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Published in:
Regional Studies

DOI:
[10.1080/00343404.2014.888712](https://doi.org/10.1080/00343404.2014.888712)

IMPORTANT NOTE: You are advised to consult the publisher's version (publisher's PDF) if you wish to cite from it. Please check the document version below.

Document Version
Publisher's PDF, also known as Version of record

Publication date:
2015

[Link to publication in University of Groningen/UMCG research database](#)

Citation for published version (APA):

Acs, Z. J., Szerb, L., Ortega-Argilés, R., Aidis, R., & Coduras, A. (2015). The regional application of the global entrepreneurship and development index (GEDI): The case of Spain. *Regional Studies*, 49(12), 1977-1994. <https://doi.org/10.1080/00343404.2014.888712>

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The Regional Application of the Global Entrepreneurship and Development Index (GEDI): The Case of Spain

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(Received December 2012; in revised form January 2014)

ÁCS Z. J., SZERB L., ORTEGA-ARGILÉS R., AIDIS R. and CODURAS A. The regional application of the Global Entrepreneurship and Development Index (GEDI): the case of Spain, *Regional Studies*. This paper constructs a regional application of the Global Entrepreneurship and Development Index (GEDI) that captures the contextual features of entrepreneurship across regions. Using institutional data and survey data, weaknesses in the incentive structure that affect regional development can be identified. The entrepreneurial disparities among regions are analysed at the country and regional levels using a penalty for bottleneck methodology. The methodology allows public policy action to be coordinated at both national and regional levels. It is found that GEDI provides a valuable tool for understanding regional differences across Spanish regions.

Entrepreneurship policy Regional development Spain Global Entrepreneurship and Development Index (GEDI) Entrepreneurship GEM

ÁCS Z. J., SZERB L., ORTEGA-ARGILÉS R., AIDIS R. and CODURAS A. 全球创业精神与发展指标 (GEDI) 的区域应用：西班牙的案例，区域研究。本文建立一个全球创业精神与发展指标 (GEDI) 的区域应用，该指标捕捉各区域中创业精神的脉络化特徵。本研究运用制度数据与调查数据，指认影响区域发展的诱因结构中的弱点。本研究并使用瓶颈损失 (penalty for bottleneck) 之方法，分析国家与区域层级中，创业精神的区域落差。该方法让公共政策行动得以在国家及区域层级同时进行调节。本研究发现，GEDI 提供了理解西班牙各区域间的区域差异的可贵工具。

创业精神 区域发展 全球创业精神与发展指标 (GEDI) 创业政策 西班牙 全球创业观察 (GEM)

ÁCS Z. J., SZERB L., ORTEGA-ARGILÉS R., AIDIS R. et CODURAS A. L'application régionale de l'indice GEDI: étude de cas de l'Espagne, *Regional Studies*. Cet article cherche à construire une application régionale de l'indice GEDI (Global Entrepreneurship and Development Index) qui saisit les caractéristiques contextuelles de l'esprit d'entreprise à travers les régions. À partir des données institutionnelles et des sondages, il est à noter les faiblesses de la structure des incitations qui risquent d'influer sur l'aménagement du territoire. Employant la méthodologie appelée la pénalité pour goulot d'étranglement (penalty for bottleneck ; PFB), on analyse l'écart entrepreneurial entre les régions sur le plan national et à l'échelon régional. Cette méthodologie permet la coordination des mesures prises à l'initiative des pouvoirs publics à la fois sur le plan national et à l'échelon régional. Il s'avère que l'indice GEDI fournit un outil inestimable pour comprendre les différences régionales à travers les régions espagnoles.

Esprit d'entreprise Aménagement du territoire Indice GEDI Politique en faveur de l'esprit d'entreprise Espagne GEM

ÁCS Z. J., SZERB L., ORTEGA-ARGILÉS R., AIDIS R. und CODURAS A. Die regionale Anwendung des Global Entrepreneurship and Development Index (GEDI): der Fall Spanien, *Regional Studies*. In diesem Beitrag entwickeln wir eine regionale Anwendung des Global Entrepreneurship and Development Index (GEDI) zur Erfassung der kontextuellen Merkmale des Unternehmertums in verschiedenen Regionen. Anhand von institutionellen und Erhebungsdaten lassen sich Schwächen in der Anreizstruktur identifizieren, die sich auf die Regionalentwicklung auswirken. Die Disparitäten des Unternehmertums in verschiedenen Regionen werden auf Landes- und Regionalebene unter Verwendung eines Korrekturabschlags für die Flaschenhals-Methode analysiert. Diese Methode ermöglicht die Koordination von Maßnahmen der öffentlichen Politik auf nationaler und regionaler

Ebene. Es zeigt sich, dass der GEDI ein nützliches Instrument zum Verständnis der Unterschiede zwischen verschiedenen spanischen Regionen darstellt.

Unternehmertum Regionalentwicklung Global Entrepreneurship and Development Index (GEDI) Unternehmenspolitik
Spanien GEM

ÁCS Z. J., SZERB L., ORTEGA-ARGILÉS R., AIDIS R. y CODURAS A. Aplicación regional del Índice Global de Emprendimiento y Desarrollo (GEDI): el caso de España, *Regional Studies*. En este artículo desarrollamos una aplicación regional del Índice Global de Emprendimiento y Desarrollo (GEDI) que capta las características contextuales del interés empresarial en todas las regiones. A partir de datos institucionales y de estudios, podemos identificar las deficiencias en la estructura de incentivos que afectan al desarrollo regional. Analizamos las desigualdades empresariales entre las regiones de ámbito nacional y regional mediante un criterio de sanciones para la metodología del embotellamiento. Con esta metodología se pueden coordinar las medidas políticas de ámbito público tanto a nivel nacional como regional. Observamos que el GEDI es una herramienta valiosa para comprender las diferencias regionales en España.

Interés empresarial Desarrollo regional Índice Global de Emprendimiento y Desarrollo (GEDI) Política empresarial
España GEM

JEL classifications: L26, R11, R58

INTRODUCTION

Over the past several decades the emphasis in regional development theory has shifted from a focus on exogenous factors to an increasing focus on endogenous factors. Traditional regional economic development approaches were erected on neoclassical growth theory, based largely on the Solow growth model. The emerging endogenous approaches attribute a much more significant role for endogenous forces. Those developments are of great interest to regional development analysts and also to practitioners for several reasons, including the recognition of the importance of cities and regions in the development process (STIMPSON *et al.*, 2011, p. 1).

Entrepreneurship has been recognized as an important driver of productivity growth, innovation, employment and competitiveness (CARREE and THURIK 2003; ACS and ARMINGTON, 2006; BRAUNERHJELM *et al.*, 2010). Entrepreneurship is a key aspect to economic dynamism and clearly influences the economic growth of countries and regions (ORGANISATION FOR ECONOMIC CO-OPERATION AND DEVELOPMENT (OECD), 2008). Entrepreneurship and the formation of new businesses are important elements in regional economic growth because they influence the composition of the regional industrial base which is an important predictor of growth and performance differences between regions (AUDRETSCH and FELDMAN 2004; FELDMAN, 2001; ACS and VARGA, 2005; FRITSCH and MUELLER, 2004; VAN DER PANNE, 2004; ACS *et al.*, 2011).¹

The contribution of entrepreneurship to regional growth differs, however, even after taking into account differences in the sectoral composition of economies (AUDRETSCH and FRITSCH, 2002). Existing evidence highlights large differences in entry rates but also in the post-entry performance of young firms between regions. Such differences are likely to reflect the role

of regulatory and institutional frameworks and labour and product market structures, all of which will affect reallocation dynamics in various ways. For example, high barriers to entry, subsidies to incumbents or policy measures that can delay the exit of failing firms may stifle competition and slow the reallocation process relative to an economy without barriers. Local regulations, agreements between incumbent market players (suppliers or distributors), limited access to local input resources, bankruptcy laws and labour market regulations also contribute to reducing the rate of entry of new firms. These barriers and institutions affect market opportunities and hence have a strong influence on industrial renewal and innovation (AGHION *et al.*, 2005; AUDRETSCH and KEILBACH, 2008).

