece	28 154	42.1
2	Denmark	39 558	76.4	48	Barbados	19 252	41.3
3	Sweden	38 947	75.2	49	Hungary 2008-2012		41.2
4	Australia	39 407	74.6	50	Western Transdanubia	18 775	39.8
5	Netherlands	42 475	73.2	51	South Africa	10 486	39.5
6	Canada	38 915	70.3	52	Macedonia	11 072	39.4
7	United Kingdom	35 860	68.6	53	Northern Hungary	12 246	39.3
8	Iceland	34 949	68.3	54	Southern Transdanubia	13 856	39.2
9	Norway	56 894	67.9	55	Mexico	14 566	39.0
10	Switzerland	46 215	66.9	56	Tunisia	8 524	38.1
11	France	33 820	66.8	57	Argentina	15 893	38.0
12	Taiwan	37 931	66.1	58	Central Transdanubia	16 726	37.0
13	Puerto Rico	16 300	65.0	59	China	7 536	37.0
14	Finland	36 660	63.1	60	Jordan	5 706	36.5
15	Belgium	37 448	62.8	61	Northern Great Plain	13 036	36.3
16	Germany	37 591	62.3	62	Dominican Republic	9 280	36.1
17	Austria	39 698	61.7	63	Southern Great Plain	13 307	36.1
18	Chile	15 044	61.7	64	Panama	13 877	34.9
19	Singapore	57 505	61.4	65	Thailand	8 490	33.8
20	Ireland	39 727	61.2	66	Trinidad and Tobago	25 539	33.0
21	Israel	28 546	59.2	67	Jamaica	7 839	32.8
22	United Arab Emirates	38 089	55.9	68	Russia	19 840	32.7
23	Slovenia	27 556	53.0	69	Kazakhstan	12 050	32.2
24	Poland	19 747	51.7	70	Serbia	11 488	32.1
25	Saudi Arabia	22 545	51.5	71	Nigeria	2 363	32.0
26	Czech	25 299	49.8	72	Syria	5 248	31.5
27	Hungary 2011	20 307	49.7	73	Brazil	11 127	31.3
28	Spain	32 070	49.1	74	Indonesia	4 293	31.2
29	Lithuania	18 184	48.6	75	Bosnia and Herzegovina	8 750	30.4
30	Latvia	16 312	47.8	76	Bolivia	4 816	30.3
31	Central Hungary	33 978	47.7	77	Egypt	6 281	30.1
32	Turkey	15 340	47.1	78	Ecuador	8 105	29.3
33	Uruguay	14 277	47.1	79	Philippines	3 940	29.0
34	Korea	29 004	46.7	80	Costa Rica	11 351	28.6
35	Italy	31 555	46.7	81	Iran	11 467	28.4
36	Hong Kong	46 157	46.2	82	Morocco	4 668	28.1
37	Colombia	9 392	45.9	83	Venezuela	11 956	27.8
38	Portugal	25 573	45.7	84	India	3 586	27.3
39	Croatia	19 516	45.6	85	Algeria	8 322	26.8
40	Japan	33 994	44.9	86	Zambia	1 550	24.6
41	Slovakia	23 897	44.8	87	Pakistan	2 674	23.4
	*Budapest**	*30 095*	*44.6*	88	Rwanda	1 155	23.1
42	Hungary 2010		44.4	89	Ghana	1 625	22.7
43	Peru	9 470	43.6	90	Guatemala	4 740	22.7
44	Romania	14 287	43.5	91	Angola	6 035	22.7
45	Lebanon	13 948	42.2	92	Uganda	1 263	22.4
46	Montenegro	12 676	42.1	93	Bangladesh	1 643	18.1

Key: Hungary's ranking is shown in bold and Hungary's regional rankings are shaded.
Source: Authors' own construction.