This paper provides a regional application of the Global Entrepreneurship and Development Index (GEDI) to Spanish regions (ACS and SZERB, 2011, 2012). Spain has been selected for two reasons. First, it is a large country with relatively large regional differences in development, industrial structure, culture, etc. (ANNIONI and KOZOVSKA, 2010; CONGREGADO *et al.*, 2005). Second, there is a sufficiently large sample size of the Global Entrepreneurship Monitor Adult Population Survey data collection that is representative for the Spanish NUTS-2 regions. The purpose of this paper is to contribute to the understanding of regional economic development by: (1) constructing a regional application of GEDI that captures the essence of the contextual features of entrepreneurship; and (2) filling a gap in the understanding of economic and social development where high heterogeneity is found in the entrepreneurial climate between countries and regions.

While GEDI does not provide tailor-made entrepreneurship policy suggestions for the different autonomous Spanish regions, it does show the relatively

weak and strong points of their entrepreneurial climate. This approach is consistent with the recent evolution in entrepreneurship policy – an increasing emphasis on taking a more holistic and multipronged view of entrepreneurship, as advocated by the ‘entrepreneurship support ecosystem’ thinking. Thus, this emphasis naturally shifts focus towards a regional level of analysis, consistent with the focus of this paper.

For an optimum configuration of public policy to improve entrepreneurship different levels of public policy are suggested as national, multi- and single levels depending on the deviation of a particular pillar from the best benchmarking value and on how many regions are affected by the weakness of a particular pillar. The next section of this paper presents the basics of index building. The third section presents the regional adaptation of GEDI; the fourth section has the results. The discussion is in the final section. It is found that GEDI provides a valuable tool for understanding regional entrepreneurship differences.

INDEX BUILDING

Introduction

Up to now regional entrepreneurship has been examined mainly in terms of measuring new firm formation (ARMINGTON and ACS, 2002), start-up activities (TOMÁSY, 2006), and attitudes (BOSMA and SCHUTJENS 2009). All these papers analyse entrepreneurship not per se, but take into account the varying effects of the different entrepreneurial activities or attitudes and highlight its regional, cultural, regulatory and other institutional embedding.

The GEDI approach is different from these uptakes in three respects. First, GEDI defines entrepreneurship not as a simple one-dimensional activity but as a complex phenomenon. Second, the 14 entrepreneurial attitudes, abilities and aspiration components, called pillars, are constructed as combining the individual and the contextual institutional (cultural, economic, regulatory and other infrastructural) components together. Third, GEDI has developed new methodologies, called the average pillar adjustment and the penalty for bottleneck (PFB) to incorporate the system perspective in the calculation of the composite entrepreneurship index and to ensure the policy applicability of the index. This section will first present a summary of the GEDI methodology, then discuss the regional adaptation of the GEDI methodology to Spain and finally compare the results.

The Global Entrepreneurship and Development Index (GEDI)

GEDI views entrepreneurship as part of a ‘National System of Entrepreneurship’.² As such entrepreneurship occurs in response to 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. GEDI is the first complex index focusing on the multidimensional quality aspects of entrepreneurship. It is based on 31 variables that make up 14 pillars further divided into three sub-indices. Each of the 14 pillars contains an individual and an institutional variable. The averages of the 14 pillars are equalized to equate the marginal effects of improvements. GEDI also applies the novel PFB methodology that facilitates the identification of bottlenecks relevant for policy development.³

For entrepreneurship, a bottleneck refers to the weakest pillar, i.e. the one that has the lowest value, relative to the other pillars. The PFB is based on the assumption that pillars are only partially substitutable with one another. Hence the strong performance in one particular pillar does not fully compensate for the weak performance in another pillar. In other words, the weakest performing pillars constrain the strongest performing pillars and, ultimately, the overall GEDI value. As a result, every country, regardless of its level of economic development, can improve its entrepreneurial performance by directing policy initiatives to address its specific ‘bottlenecks’.

GEDI’s three sub-indexes capture these three dimensions of entrepreneurship in a national level. As presented in further detail below, the abilities and aspiration sub-indices capture actual entrepreneurship activities as they relate to nascent and start-up businesses, while the Entrepreneurial Attitude (ATT) sub-index identifies the attitudes of a country’s population as they relate to entrepreneurship.

The ATT pillar measures entrepreneurial opportunity perception potential since entrepreneurship depends on recognizing and exploring novel business opportunities. In addition, it is critical to have the proper start-up skills and personal networks to exploit these opportunities. Moreover, fear of failure to start a business can have a negative effect on entrepreneurial attitudes, even when opportunity recognition and start-up skills exist. Further, institutional factors such as market size, a population’s post-secondary educational level, a country’s business climate, Internet usage and cultural attitudes also influence entrepreneurship development. In contrast, the Entrepreneurial Abilities (ABT) sub-index is principally concerned with measuring start-up activities with high growth potential. High growth potential is measured in terms of quality measures such as opportunity motivation for start-up activity, and technology-intensive orientation as well as the entrepreneur’s level of education, and the overall level of competition. The institutional variables measuring entrepreneurial action include freedom for opening, operating and closing a business, technology absorption capacity, the extent of staff training, and a business environment dominated by a few powerful groups.

Finally, the Entrepreneurial Aspiration (ASP) sub-index includes the most relevant individual and institutional variables that measure both the individual and institutional aspects related to further market-expanding, innovative entrepreneurial development. The individual variables measure the newness of a product and of technology used, business internationalization, high growth ambitions and availability of informal financing while the institutional variables measure research and development (R&D) potential, business sophistication and innovation, the level of globalization, and the availability of venture capital.

Table 1 shows the full structure of the GEDI in the sub-index, pillar and variable levels. A detailed description of the variables can be found in Appendices A and B.

The penalty for bottleneck (PFB)

Entrepreneurship has been defined here as the interaction of entrepreneurial attitudes, abilities and aspiration across different levels of development. One issue this definition raises is how to bring interaction into the model. There are basically two choices: to rely on the statistical attributes of the dataset or to make theory-based assumptions. As VAN MAANEN *et al.* (2007) suggest, theoretical and methodological considerations should be considered simultaneously and not in isolation. Since classical econometric methods ‘imply linearity, additive effects, and unifinality’ (FISS, 2007, p. 1181), they are less suitable to examine interactive effects.

At the same time, configuration theory, a dominant approach of studying organizations and strategy, provides a useful way of thinking about this issue (MILLER, 1986, 1996). Miller views configuration

from the system perspective as a way to achieve internal harmony among its elements. According to DESS *et al.* (1993) configurations represent such attributes that have a meaningful effect not only individually but also rather collectively. By adopting the organizational configuration theory at the national level, it is suggested that the configuration of the 14 entrepreneurship pillars rather than any of the individual pillars is the main determinant of the development of a country. Moreover, composite index construction is the proper method to combine together the pillars (OECD, 2008).

From the technical index construction angle the main problems are: (1) the determination of the optimal combination of the elements and (2) the numeration of the penalty because of non-optimality, (3) the compensability of the pillars and (4) the presentation of how the elements could move from the non-optimal configuration toward the optimal solution. (1) Optimal configuration is defined as the balanced combination of the pillars at the country level. Balanced virtually means the equality of the normalized pillar scores (TARABUSI and PALAZZI, 2004; TARABUSI and GUARINI, 2013). (2) Unbalance is defined as the disequilibrium amongst pillars and measured as the difference between a particular pillar and the worst pillar scores. (3) Imperfect compensability of the pillars is assumed. Moreover, compensability is case- (country- or region-) specific depending on the size of disequilibrium as well as on the magnitude of the penalty. Disequilibrium implies the inefficient use of the resources. Practically, it means that the incorporation of the penalty with respect to the size of imbalance should be built into the index score. (4) The movement from the disequilibrium to the optimal configuration means that the pillar scores should be equalized to provide the most efficient use of the available resources

Table 1. Structure of Global Entrepreneurship and Development Index (GEDI)

Global Entrepreneurship and Development Index (GEDI)																				
Entrepreneurial Attitudes (ATT) sub-index					Entrepreneurial Abilities (ABT) sub-index					Entrepreneurial Aspirations (Asp) sub-index										
  (																				

Note: GEDI is a super-index made up of three sub-indices, each of which is composed of several pillars. Each pillar consists of an institutional variable (denoted in bold) and an individual variable (denoted in italics).

starting with those pillar(s) that provide the highest enhancement of the index. This kind of marginal improvement is different from the classical marginal analysis based on the *ceteris paribus* postulate, because of the interrelation of the pillars (ACS *et al.*, 2014).

In order to construct an index considering the above points another assumption about the centre of balance has to be made. TARABUSI and GUARINI (2013) claim that the average of the pillar values should be the point of relation and penalize pillars situating both above and below the average pillar values. Here, this paper applies a slightly different approach by taking the minimum pillar value as the main reference point.

Mathematically, the PFBs is modelled following the approach proposed by TARABUSI and PALAZZI (2004). They suggest a correction form of an exponential function of $a e^{-bx}$ with two parameters, a and b . Modifying TARABUSI and PALAZZI's (2004) original function for present purposes, a penalty function is defined as:

$$h_{ij} = \gamma_{\min} + (1 - e^{-(\gamma_{ij} - \gamma_{\min})}) \quad (1)$$

where h_{ij} is the modified, post-penalty value of index component j in country i ; γ_{ij} is the normalized value of index component j in country i ; $\gamma_{\min}$ is the lowest value of γ_{ij} for country i ; $i = 1, 2, \dots, m$ is the number of countries; and $j = 1, 2, \dots, n$ is the number of index components.

The bottleneck is achieved for each indicator by adding 1 minus the base of the natural logarithm of the negative difference between a given index component's value in country i and the lowest normalized value of any index component for that country. Thus, improving the score of the weakest index component will have a greater effect on the index than will the act of improving the score of stronger index components. For example, assume that the normalized score of a particular index component in a country is 0.60, and the lowest value of all components is 0.40. The difference is 0.20. The base of natural logarithm of -0.2 is 0.82. Therefore, the final adjusted value of the index component is $0.40 + 1 - 0.82 = 0.58$, instead of 0.60. The largest potential difference between two index components is 1, when a particular country exhibits the highest value for one index component (across all countries) and the lowest value for another index component, again across all countries. In this case, the maximum penalty is 0.37. It also means that the best indicator performance just compensates for the bad performance of the worst indicator by only 63%.

This dynamic index construction is particularly useful for enhancing entrepreneurship in a particular country. Although it could be argued that entrepreneurship is a horizontal policy concept with relevance across a number of traditional policy domains (e.g. trade

policy, regulatory policy, fiscal policy), the application of the dynamic index construction would enable the effectiveness of different policy steps toward entrepreneurship to be measured. This method could rearrange the rank order of the countries in a particular feature. The level of the rearrangement depends on the relative position of a country in terms of bottlenecks compared with the others. If every country has similar differences in terms of the features, then the rank order does not change too much; if one country is very unbalanced compared with the others, then a lower rank for that particular country can be expected. The policy message is that weak performances in a particular feature, i.e. a bottleneck, should be handled first because it has the most negative effect on all the other features.

There are two potential drawbacks of the PFB method. One is the arbitrary selection of the magnitude of the penalty. There is no research that can underline how big the penalty should be. This is the reason why a conservative estimation of the penalty was applied. The other problem is that the potential that a particularly good feature can have a positive effect on the weaker performing features cannot be excluded fully. 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, it is claimed here that the PFB methodology is theoretically better than the arithmetic average calculation. However, the PFB-adjusted GEDI is not necessary an optimal solution since the magnitude of the penalty is unknown.

THE REGIONAL ADAPTATION OF GEDI

In order to use GEDI for a regional analysis, the data and variable used must be adapted to reflect regional conditions. The main concern for the individual variables used is the availability of a representative sample size for each region. This is not a problem for Spain since it collects data for a regional-level GEM survey on an annual basis which contains over 30 000 respondents. This large and regionally representative sample provides the 14 individual variables used in the standard GEDI model for all 17 of Spain's regions for 2007 and 2008. This allows Spain's regions to be calculated in the same way as individual variables are calculated for the country level.

Over the last decades it has been an increasing movement in the European Union to collect institutional variables not only at country but also at regional levels (NUTS-1, NUTS-2 and NUTS-3).⁴ This increasing data-collection activity provides a unique opportunity to construct an entrepreneurship index similar to the national GEDI. The idea behind the regional entrepreneurship index construction is to find regional-level institutional data that are also available at the country

level. Another possible solution is to use closely correlated regional proxies to substitute for a missing variable. If the regional institutional data are lacking, then country-level institutional data can be applied. Of the 14 institutional variables applied for the entrepreneurship index construction, ten are available in the NUTS-2 regional levels.⁵

To be able to relate the entrepreneurial performance of the 17 Spanish autonomous regions to the regional variables, either the same variable (urbanization, *GERD*, tertiary education, Internet penetration), or similar variables collected from the European Union Regional Competitiveness Index (ANNIONI and KOZOVSKA, 2010) were used. In the latter case the regional variable values were recalculated to the same scale as the country-level values. Because of the lack of the remaining five cases the Spanish country-level variables (business risk, economic freedom, market dominance, globalization, venture capital) were used. As a consequence, real Spanish regional differences may be higher than the present analysis shows. The overall regional-level entrepreneurship and development index for the Spanish regions are calculated as benchmarking the country-level pillars. While this combined methodology makes it possible to contrast the entrepreneurial performance of the Spanish regions to other countries, it is more appropriate to compare the regions with one another:

- In four cases the institutional variables used by GEDI are available at the regional level for Spain: (1) the rate of urbanization (*URBANIZATION*);⁶ (2) the tertiary education participation rate (*EDUCPOSTSEC*); (3) the percentage of Internet users (*INTERNETUSAGE*); and (4) R&D spending as a percentage of gross domestic product (GDP) (*GERD*) at the regional level.
- Six other cases use a close regional-level proxy of the country-level variables used in GEDI. Five of these proxies are derived from the EU Regional Competitiveness Index (ANNIONI and KOZOVSKA 2010): (1) the size of the market (*MARKETDOM*); and (2) the availability of the latest technology is used as a proxy for technological absorption (*TECHABSORP*); a higher education and lifelong learning variable is used as a proxy for a country's level of investment in business training and employment development (*STAFFTRAIN*); the innovation variable is used to proxy *TECHTRANSFER*; and the business sophistication variable is used for a proxy for business strategy (*BUSS STRATEGY*). Finally, the sixth regional variable that provides a regional corruption variable (*CORRUPTION*) is taken from a database compiled by CHARRON *et al.* (2011). In all these cases the regional variables had to be rescaled to the same level as the country-level variable. The rescaling methodology is further described in Appendix C.

- In the remaining five cases where no regional proxy was available the existing country-level institutional data for Spain were simply used. These five variables include: (1) the availability and reliability of corporate financial information (*BUSINESS RISK*); (2) the overall burden of regulation for starting, operating and closing a business (*FREEDOM*); (3) the extent of market dominance by a few business groups (*MARKDOM*); (4) the international orientation of the domestic market (*GLOB*); and (5) access of venture capital (*VENTCAP*). The lack of corresponding regional-level variables in these five cases limits the ability to analyse these specific issues at the regional level.

To calculate the country- and regional-level index the next steps are followed.

First, after handling the outliers the pillar values are normalized:

$$x_{ij} = \frac{z_{ij}}{\max_i z_{ij}} \quad (2)$$

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

The average of each of the 14 pillars can be calculated as:

$$\bar{x}_j = \frac{\sum_{i=1}^n x_{ij}}{n} \quad \text{for all } j \quad (3)$$

where x is the normalized score for country or region i for a particular pillar, $\bar{x}_j$. Here an amended version of the GEDI methodology is used that adjusts the individual pillar averages before penalizing then. The different averages of the 14 pillars imply that reaching the same performance requires different effort and consequently resources. Higher average values could mean it is easier to reach as compared with lower average value. Since the aim is to apply GEDI for public policy purposes, the additional resources for the same marginal improvement of the pillar values should be the same for all the 14 pillars.