Table 2

Hungarian regions' relative position: sub-index level and GEDI

	ATT		ABT		ASB		GEDI	
	Rank	**Value**	**Rank**	**Value**	**Rank**	**Value**	**Rank**	**Value**
Central Hungary	1	51.33	1	43.36	1	48.55	1	**47.74**
Central Transdanubia	5	33.41	6	38.23	6	39.28	5	**36.98**
Western Transdanubia	2	35.54	2	42.96	5	41.02	2	**39.84**
Southern Transdanubia	3	33.98	3	39.83	3	43.93	4	**39.25**
Northern Hungary	4	33.68	4	38.42	2	45.75	3	**39.28**
Northern Great Plain	6	32.53	5	38.26	7	38.23	6	**36.34**
Southern Great Plain	7	31.36	7	35.49	4	41.44	7	**36.10**
Budapest		42.47		43.68		47.77		**44.64**
Hungary 2011		**45.59**		**53.40**		**50.21**		**49.70**
Hungary 2010		**43.95**		**46.35**		**42.91**		**44.40**
Hungary 2008-2012		**37.93**		**42.25**		**43.45**		**41.21**

Source: Authors' own construction.

mies[6] and the average value of Hungary's seven regions. We can also identify the most favourable and the least favourable pillar value for each region.

The smallest overall regional pillar variance (0.01) was found in the pillar capturing regional entrepreneurial culture (Cultural Support), implying a relatively equal acceptance and recognition of the role of entrepreneurs throughout the seven regions. At the other end, the Start-up Skills pillar, representing the start-up skills of the population, shows the largest pillar differences in variance (0.25), since it ranges from 0.27 (Central Transdanubia) to 1.00 (Central Hungary). The excessive deviation is mainly due to the differences in the tertiary-level education that is the highest in Central Hungary. Examining the least favourable pillars, we can see that the Hungarian population faces problems in the recognition and the utilisation of good business opportunities and ideas exemplified by the Opportunity Perception pillar. This pillar is found to be the weakest one in all regions. Since Opportunity Perception belongs to the ATT sub-index, it explains the generally weak performance of Hungary and the Hungarian regions in entrepreneurial attitudes. While Opportunity Perception appears to be the weakest pillar of innovation-driven economies as well, the difference is substantial: the innovation-driven country average is 0.53, and the Hungarian regional average is 0.19 (Hungary 2008–2012). The most favourable pillar for four out of the seven regions is Inter-

[6] Innovation-driven economies are defined according to the World Competitiveness Survey categorisation (Porter – Schwab 2008).

Table 3

The pillar-level values of the Hungarian regions

Regions	1	2	3*	4	5	6*	7	8	9*	10	11	12	13*	14*	Less favourable	Most favourable
Central Hungary	0.30	1.00	0.42	0.69	0.44	0.54	0.42	0.50	0.33	0.33	0.47	0.54	0.61	0.61	OPPORTUNITY PERCEPTION	STARTUP SKILLS
Central Transdanubia	0.15	0.27	0.42	0.52	0.45	0.61	0.26	0.39	0.43	0.37	0.37	0.49	0.50	0.42	OPPORTUNITY PERCEPTION	OPPORTUNITY STARTUP
Western Transdanubia	0.17	0.34	0.44	0.50	0.45	0.65	0.36	0.48	0.40	0.33	0.34	0.40	0.76	0.44	OPPORTUNITY PERCEPTION	INTERNATIONALISATION
Southern Transdanubia	0.11	0.42	0.43	0.51	0.44	0.55	0.54	0.33	0.41	0.42	0.33	0.66	0.77	0.44	OPPORTUNITY PERCEPTION	INTERNATIONALISATION
Northern Hungary	0.14	0.33	0.48	0.45	0.43	0.54	0.37	0.31	0.46	0.46	0.36	0.94	0.49	0.45	OPPORTUNITY PERCEPTION	HIGHGROWTH
Northern Great Plains	0.10	0.36	0.46	0.46	0.44	0.50	0.40	0.39	0.44	0.34	0.46	0.38	0.53	0.45	OPPORTUNITY PERCEPTION	RISK CAPITAL
Southern Great Plain	0.09	0.33	0.45	0.44	0.44	0.57	0.38	0.25	0.41	0.41	0.41	0.39	0.64	0.57	OPPORTUNITY PERCEPTION	INTERNATIONALISATION
Budapest	*0.19*	*0.90*	*0.36*	*0.60*	*0.38*	*0.59*	*0.50*	*0.46*	*0.35*	*0.36*	*0.45*	*0.66*	*0.56*	*0.66*	*OPPORTUNITY PERCEPTION*	*STARTUP SKILLS*
Hungarian Regional Average	*0.15*	*0.44*	*0.44*	*0.51*	*0.44*	*0.57*	*0.39*	*0.38*	*0.41*	*0.38*	*0.39*	*0.54*	*0.61*	0.48	*OPPORTUNITY PERCEPTION*	*INTERNATIONALISATION*
Hungary 2011	**0.30**	**0.55**	**0.54**	**0.55**	**0.45**	**0.55**	**0.84**	**0.43**	**0.49**	**0.41**	**0.44**	**0.68**	**0.76**	**0.39**	OPPORTUNITY PERCEPTION	TECHNOLOGY SECTOR
Hungary 2010	**0.24**	**0.58**	**0.58**	**0.55**	**0.42**	**0.56**	**0.56**	**0.50**	**0.36**	**0.32**	**0.39**	**0.51**	**0.63**	**0.43**	OPPORTUNITY PERCEPTION	INTERNATIONALISATION
Hungary 2008-2012	**0.19**	**0.54**	**0.43**	**0.50**	**0.37**	**0.55**	**0.41**	**0.43**	**0.43**	**0.36**	**0.30**	**0.57**	**0.63**	**0.53**	OPPORTUNITY PERCEPTION	OPPORTUNITY STARTUP
Innovation-driven countries	*0.50*	*0.68*	*0.85*	*0.73*	*0.79*	*0.83*	*0.60*	*0.67*	*0.78*	*0.71*	*0.61*	*0.58*	*0.72*	*0.57*	*OPPORTUNITY PERCEPTION*	*NON-FEAR OF FAILURE*

Key: Opportunity Perception (1); Start-up Skills (2); Risk Acceptance (3); Networking (4); Cultural Support (5); Opportunity Start-up (6); Technology sector (7); Human Capital (8); Competition (9); Product Innovation (10); Process Innovation (11); High Growth (12); Internationalisation (13); Risk Capital (14).

List of innovation-driven countries: Australia, Austria, Belgium, Canada, Cyprus, Czech Rep., Denmark, Finland, France, Germany, Greece, Hong Kong, Iceland, Ireland, Israel, Italy, Japan, Korea Rep., Luxemburg, Malta, Netherland, New Zealand, Norway, Portugal, Singapore, Slovenia, Spain, Sweden, Switzerland, United Arab Emirates, United Kingdom, United States. GEDI 2010 country scores are available only for countries in italics.

Source: The Global Competitiveness Report 2010–2011, page 11.

* = pillars where the institutional variable used is the same for all 7 regions.

nationalisation. Central Hungary has a maximum value in Start-up Skills mainly due to the high proportion of educated people in the entire population. Central Transdanubia's strongest pillar is Opportunity Start-up, and surprisingly, Northern Hungary has an extremely high value for the High Growth pillar.

An important implication of the GEDI is related to how to improve the entrepreneurship scores. We simulated a situation in which all the Hungarian regions increased their allocation of entrepreneurship policy resources in an effort to gain a 10-point improvement in their entrepreneurial performance, as captured by the GEDI Index. The Penalty for Bottleneck method used in the GEDI index calculation implies that the greatest performance enhancement will be achieved when additional resources are always allocated to alleviating the most constraining bottleneck. Once the bottleneck pillar has improved sufficiently so as to no longer constitute the most important constraint to system performance, further resource additions need to be allocated to the next most severe bottleneck. We iterated this

Table 4

Simulation of 'optimal' policy allocation to increase the GEDI score by 1% in the Hungarian regions