The average of the 14 pillars average is the following:

$$\bar{y} = \frac{\sum_{j=1}^k \bar{x}_j}{m} \quad (4)$$

The desire is to transform the x values such that the potential values to be in the $[0,1]$ range.

$$y_{ij} = x_{ij}^k \quad (5)$$

where k is the 'strength of adjustment'; the k th moment of X is exactly the needed average, $\bar{y}_j$. The root of the following equation for k has to be found:

$$\sum_{i=1}^n x_{i,j}^k - n\bar{y}_j = 0 \quad (6)$$

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.

The penalty-adjusted pillar scores can be calculated according to equation (1). The three sub-indices, ATT, ABT and ASP, for each country and region are the arithmetic average of its PFB-adjusted pillars for that sub-index multiplied by a 100:

$$ATT_i = 100 \sum_{j=1}^5 h_j \quad (7a)$$

$$ABT_i = 100 \sum_{j=6}^{10} h_j \quad (7b)$$

$$ASP_i = 100 \sum_{j=11}^{14} h_j \quad (7c)$$

where $h_{i,j}$ is the modified, post-penalty value of pillar j in country region i ; $i = 1, 2, \dots, n$ is the number of countries and regions; and $j = 1, 2, \dots, 14$ is the number of pillars.

To calculate the final value of GEDI, y_i was multiplied by 100.

GEDI is simply the average of the three sub-indices:

$$GEDI_i = \frac{1}{3} (ATT_i + ABT_i + ASP_i) \quad (8)$$

where $i = 1, 2, \dots, n$ is the number of regions.

RESULTS

The importance of endogenous factors in regional economic development and growth has long been recognized and is largely the basis of the so-called ‘new growth theory’ that has been popularized over the last couple of decades. Theories of endogenous growth place emphasis not only on regional resources endowments and human capital, which have always been viewed as important factors affecting economic development, but also on technology, entrepreneurship and institutional factors, including the role of leadership and creativity. It is essentially a blend of microeconomics and macroeconomic growth theory in which smart use of the indigenous resources of a region plays a critical role (CAPELLO and NIJKAMP, 2011).

These recent developments, regional economic growth and development theory are welcome because

they explicitly introduce a spatial dimension into economic growth theory. This is important as globalization and structural change have had an important impact on regions. Just as important is the need to address endogenous factors and processes carefully to enhance the capacity and capabilities of a region to proceed along a path of achieving sustainable development and growth (STIMSON and STOUGH, 2011).

This section uses GEDI to analyse and compare entrepreneurial performance in Spain’s 17 autonomous regions. It begins the analysis with the GEDI super-index results that allows Spain’s individual regional scores to be compared not only with each other but also with the overall GEDI scores for 71 countries worldwide. The analysis then shifts to the three sub-indices followed by a more detailed analysis based on GEDI’s 14 pillars and 28 variables (ACS, 2010).

Spain’s regions compared at the GEDI aggregate level

The relative rankings of Spain’s regions based on their aggregate GEDI scores are compared with 42 other countries participating in the 2008 GEM survey (Table 2). Unsurprisingly, the regional scores are quite heterogeneous. The regional scores and rankings for Spain range from at the high end, 60.0 for *Madrid*, which is ranked in 11th place, to 39.4 at the low end for *Extremadura*, which is ranked in 45th place. In terms of country comparisons, Madrid’s score ranks it at a level similar to Israel and Slovenia, while Extremadura’s ranking is similar to Argentina and the Dominican Republic. Seven regions receive higher rankings than Spain as a country (ranked in 25th place), while ten regions receive lower rankings. Interestingly, Spain’s score ranks it at a level close to Japan. While it may seem contradictory that Japan, one of the richest countries in the world, has a GEDI score similar to Spain, one of the poorer countries in the OECD. The answer to the puzzle is that Japan’s GEDI score and start-up rate have been in decline for over 20 years ever since the near collapse of the country’s economy in 1989. Following the financial crisis banks stopped lending to start-ups and the GEDI score dropped, even though the level of income stayed relatively high.

In order to understand better the numbers behind the overall ranking shown in Table 2, Spain’s regional rankings for the three GEDI sub-indices are provided: ATT, ABT and ASP. These sub-indices make up the overall GEDI score and address specific issues regarding entrepreneurship development. As shown in Table 3, regional differences increase for two out of the three GEDI sub-indices.

While the overall difference between the highest and the lowest ranked regions in Spain is 20.7, the differences between the highest and the lowest ranked region for the three sub-indices is 20.9 for ATT, 21.6 for ABT and 20.8 for ASP. For all three sub-indices

Table 2. The Global Entrepreneurship and Development Index (GEDI) 2008 ranking: countries and Spain's regions compared

Rank	Country/region	GDP	GEDI	Rank	Country/region	GDP	GEDI
1	Denmark	38206	83.3	31	Turkey	13035	49.3
2	United States	47179	80.1	32	Uruguay	11692	49.2
3	Iceland	41233	71.5	33	Castile-La Mancha	23370	48.2
4	Ireland	45372	69.0	34	Andalusia	23236	47.6
5	Finland	37020	68.3	35	Murcia	24982	47.0
6	Norway	55776	66.4	36	Balearic Islands	32771	46.2
7	United Kingdom	36615	64.8	37	Colombia	8941	45.1
8	Belgium	37476	63.5	38	Croatia	16272	45.1
9	Netherlands	40577	62.6	39	Cantabria	29548	44.5
10	Israel	30907	60.5	40	Peru	8426	43.4
11	Madrid	39084	60.0	41	Greece	31945	42.9
12	Slovenia	28964	59.5	42	South Africa	11328	41.1
13	Korea	26436	58.5	43	Romania	12266	41.0
14	France	33158	58.5	44	Argentina	14026	39.4
15	Germany	35444	57.8	45	Extremadura	20281	39.4
16	Chile	15000	57.7	46	Dominican Republic	8014	39.1
17	Italy	31323	57.4	47	Macedonia	9100	38.7
18	Catalonia	35323	57.2	48	Mexico	14099	37.8
19	Navarre	37607	54.2	49	Egypt	5423	36.5
20	Basque Country	38412	53.2	50	Hungary	20078	36.2
21	Aragon	32100	52.6	51	Russia	16241	33.8
22	Canary Islands	26593	52.3	52	Brazil	10296	33.7
23	Asturias	27131	52.1	53	Serbia	7945	33.2
24	Japan	34608	51.5	54	India	2879	32.5
25	Spain	34584	51.3	55	Bosnia and Herzegovina	6627	30.5
26	Galicia	26056	50.6	56	Ecuador	7515	30.4
27	Valencia	27399	50.2	57	Jamaica	7587	29.4
28	Castile and Leon	28474	50.2	58	Bolivia	4698	28.0
29	Rioja	32100	50.1	59	Iran	12400	27.6
30	Latvia	18001	49.5				

Notes: Spain's ranking is shown in bold and its regional rankings are shaded.
GDP, gross domestic product.

Table 3. Spanish regions relative position: sub-index level and the Global Entrepreneurship and Development Index (GEDI)

Region	Entrepreneurial Attitude (ATT)		Entrepreneurial Abilities (ABT)		Entrepreneurial Aspiration (ASP)		GEDI	
	Rank	Value	Rank	Value	Rank	Value	Rank	Value
Andalusia	13	47.6	14	52.9	13	42.3	13	47.6
Aragon	4	52.6	4	61.5	11	43.6	5	52.6
Asturias	7	50.3	6	59.3	6	46.8	7	52.1
Balearic Islands	15	44.1	13	54.1	14	40.5	15	46.2
Canary Islands	5	51.8	7	58.3	5	46.8	6	52.3
Cantabria	14	45.5	16	48.2	16	39.9	16	44.5
Castile and Leon	11	49.2	11	55.8	8	45.6	10	50.2
Castile-La Mancha	16	41.9	8	57.9	10	45.0	12	48.2
Catalonia	2	57.8	3	62.2	2	51.6	2	57.2
Valencia	6	51.6	9	56.2	12	42.8	9	50.2
Extremadura	17	39.6	17	42.4	17	36.0	17	39.3
Galicia	9	50.0	10	56.1	9	45.6	8	50.6
Madrid	1	60.5	2	62.7	1	56.8	1	60.0
Murcia	12	48.7	15	52.2	15	40.1	14	47.0
Navarre	10	49.3	1	64.0	3	49.3	3	54.2
Basque Country	3	53.1	5	59.7	4	46.9	4	53.2
Rioja	8	50.1	12	54.5	7	45.7	11	50.1
Spain		53.4		54.7		45.9		51.3

Extremadura receives the lowest values, while Madrid receives the highest values for ATT and ASP, but it is in the second place for ABT.