Regions		1	2	3	4	5	6	7	8	9	10	11	12	13	14	Total effort
Central Hungary	A	0.23	0	0.11	0	0.09	0	0.12	0.03	0.2	0.2	0.07	0	0	0	1.05
	B	22%	0%	10%	0%	9%	0%	11%	3%	19%	19%	7%	0%	0%	0%	
Central Transdanubia	A	0.3	0.17	0.03	0	0	0	0.19	0.06	0.02	0.07	0.08	0	0	0.03	0.95
	B	32%	18%	3%	0%	0%	0%	20%	6%	2%	7%	8%	0%	0%	3%	
Western Transdanubia	A	0.29	0.13	0.02	0	0.01	0	0.1	0	0.06	0.13	0.13	0.06	0	0.02	0.95
	B	31%	14%	2%	0%	1%	0%	11%	0%	6%	14%	14%	6%	0%	2%	
Southern Transdanubia	A	0.33	0.02	0.01	0	0	0	0	0.11	0.03	0.02	0.11	0	0	0	0.63
	B	52%	3%	2%	0%	0%	0%	0%	17%	5%	3%	17%	0%	0%	0%	
Northern Hungary	A	0.31	0.13	0	0.01	0.03	0	0.08	0.17	0	0	0.1	0	0	0.01	0.84
	B	38%	16%	0%	1%	4%	0%	10%	17%	0%	0%	12%	0%	0%	1%	
Northern Great Plains	A	0.35	0.1	0	0	0.01	0	0.06	0.06	0.01	0.11	0	0.07	0	0	0.77
	B	45%	13%	0%	0%	1%	0%	8%	8%	1%	14%	0%	9%	0%	0%	
Southern Great Plain	A	0.33	0.09	0	0	0	0	0.04	0.17	0.02	0.01	0.01	0.04	0	0	0.71
	B	46%	13%	0%	0%	0%	0%	6%	24%	3%	1%	1%	6%	0%	0%	
Budapest	*A*	*0.29*	*0*	*0.12*	*0*	*0.1*	*0*	*0*	*0.02*	*0.12*	*0.12*	*0.03*	*0*	*0*	*0*	*0.8*
	B	*36%*	*0%*	*15%*	*0%*	*13%*	*0%*	*0%*	*3%*	*15%*	*15%*	*4%*	*0%*	*0%*	*0%*	
Hungary 2011	A	0.26	0.01	0.02	0.01	0.11	0	0	0.13	0.06	0.15	0.11	0	0	0.17	1.03
	B	25%	1%	2%	1%	11%	0%	0%	13%	6%	15%	11%	0%	0%	17%	
Hungary 2010	A	0.28	0	0	0	0.11	0	0	0.02	0.16	0.2	0.13	0.01	0	0.1	1.01
	B	28%	0%	0%	0%	11%	0%	0%	2%	16%	20%	13%	1%	0%	10%	
Hungary 2008-2012	A	0.29	0	0.05	0	0.11	0	0.08	0.05	0.06	0.12	0.19	0	0	0	0.95
	B	31%	0%	5%	0%	12%	0%	8%	5%	6%	13%	20%	0%	0%	0%	

Note: A: Required increase in pillar, B: Percentage of total effort. Variables from 1 to 14 are the same as in *Table 3*.

Source: Authors' own construction.

procedure until an overall GEDI Index performance of 10 points in every region had been achieved. This simulation is based on two important assumptions: (1) we allocate additional resources over current resource allocation; and (2) the cost of improving performance is equal for all pillars. The result of the simulation is shown in *Table 4*.

This simulation produces a more nuanced picture of the required allocation of policy effort, if policy were to be optimised to maximise the GEDI index value. We can see that to improve Hungary's 2008–2012 GEDI index score by 10, an 'optimal' effort allocation would call for a 31% improvement in the Opportunity Perception pillar, 20% in the Process Innovation pillar, 13% in the Product Innovation pillar, and 12% in the Cultural Support pillar. Of the remaining effort, our simulation suggests that 8% should be allocated to Technology Sector and 6% to Competition. Less than 5% new effort is necessary to enhance the Risk Acceptance pillar and the Human Capital pillar.

Looking at *Table 4,* it is apparent that the 'optimal' policy mix is different for the seven regions of Hungary. All regions need to improve the Opportunity

Perception pillar, but with varying magnitudes: Central Hungary should spend only 22%, while Southern Transdanubia should require 52% of its new resources to improve the opportunity perception potential of the region. All the other regions are between these two extremes. Besides Opportunity Perception, Process Innovation is also a binding constraint for many regions. Interestingly, the two most developed regions, Central Hungary and Western Transdanubia should lay more emphasis on the strengthening of their innovation activity.

The regions also differ regarding their required total efforts to improve their GEDI score by 1%: for Southern Transdanubia, only 0.63 new resources are necessary, while for Central Hungary, this figure is 1.05.

4. CONCLUDING REMARKS

Over recent years, increasing attention has been paid to the role played by regional-level factors in driving entrepreneurship and thereby regional and national development. Within the EU, an important aim is to decrease regional inequalities. Despite enormous efforts, regional disparities in many countries have been increasing. The examination of the drivers of entrepreneurship at the regional level may explain some of the reasons for these continuing regional inequalities.