If one examines the top four ranking regions for all three sub-indices, it is found that Madrid, Catalonia, Navarre and Basque Country hold the top positions for

ASP, while for ABT *Navarre, Madrid, Catalonia* and *Aragon* are in the top four regions. However, for ABT, *Madrid, Catalonia* and *Basque Country* are in the top three, *Navarre* drops to tenth place while *Aragon* takes fourth place.

The average results of the sub-indices scores, the regional GEDI scores and other indicators from [Tables 2](#) and [3](#) allow one to create three cluster groups for Spain's 17 autonomous regions based on their average performance.⁷

- The first group contains Spain's four *leading entrepreneurial regions*: *Madrid, Catalonia, Basque Country, Navarre* and *Aragon*. These five regions are characterized by a relatively strong performance for all three sub-indices. They tend to be urbanized regions with high levels of income and higher innovation ratios with a more highly educated population ([Table 2](#)). In the last decades Spain's regions have undergone an important process of policy decentralization. In particular, these four 'leading' regions present higher levels of policy independence.
- The second group consists of Spain's *well-performing entrepreneurial regions* and includes the regions of: *Canary Islands, Asturias, Galicia, Valenciana, Castile and Leon*, and *Rioja*. These six regions receive scores that for the most part reflect the average values for Spain as a whole. Spain's entrepreneurship and innovation policy measures seem to have had a positive effect on the rather supportive entrepreneurial environment of these regions.
- Finally, the third group contains Spain's *lagging entrepreneurial regions*. These six regions include: *Castile-La Mancha, Andalusia, Murcia, Balearic Islands, Cantabria* and *Extremadura*. The majority of these regions show low income levels and high unemployment rates. Most of these regional economies are still agriculturally based and characterized by small percentages of innovative companies, low levels of patenting activity and a less-educated workforce. In spite of the fact that some of these regions have experienced important advances in their regional and sub-regional institutions, their unfavourable social and economic environments clearly impede the successful implementation of business-friendly policy instruments.

Spain's regions compared at GEDI's pillar level

This section focuses on the analysis of Spain's 17 regions at the pillar level. [Table 4](#) shows the pillar values for Spain's regions and includes two additional useful benchmarks: the average pillar values for the most advanced innovation-driven economies⁸ and the average value of Spain's 17 autonomous regions. The most favourable and the least favourable pillar value for each region and benchmark are also identified.

As discussed in the methodology section above, each pillar consists of an individual and an institutional

variable. However regional data for the institutional variables for five pillars were not obtained and as a result these five pillars include the aggregate institutional variable score for Spain (indicated in [Table 4](#)). As would be expected, the least variance can be seen in those cases where the institutional variables are the same for all the regions, and the variations are due purely to the individual variables (*NON-FAIR OF FAILURE, OPPORTUNITY START-UP, INTERNATIONALIZATION, COMPETITION and RISK CAPITAL*).

For the *OPPORTUNITY PERCEPTION, START-UP SKILLS, NETWORKING, TECH SECTOR, QUALITY OF HUMAN RESOURCES, PRODUCT INNOVATION, PROCESS INNOVATION* and *HIGH GROWTH* pillars, which contained both regional-specific individual and institutional variables, the pillar variance for them exceeds both the variance for the aggregate and sub-index GEDI scores. The least overall regional pillar variance was found in the case of the pillar capturing the regional entrepreneurial culture (*CULTURAL SUPPORT*), implying a relatively equal acceptance and recognition of the role of entrepreneurs throughout the 17 regions. While the absolute difference in the pillar related to the presence of firms belonging to technology-intensive industries (*TECH SECTOR*) appears to be the largest (0.69), it ranges from 0.22 (in *Cantabria* and *Extremadura*) to 0.91 (in *Aragon*).

Large differences can be found in the quality of human capital (*QUALITY OF HUMAN RESOURCES*) (0.51) as well. In the case of this pillar, it ranges from 0.39 (*Balearic Islands*) to 0.90 (*Navarre*). The *START-UP SKILLS* pillar can be characterized by quite decisive difference (0.51): it ranges from 0.25 (*Balearic Islands*) to 0.75 (*Madrid*). The presence of large differences can also be observed in *PROCESS INNOVATION* (0.52), *OPPORTUNITY PERCEPTION* (0.40), *HIGH GROWTH* (0.27), *PRODUCT INNOVATION* (0.26), *INTERNATIONALIZATION* (0.21) and *NETWORKING* (0.20).

Examining the least favourable indicators, the difficulties facing Spanish businesses across the regions can be seen to grow and become market leaders exemplified by the *HIGH GROWTH* pillar which is the weakest pillar in 16 regions. Since *HIGH GROWTH* belongs to the ASP sub-index, it explains the generally weak performance of Spain and the Spanish regions in entrepreneurial aspirations. Only for *Castile-La Mancha* is the *START-UP SKILL* pillar the weakest pillar.

While *OPPORTUNITY PERCEPTION* appears to be the weakest pillar of the innovation-driven economies average,⁹ *HIGH GROWTH* takes second place as the second weakest pillar. Concerning the *HIGH GROWTH* pillar, the innovation-driven country average is 0.60, and the Spanish regional average is 0.28, which indicates a substantial difference.

Table 4. Spanish regions relative position: pillar level

Regions	1	2	3 ^a	4	5	6 ^a	7	8	9 ^a	10	11	12	13 ^a	14 ^a	Less favourable	Most favourable
Andalusia	0.54	0.50	0.46	0.44	0.64	0.59	0.54	0.63	0.59	0.55	0.48	0.22	0.53	0.49	High growth	Cultural support
Aragon	0.55	0.56	0.50	0.49	0.62	0.67	0.91	0.57	0.51	0.54	0.4	0.36	0.47	0.45	High growth	Technology sector
Asturias	0.58	0.58	0.47	0.48	0.61	0.61	0.74	0.65	0.68	0.63	0.56	0.25	0.56	0.52	High growth	Technology sector
Balearic Islands	0.47	0.25	0.54	0.48	0.62	0.65	0.84	0.39	0.59	0.53	0.31	0.23	0.51	0.58	High growth	Technology sector
Canary Islands	0.60	0.45	0.52	0.48	0.65	0.64	0.73	0.47	0.67	0.56	0.38	0.33	0.59	0.55	High growth	Technology sector
Cantabria	0.45	0.44	0.52	0.47	0.60	0.62	0.22	0.73	0.66	0.58	0.41	0.19	0.47	0.51	High growth	Quality of human resources
Castile and Leon	0.35	0.67	0.50	0.44	0.61	0.59	0.55	0.57	0.65	0.55	0.51	0.32	0.45	0.51	High growth	Start-up skills
Castile-La Mancha	0.35	0.30	0.47	0.41	0.64	0.63	0.68	0.55	0.65	0.53	0.43	0.37	0.49	0.50	Start-up skills	Technology sector
Catalonia	0.75	0.57	0.51	0.59	0.61	0.62	0.73	0.64	0.64	0.58	0.49	0.38	0.65	0.55	High growth	Opportunity perception
Valencia	0.70	0.61	0.50	0.49	0.63	0.66	0.64	0.75	0.56	0.63	0.46	0.20	0.52	0.56	High growth	Quality of human resources
Extremadura	0.35	0.40	0.49	0.39	0.65	0.64	0.22	0.52	0.64	0.53	0.41	0.10	0.49	0.54	High growth	Cultural support
Galicia	0.51	0.57	0.50	0.41	0.66	0.63	0.58	0.64	0.56	0.60	0.45	0.30	0.48	0.55	High growth	Cultural support
Madrid	0.73	0.76	0.51	0.56	0.64	0.65	0.55	0.88	0.62	0.78	0.83	0.38	0.55	0.49	High growth	Quality of human resources
Murcia	0.71	0.44	0.48	0.40	0.64	0.62	0.55	0.57	0.58	0.52	0.44	0.22	0.44	0.49	High growth	Opportunity perception
Navarre	0.39	0.58	0.51	0.48	0.63	0.64	0.71	0.90	0.64	0.74	0.58	0.30	0.46	0.56	High growth	Quality of human resources
Basque Country	0.61	0.64	0.51	0.52	0.62	0.66	0.63	0.84	0.59	0.72	0.58	0.26	0.46	0.53	High growth	Quality of human resources
Rioja	0.45	0.49	0.51	0.54	0.64	0.64	0.52	0.58	0.59	0.60	0.47	0.30	0.44	0.57	High growth	Opportunity start-up
<i>Spanish regional average</i>	<i>0.53</i>	<i>0.52</i>	<i>0.50</i>	<i>0.47</i>	<i>0.63</i>	<i>0.63</i>	<i>0.61</i>	<i>0.64</i>	<i>0.61</i>	<i>0.60</i>	<i>0.48</i>	<i>0.28</i>	<i>0.50</i>	<i>0.53</i>	High growth	Quality of human resources
Spain	0.55	0.68	0.50	0.56	0.61	0.58	0.62	0.57	0.61	0.56	0.52	0.27	0.54	0.53	High growth	Start-up skills
<i>Innovation-driven countries</i>	<i>0.51</i>	<i>0.62</i>	<i>0.68</i>	<i>0.67</i>	<i>0.67</i>	<i>0.65</i>	<i>0.70</i>	<i>0.76</i>	<i>0.65</i>	<i>0.66</i>	<i>0.71</i>	<i>0.60</i>	<i>0.70</i>	<i>0.72</i>	Opportunity perception	Quality of human resources (ABT)

Notes: Pillar names: OPPORTUNITY PERCEPTION (1); START-UP SKILLS (2); NON-FEAR OF FAILURE (3); NETWORKING (4); CULTURAL SUPPORT (5); OPPORTUNITY START-UP (6); TECH SECTOR (7); QUALITY OF HUMAN RESOURCES (8); COMPETITION (9); PRODUCT INNOVATION (10); PROCESS INNOVATION (11); HIGH GROWTH FIRM (12); INTERNATIONALIZATION (13); and RISK CAPITAL (14).

Text in italics is Spanish regional and innovation-driven country averages.

^aPillars where the institutional variable used is the same for all 17 regions.

National, multi- and single-level policies based on GEDI pillar scores

The comparison of pillars of the three Spanish regions shows both similarities and also considerable differences in the strengths and weaknesses of different regions. Even when countries are grouped according to leading, average and lagging regions, a striking degree of heterogeneity in terms of GEDI pillar scores is still encountered. Therefore it seems appropriate to develop policy suggestions using a three-pronged approach focusing on the national, multi- and single-level policies. *National-level policy* addresses general, country-wide weaknesses such as enhancing entrepreneurship and improving the GEDI value by increasing the weakest pillar value(s). In addition, regional policy should boost entrepreneurship and reduce regional differences in entrepreneurship. *Multi-level policy* is suitable for weaknesses that are faced by many, but not all, of the regions; whereas *single-level policy* aims at improving a pillar that is problematic for just one or only a few regions. Regional policy should therefore combine national, multi- and single-level policy initiatives in order to improve their entrepreneurial performance.

Based on Table 4, the five least favourable pillars for Spain's 17 regions can be identified. The pillar of HIGH GROWTH is among the weakest 'top five pillars' for 16 regions. START-UP SKILLS (possession of the required knowledge/skills to start a business) is the weakest for one of the 17 regions (Castile-La Mancha). However, in addition to these pillars, a great degree of variation can also be seen. For example, TECH SECTOR is the second weakest pillar for Extremadura and Cantabria, and the fourth weakest pillar for Madrid, but is not a 'top five' weakness for the most other regions. Interestingly, QUALITY OF HUMAN RESOURCES is a weak pillar for both the Canary Islands and Balearic Islands yet is the strongest pillar for five of Spain's other regions: Navarre, Basque Country, Madrid, Valencia and Cantabria (Table 4).

National-level policy is required for HIGH GROWTH. In 16 Spanish autonomous regions this pillar is ranked amongst the weakest pillars, therefore country-wide steps are necessary to improve the pillar value. National policy and regional policy should work in tandem to support the regional-specific indicators influencing the national policy agenda.

Multi-level policy is required for PROCESS INNOVATION specifically to increase the number of businesses using new technologies. This pillar often appears in the second place as a weak variable influencing entrepreneurial aspirations. Altogether, this pillar can be found among the top five weakest pillars in 12 cases. NETWORKING is also one of the top five weakest pillars for 12 regions. On the other hand, there are nine regions that exhibit weaknesses in low values for NON-FEAR OF FAILURE and INTERNATIONALIZATION. START-UP SKILLS and

OPPORTUNITY PERCEPTION are also amongst the top five weakest pillars for eight and seven autonomous regions, respectively.

Single-level policy is required in the cases of the RISK CAPITAL pillar (five regions are affected), TECH SECTOR (three regions are affected in each cases) and QUALITY OF HUMAN RESOURCES (two regions are affected).

A simulation on how to improve Entrepreneurship in the Spanish regions

The following simulation exercise is not prescriptive. It should not be read as a policy recommendation, because it carries important assumptions. First, the 14 pillars of GEDI only partially capture the system of entrepreneurship. This also means that what is being 'optimized' here is the GEDI value and not the actual system of entrepreneurship of a particular country or region. Second, the simulation assumes that all index pillars are equally amenable to manipulation through concentrated policy effort. In reality, some pillars are likely to be easier to adjust than others. Third, the simulation assumes that the cost of improving any pillar is about constant. In reality, the cost may differ considerably over pillars and over different countries. Fourth, the simulation implies that one correct policy mix (allocation of effort in a policy portfolio) is optimal across countries. In reality, the system dynamics of national systems of entrepreneurship are considerably more complex than captured by the following simple simulation.

An important implication of GEDI is related to improving the entrepreneurship scores. According to the PFB methodology the best progress can be achieved by abolishing the bottleneck, the weakest performing pillar. However, it should be remembered that the system of entrepreneurship is a dynamic system: if one bottleneck is alleviated, another factor soon becomes the most binding constraint for system performance. This raises the question of 'optimal' allocation of policy effort. In other words, if a particular region of Spain were to allocate additional resources to improving its GEDI performance, how should this additional effort be allocated to achieve an 'optimal' outcome?¹⁰

The PFB method used in the GEDI calculation implies that the greatest performance enhancement will be achieved when additional resources are always allocated to alleviate the most constraining bottleneck at a regional level. Once the bottleneck pillar has improved sufficiently so as to constitute no longer the most important constraint to system performance, further resource additions need to be allocated to the next most severe bottleneck. This procedure was iterated until an overall GEDI performance of 10 in every region had been achieved. This simulation is based on two important assumptions:

(1) additional resources are allocated over current resource allocation; and (2) the cost of improving performance is equal for all pillars. The simulation shown in Table 5 has targeted an overall improvement of 10 in GEDI by sequencing successive policy interventions in such a way that they always addressed the least well-performing pillar in consecutive iterations in every region.

This simulation produces a more nuanced picture of the required allocation of policy effort, if policy were to be optimized to maximize the GEDI value. It can be seen that to improve Spain's GEDI score by 10, an 'optimal' effort allocation would call for a 38% improvement in the HIGH GROWTH pillar, a 12% in the NON-FEAR OF FAILURE pillar and a 9% in the PROCESS INNOVATION pillar.