For a long time, the number of firms or some kind of activity-related business density data-based variables served to examine entrepreneurship. However, these approaches consider only the quantity aspects of entrepreneurship and neglect the quality differences that are more important for economic development. In this paper, we adapted the GEDI Index to a regional analysis of Hungary's seven regions. While Hungary's regional GEDI values are calculated in the same way as would be those of independent countries, our analysis focuses on comparing the Hungarian regions to one another. The Hungarian regions are investigated in terms of the GEDI, the sub-index as well as the pillar level. According to the regional GEDI scores, Central Hungary enjoys a relatively better position, while the remaining 6 regions do not differ from each other regarding their entrepreneurial attitudes, abilities, or aspirations to a great extent. This finding implies that differences in the domestic regional economic development of the 6 regions are mainly due to existing domestic firms and large multinationals. It is also an indirect proof that foreign direct investment (FDI) has a negligible effect on local entrepreneurship development, at least in the investigated 2008–2011 time period.

The Hungarian regions are found to be particularly weak in the entrepreneurial attitudes- and aspiration-related pillars. In particular, the results show that Hungarian firms exhibit reduced levels of innovation performance. Some of the causes

can be found in the economic structure of Hungarian firms that are focused mainly in services and also the lags in their incorporation of new technologies. Taken together, these all have a negative influence on the productivity and growth of firms. Approximately two-thirds of R&D expenditures were concentrated in the Central Hungarian region in 2011. Considerable research activity can be found in the Northern Great Plain and Southern Great Plain as well, due to their quite large research bases relating to traditional sectors (e.g. agriculture) (HCSO 2012).

Finally, the individual characteristics-based analysis of Hungarian entrepreneurs (potential entrepreneurs) shows that the Hungarian population lacks start-up skills and generally also exhibits a negative attitude towards potential economic or business opportunities.

The policy optimisation simulation revealed that despite similarities in the overall GEDI scores, significant regional differences exist in terms of the 14 pillars of entrepreneurship. The one exception is Opportunity Perception that would call for a nationwide policy intervention. Besides this pillar, one size does not fit all and for resource optimisation, a tailor-made regional policy approach is necessary, taking into account the differences over the fourteen pillar values of the seven regions. For example, Central Transdanubia needs to develop Start-up Skills, Southern Transdanubia's second weakest pillar is Process Innovation, Western Transdanubia is constrained in Product Innovation, Northern Hungary and the Southern Great Plain lack human resources. An important note is that this simulation is not the final outcome of a regional analysis, but rather a starting point of an in-depth investigation to identify accurately the magnitude of the bottlenecks in the Hungarian regions for exact policy measures.

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APPENDIX A

Description of the regional-level individual variables used

Individual variable	Description
OPPORTUNITY	The percentage of the 18–64 aged population recognising good conditions to start business next 6 months in the area he/she lives
SKILL	The percentage of the 18–64 aged population claiming to possess the required knowledge/skills to start business
NONFAIRFAIL	The percentage of the 18–64 aged population stating that the fear of failure would not prevent starting a business
KNOWENT	The percentage of the 18–64 aged population knowing someone who started a business in the past 2 years
NBGOODAV	The percentage of the 18–64 aged population saying that people consider starting a business as good carrier choice
NBSTATAV	The percentage of the 18–64 aged population thinking that people attach high status to successful entrepreneurs
CARSTAT	The status and respect of entrepreneurs calculated as the average of NBGOODAV and NBSTATAV
TEAOPPORT	Percentage of the TEA* businesses initiated because of opportunity start-up motive
TECHSECT	Percentage of the TEA businesses that are active in technology sectors (high or medium)
HIGHEDUC	Percentage of the TEA businesses owner/managers having participated over secondary education
COMPET	Percentage of the TEA businesses started in those markets where not many businesses offer the same product
NEWP	Percentage of the TEA businesses offering products that are new to at least some of the customers
NEWT	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 the country (over 1%)
INFINVMEAN	The mean amount of 3-year informal investment
BUSANG	The percentage of the 18–64 aged population who provided funds for new business in past 3 years, excluding stocks & funds, average
INFINV	The amount of informal investment calculated as INFINVMEAN* BUSANG

Key: TEA (Total Entrepreneurial Activity) = The proportion of the 18–64 year aged working population who is in the process of business start-up and/or has an operating young venture.

Source: Authors' own construction.

APPENDIX B

Description of GEDI's national and regional institutional variables used

Institutional variable	Description	Source of data	Data availability
MARKETDOM	Country level: Domestic market size that is the sum of gross domestic product plus value of imports of goods and services, minus value of exports of goods and services. Data are from 2012.	World Economic Forum	The Global Competitiveness Report 2012–2013, p. 496. http://www3.weforum.org/docs/WEF_GlobalCompetitivenessReport_2012-13.pdf
	Hungary's regional data: Calculation based on the EU regional competitiveness market size calculation, rescaling the variable to a 7-point Likert scale (calculation method in Appendix D).	EU Regional competitiveness 2010	EU Regional Competitiveness Index 2010, p. 154.
URBANISATION	Country level: Urbanisation that is the percentage of the population living in urban areas. Data are from the Population Division of the United Nations, 2011.	United Nations, World Urbanization Prospects: The 2011 Revision	Percentage of population residing in urban areas, 1950–2050 http://esa.un.org/unpd/wup/CD-ROM/Urban-Rural-Population.htm
	Hungary's regional data: Same as above. Data are from 2000–2001.	OECD Regional Typology	OECD Regional Typology, Directorate for Public Governance and Territorial Development, 22 February 2010, p. 21. OECD, StatExtracts http://stats.oecd.org
MARKETAGGLOM	The size of the market: A combined measure of the domestic market size and the urbanisation that later measures the potential agglomeration effect. Calculated as MARKETDOM*URBANIZATION.	Own calculation	-
EDUCPOSTSEC	Country level: Gross enrolment ratio in tertiary education, 2010.	UNESCO Institute for Statistics	World DataBank, World Development Indicators (WDI) http://data.worldbank.org/indicator/SE.TER.ENRR/countries?display=default
	Hungary's regional data: Same as above. Data are from 2011.	Eurostat, Education indicators by NUTS-2 regions	http://appsso.eurostat.ec.europa.eu/nui/setupModifyTableLayout.do

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BUSINESS RISK	Country- and regional-level data source is the same: The business climate rate "assesses the overall business environment quality in a country… ".The alphabetical rating is turned to a 7-point Likert scale from 1 ("D" rating) to 7 (A1 rating). 30. Data are from 2008 except 2009 countries that are from 2009.	Coface	Business Climate Assessment, Coface Country Risk and Economic Research, January, 2013 http://www.coface.com/CofacePortal/COM_en_EN/pages/home/risks_home/business_climate
INTERNET USAGE	Country-level data: The number Internet users in a particular country per 100 inhabitants, 2010.	International Telecommunication Union	ICT Statistics, ITU ICT Eye http://www.itu.int/ITU-D/ICTEYE/Default.aspx
	Hungary's regional data: Same as above. Data are from 2011.	Eurostat, Regional information society statistics	http://appsso.eurostat.ec.europa.eu/nui/show.do
CORRUPTION	Country-level data: The Corruption Perceptions Index (CPI) measures the perceived level of public-sector corruption in a country. Data are from 2012.	Transparency International	http://cpi.transparency.org/cpi2012/in_detail/
	Hungary's regional data: Based on a standardised variable combining education, health, and general public corruption in addition to law enforcements and bribe payment. Calculation is based on Charron et al. (2011), rescaling it to a 10-point scale (see Appendix D for details). Data are from 2009.	Charron et al. (2011)	EU QoG Corruption Index (EQI) http://www.qog.pol.gu.se/data/datadownloads/qogeuregionaldata/
FREEDOM	Country- and regional-level data source is the same: 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. Data are from 2013.	Heritage Foundation/ World Bank	2013 Index of Economic Freedom http://www.heritage.org/index/visualize