Table 5. Simulation of 'optimal' policy allocation to increase the Global Entrepreneurship and Development Index (GEDI) score by ten points in the Spanish regions

Region		1	2	3	4	5	6	7	8	9	10	11	12	13	14	Total effort
Andalusia	A	0.02	0.06	0.1	0.12	0	0	0.02	0	0	0.01	0.08	0.34	0.03	0.08	0.86
	B	2%	7%	12%	14%	0%	0%	2%	0%	0%	1%	9%	40%	3%	9%	
Aragon	A	0.05	0.03	0.1	0.11	0	0	0	0.03	0.08	0.06	0.2	0.24	0.13	0.14	1.17
	B	4%	3%	9%	9%	0%	0%	0%	3%	7%	5%	17%	21%	11%	12%	
Asturias	A	0.01	0.01	0.12	0.12	0	0	0	0	0	0	0.04	0.34	0.03	0.07	0.74
	B	1%	1%	16%	16%	0%	0%	0%	0%	0%	0%	5%	46%	4%	9%	
Balearic Islands	A	0.03	0.25	0	0.03	0	0	0	0.12	0	0	0.19	0.28	0	0	0.9
	B	3%	28%	0%	3%	0%	0%	0%	13%	0%	0%	21%	31%	0%	0%	
Canary Islands	A	0.01	0.15	0.08	0.12	0	0	0	0.14	0	0.04	0.22	0.27	0.01	0.05	1.09
	B	1%	14%	7%	11%	0%	0%	0%	13%	0%	4%	20%	25%	1%	5%	
Cantabria	A	0.04	0.05	0	0.02	0	0	0.27	0	0	0	0.08	0.29	0.02	0	0.77
	B	5%	6%	0%	3%	0%	0%	35%	0%	0%	0%	10%	38%	3%	0%	
Castile and Leon	A	0.24	0	0.09	0.15	0	0	0.04	0.02	0	0.04	0.08	0.27	0.14	0.08	1.15
	B	21%	0%	8%	13%	0%	0%	3%	2%	0%	3%	7%	23%	12%	7%	
Castile-La Mancha	A	0.21	0.26	0.08	0.14	0	0	0	0	0	0.02	0.12	0.19	0.06	0.06	1.14
	B	18%	23%	7%	12%	0%	0%	0%	0%	0%	2%	11%	17%	5%	5%	
Catalonia	A	0	0.09	0.15	0.07	0.05	0.04	0	0.02	0.02	0.08	0.17	0.28	0.02	0.11	1.1
	B	0%	8%	14%	6%	5%	4%	0%	2%	2%	7%	15%	25%	2%	10%	
Valencia	A	0	0	0.04	0.06	0	0	0	0	0	0	0.09	0.34	0.03	0	0.56
	B	0%	0%	7%	11%	0%	0%	0%	0%	0%	0%	16%	61%	5%	0%	
Extremadura	A	0.06	0.01	0	0.03	0	0	0.19	0	0	0	0.01	0.31	0	0	0.61
	B	10%	2%	0%	5%	0%	0%	31%	0%	0%	0%	2%	51%	0%	0%	
Galicia	A	0.09	0.02	0.1	0.19	0	0	0.01	0	0.04	0	0.14	0.3	0.11	0.04	1.04
	B	9%	2%	10%	18%	0%	0%	1%	0%	4%	0%	13%	29%	11%	4%	
Madrid	A	0	0	0.14	0.1	0.01	0.01	0.11	0	0.03	0	0	0.28	0.1	0.16	0.94
	B	0%	0%	15%	11%	1%	1%	12%	0%	3%	0%	0%	30%	11%	17%	
Murcia	A	0	0.1	0.06	0.14	0	0	0	0	0	0.02	0.1	0.32	0.1	0.05	0.89
	B	0%	11%	7%	16%	0%	0%	0%	0%	0%	2%	11%	36%	11%	6%	
Navarre	A	0.2	0.01	0.08	0.11	0	0	0	0	0	0	0.01	0.3	0.13	0.03	0.87
	B	23%	1%	9%	13%	0%	0%	0%	0%	0%	0%	1%	34%	15%	3%	
Basque Country	A	0	0	0.08	0.07	0	0	0	0	0.01	0	0.02	0.34	0.13	0.07	0.72
	B	0%	0%	11%	10%	0%	0%	0%	0%	1%	0%	3%	47%	18%	10%	
Rioja	A	0.14	0.11	0.08	0.06	0	0	0.08	0.01	0.01	0	0.12	0.29	0.15	0.03	1.08
	B	13%	10%	7%	6%	0%	0%	7%	1%	1%	0%	11%	27%	14%	3%	
Spain	A	0.06	0	0.11	0.05	0	0.03	0	0.04	0	0.05	0.08	0.34	0.06	0.07	0.89
	B	7%	0%	12%	6%	0%	3%	0%	4%	0%	6%	9%	38%	7%	8%	

Notes: Pillar names: OPPORTUNITY PERCEPTION (1); START-UP SKILLS (2); NON-FEAR OF FAILURE (3); NETWORKING (4); CULTURAL SUPPORT (5); OPPORTUNITY START-UP (6); TECH SECTOR (7); QUALITY OF HUMAN RESOURCES (8); COMPETITION (9); PRODUCT INNOVATION (10); PROCESS INNOVATION (11); HIGH GROWTH FIRM (12); INTERNATIONALIZATION (13); and RISK CAPITAL (14).

The darkness of the shade reflects the magnitude of the required improvement; a darker shade means more required improvement and no shade implies no required improvement.

Of the remaining effort, the simulation suggests that 8% should be allocated to the RISK CAPITAL pillar, 7% to OPPORTUNITY PERCEPTION, also 7% to INTERNATIONALIZATION, 4% to NETWORKING and 4% PRODUCT INNOVATION. The remaining pillars require less than 5% new effort to enhance their performance.

Although when looking at Table 5 it is apparent that the 'optimal' policy mix is different for the 17 autonomous regions of Spain. All regions need to improve the HIGH GROWTH pillar, e.g. for Valencia it is necessary to focus the 61% of new resources on this pillar, while for Castile-La Mancha it requires only 17%; all other regions are between these two extremes. The regions are also differing regarding their required total efforts to improve their GEDI score by 10; for Valencia there are only 0.56 new resources necessary while for Central Aragon there are 1.17.

DISCUSSION

This paper adapted GEDI to a regional analysis of Spain's 17 autonomous regions. While Spain's regional GEDI values are calculated in the same way as would be those of independent countries, the analysis focuses on comparing the Spanish regions with each other. The Spanish regions are investigated in terms of GEDI, at the sub-index as well as at the pillar level. The Spanish regions are found to be particularly weak in the aspiration-related pillars. A system has also been developed for assisting in the design of an appropriate public policy framework for improving entrepreneurship in the Spanish regions. Three levels of policies are classified as national, multi- and single levels, and based on the identification of the five worst pillars of each of the Spanish regions a useful system was provided to help develop good entrepreneurship policy for Spain by taking into account national and regional priorities.

What has been learnt from this analysis? The purpose of this paper was (1) to construct a GEDI for Spanish regions and (2) to understand better the high levels of heterogeneity in entrepreneurship and economic growth across regions. The construction of a regional index proved to be possible but highly challenging. While the methodology can be applied to the sub-regions of a country rather easily, the main challenge is to find regional institutional variables. In fact the very question of how institutions vary across regions is itself an interesting question.

The index performed well in its main mission of identifying the weakest pillars and variables. Perhaps the greatest weakness across the country as a whole is the lack of high-growth aspirations. The most favourable pillars vary across the country. When the depth of these weaknesses were examined more closely and

identified, it could be seen how the weakness in high growth is supported by weaknesses in technology, networking, process innovation and start-up skills.

From a theoretical point of view the GEDI methodology reinforces the vision that both institutions and agency are important for economic development. While many attempts (national systems of innovation) have focused exclusively on institutions and the entrepreneurship literature has focused solely on agency, both appear to be important and are moved by different policy levers. Moreover, the systems approach to entrepreneurship appears to be a useful tool as opposed to the 'sum of parts' approach often implied by regression analysis.

The authors think that the present methodology offers important benefits for the analysis, design, and implementation of policies and support measures aimed at strengthening the entrepreneurial potential of individual regions. First, regional-level entrepreneurship clearly is a systemic phenomenon. What is needed, therefore, is a measurement approach that addresses the systemic character head on. To date, entrepreneurship policy design and implementation functions have tended to be confined to specific policy departments, with little or no coordination across policy silos. Such reductionist approaches can easily lead to suboptimal policy frameworks that address surplus resources and ignore systemic constraints. By highlighting relative strengths and weaknesses, the methodology should help promote more balanced and better-coordinated entrepreneurship policy frameworks. Second, because the approach is based on normalized scores, it enables comparisons between constituent pillars, as well as across countries. An important benefit of this normalization is that the method gives policy-makers an idea of how well their regions are performing relative to others, given their country-specific features.