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TECHABSORP	Country-level data: Firm-level technology absorption capability: "Companies in your country are (1 = not able to absorb new technology, 7 = aggressive in absorbing new technology)". Data are from 2011–2012, weighted average.	World Economic Forum	The Global Competitiveness Report 2012–2013, p. 489. http://www3.weforum.org/docs/WEF_GlobalCompetitivenessReport_2012-13.pdf
	Hungary's regional data: Proxied by the technological readiness data from the EU regional competitiveness index and rescaling it to the original 7-point scale (see Appendix D for details).	EU Regional competitiveness 2010	EU Regional competitiveness 2010, p. 176
STAFFTRAIN	Country-level data: 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)". Data are from 2011–2012, weighted average.	World Economic Forum	The Global Competitiveness Report 2012–2013, p. 447. http://www3.weforum.org/docs/WEF_GlobalCompetitivenessReport_2012-13.pdf
	Hungary's regional data: Proxied by the Higher education and life long learning sub-index data from the EU regional competitiveness index and rescaling it to the original 7-point scale (see Appendix D for details).	EU Regional competitiveness 2010	EU Regional competitiveness 2010, p. 126.
MARKDOM	Country- and regional-level data sources are the same: Extent of market dominance: "Corporate activity in your country is (1 = dominated by a few business groups, 7 = spread among many firms)". Data are from 2011–2012, weighted average.	World Economic Forum	The Global Competitiveness Report 2012–2013, p. 451. http://www3.weforum.org/docs/WEF_GlobalCompetitivenessReport_2012-13.pdf

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TECHTRANSFER	Country-level data: These are the innovation index points from GCI: a complex measure of innovation. Data are from 2011–2012, weighted average.	World Economic Forum	The Global Competitiveness Report 2012–2013, p. 20. http://www3.weforum.org/docs/WEF_GlobalCompetitivenessReport_2012-13.pdf
	Hungary's regional data: Proxied by the Innovation sub-index data from the EU regional competitiveness index and rescaling it to the original 7-point scale (see Appendix D for details).	EU Regional competitiveness 2010	EU Regional competitiveness 2010, p. 204.
GERD	Country-level data: Gross domestic expenditure on Research & Development (GERD) as a percentage of GDP. Data are from 2010.	UNESCO Institute for Statistics	http://stats.uis.unesco.org/unesco/ReportFolders/ReportFolders.aspx?IF_ActivePath=P,54
	Hungary's regional data: Same content, regional-level application.	Eurostat Regional Database	http://appsso.eurostat.ec.europa.eu/nui/show.do
BUSS STRATEGY	Country-level data: Refers to the ability of companies to pursue distinctive strategies, which involves differentiated positioning and innovative means of production and service delivery. Data are from 2011–2012, weighted average.	World Economic Forum	The Global Competitiveness Report 2012–2013, p. 20. http://www3.weforum.org/docs/WEF_GlobalCompetitivenessReport_2012-13.pdf
	Hungary's regional data: Proxied by the Business strategy sophistication sub-index data from the EU regional competitiveness index and rescaling it to the original 7-point scale (see Appendix D for details).	EU Regional competitiveness 2010	EU Regional competitiveness 2010, p. 188.
GLOB	Country- and regional-level data sources are the same: A part of the Globalisation Index measuring the economic dimension of globalisation. Data are from the 2012 report and based on the 2009 survey.	KOF Swiss Economic Institute	Dreher, A. (2006) http://globalization.kof.ethz.ch/
DCM	Country- and regional-level data sources are the same: The Depth of Capital Market is one of the six sub-indices of the Venture Capital and Private Equity index.	EMLYON Business School France, IESE Business School, Barcelona, Spain	Groh, A. – Liechtenstein, H. – Lieser, K. (2012) http://blog.iese.edu/vcpeindex/about/

APPENDIX C

The rescaling of the regional variables for the level and range of the country-level variable

Example: MARKETSIZE

MARKETSIZE = Hungary's average market size from World Economic Forum = 3.9

Maximum MARKETSIZE = 7 country maximum market size from WEF

$MARKETSIZE_j$ = The applied market size variable for the j^{th} Hungarian region

$REGMARKETSIZE_j$ = jth region market size from Regional Competitiveness score j = 1,……k, k is the number of region in Hungary

Maximum $REGMARKETSIZE_j$ = 100

AVREGAMARKETSIZE = Regional average market size as the average of a country regional market size values

$$MARKETSIZE_j = MARKETSIZE + (REGMARKETSIZE_j – AVREGAMARKETSIZE)(7 – 3.9) / (100 – AVREGAMARKETSIZE$$