The centrality of Smart Specialization Strategies (smart use of regional resources) for European Union competitiveness policy is highlighted by the fact that an explicit Smart Specialization Strategy will be a precondition for using the European Regional Development Fund (ERDF) to support investments in research and innovation in European Union regions. To receive funding from ERDF and from European Union Structural and Cohesion Funds, European Union regions need to be able to articulate their strategies for building on their distinctive regional strengths. This, for its part, makes it necessary for regions to recognize their strengths as well as their weaknesses. Identifying these strengths and weaknesses will therefore be a priority as the European Union moves towards implementing the 'Horizon 2020' strategy.

The first distinctive features of GEDI – notably, its systemic approach and the PFB feature – can be leveraged to support entrepreneurial discovery processes in two distinct ways, as European Union regions develop

Smart Specialization Strategies. First, the index itself provides initial clues on whether a given region's strengths and weaknesses might be found. Second – and more importantly – GEDI can be used as a platform that facilitates the design of effective policies to support entrepreneurial discovery. If used correctly, therefore, GEDI can support the preconditions for creating Smart Specialization Strategies.

One of the weaknesses of the current approach is that the authors were constrained to picking institutional variables that were consistent with data availability on a global scale. This constraint was necessary in order to be able to make comparisons in a globalized world. However, the regional GEDI can be further developed, e.g. in an European Union framework where the institutional variables are not constrained by global data demands and can draw on the wealth of data from the European Union. In this way recent regional research on clusters, concentration, best practices, density, distance to the frontier, knowledge spillovers, etc. can be built into the regional analysis to enrich the institutional variables and make the pillars more robust.

Whatever the causes of regional differences, evidence is found that just as there are differences at the

national level in entrepreneurship that can be explained, these differences at the regional level are also found. The within-regional difference may in fact be greater than the between-country differences. So from a theoretical perspective the systems approach seems to work at both the national and the regional levels and can be compared and explained. Both institutional and individual (agency) variables seem to play an important role. So the method was applied at the national level.

Acknowledgements – The authors thank the national teams for permission to use the data; the Spanish team for the regional data; and three anonymous referees for helpful comments. Éva Komlósi recalculated the results according to the amended the GEDI methodology introduced in January 2013. All errors and omissions are the authors' responsibility.

Funding – László Szerb would like to thank the OTKA Research Foundation [NK 69283] for financial support. Zoltan J. Ács thanks Imperial College Business School for supporting his study leave.

APPENDIX A

Table A1. Description of the regional-level individual variables used

Individual variable	Description
<i>OPPORTUNITY</i>	Percentage of the 18–64-year-aged population recognizing good conditions to start a business in the next 6 months in the area in which he/she lives
<i>SKILL</i>	Percentage of the 18–64-year-aged population claiming to possess the required knowledge/skills to start a business
<i>NONFAIRFAIL</i>	Percentage of the 18–64-year-aged population stating that the fear of failure would not prevent them starting a business
<i>KNOWENT</i>	Percentage of the 18–64-year-aged population knowing someone who started a business in the past two years
<i>NBGOODAV</i>	Percentage of the 18–64-year-aged population saying that people consider starting business as a good career choice
<i>NBSTATAV</i>	Percentage of the 18–64-year-aged population thinking that people attach high status to successful entrepreneurs
<i>CARSTAT</i>	Status and respect of entrepreneurs calculated as the average of <i>NBGOODAV</i> and <i>NBSTATAV</i>
<i>TEAOPPORT</i>	Percentage of the TEA ^a businesses initiated because of the opportunity to start-up motive
<i>TECHSECT</i>	Percentage of the TEA businesses that are active in technology sectors (high or medium)
<i>HIGHEDUC</i>	Percentage of the TEA businesses' owner/managers having participated over secondary education
<i>COMPET</i>	Percentage of the TEA businesses started in those markets where not many businesses offer the same product
<i>NEWP</i>	Percentage of the TEA businesses offering products that are new to at least some of the customers
<i>NEWT</i>	Percentage of the TEA businesses using new technology that is less than five years old average (including one year)
<i>GAZELLE</i>	Percentage of the TEA businesses having high job expectation average (over ten more employees and 50% in five years)
<i>EXPORT</i>	Percentage of the TEA businesses where at least some customers are outside of the country (over 1%)
<i>INFINVMEAN</i>	Mean amount of three-year informal investment
<i>BUSANG</i>	Percentage of the 18–64-year-aged population who have provided funds for new business in the past three years excluding stocks and funds, average
<i>INFINV</i>	Amount of informal investment calculated as <i>INFINVMEAN</i> * <i>BUSANG</i>

Note: ^aTEA (total entrepreneurial activity) is the proportion of the 18–64-year-aged working population who are in the process of starting-up a business and/or having an operating young venture.

APPENDIX B

Table B1. 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 the gross domestic product (GDP) plus the value of imports of goods and services, minus a value of exports of goods and services, normalized on a 1–7 (best) scale. Data are from the World Economic Forum Competitiveness	World Economic Forum	SCHWAB and PORTER (2008), p. 470, SCHWAB (2009), p. 450
	Spain's regional data: calculation based on the EU Regional Competitiveness market size calculation, rescaling the variable to a seven-point Likert scale (for the calculation method, see Appendix A)	ANNIONI and KOZOVSKA (2010)	Based on ANNIONI and KOZOVSKA (2010), p. 154
URBANIZATION	Country level: 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://esa.un.org/unup/index.asp?panel=1/
	Spain's regional data: same as above. Data are from 2008	OECD applied	http://www.oecd.org/dataoecd/35/48/43245602.pdf/
MARKETAGGLOM	Size of the market: a combined measure of the domestic market size and the urbanization that later measures the potential agglomeration effect. Calculated as $MARKETDOM * URBANIZATION$	Own calculation	–
EDUCPOSTSEC	Country level: gross enrolment ratio in tertiary education, 2008 or the latest available data	UNESCO	http://stats.uis.unesco.org/unesco/TableViewer/tableView.aspx?ReportId=167/
	Spain's regional data same as above. Data are from 2008	EUStat	http://epp.eurostat.ec.europa.eu/tgm/table.do?tab=table&init=1&language=en&pcode=tgs00094&plugin=1/ http://www.trading-safely.com/
BUSINESS RISK	Country- and regional-level data source is the same: the business climate rate 'assesses the overall business environment quality in a country. [...] It reflects whether corporate financial information is available and reliable, whether the legal system provides fair and efficient creditor protection, and whether a country's institutional framework is favourable to intercompany transactions' (http://www.trading-safely.com/). It is a part of the Country Risk Rate. The alphabetical rating is turned into a seven-point Likert scale from 1 ('D' rating) to 7 (A1 rating). 30. Data are from 2008, except for 2009 countries that are from 2009	Coface	
INTERNETUSAGE	Country-level data: the number of Internet users in a particular country per 100 inhabitants, 2008, except for 2009 countries that are from 2009	International Telecommunication Union	http://www.itu.int/ITU-D/ict/statistics/
	Spain's regional data: same as above. Data are from 2008	EUStat	http://epp.eurostat.ec.europa.eu/tgm/table.do?tab=table&init=1&language=en&pcode=tgs00050&plugin=1/ http://www.transparency.org/policy_research/surveys_indices/cpi/2010/results/
CORRUPTION	Country-level data: 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_indices/cpi/2009/) Overall performance is measured on a ten-point Likert scale. Data are from 2008 except for 2009 countries that are from 2009	Transparency International	http://www.qog.pol.gu.se/eu_project_2010/eu_project.htm/
	Spain's regional data is based on a standardized variable combining education, health and general public corruption in addition to law enforcements and bribe payment. The calculation is based on CHARRON <i>et al.</i> (2011), rescaling it to a ten-point scale (see Appendix A for details)	CHARRON <i>et al.</i> (2011)	

(Continued)

Table B1. Continued

Institutional variable	Description	Source of data	Data availability
<i>FREEDOM</i>	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. The business freedom score for each country is a number between 0 and 100, with 100 equalling the freest business environment. The score is based on 10 factors, all weighted equally, using data from the World Bank's <i>Doing Business</i> study' (http://www.heritage.org/Index/pdf/Index09_Methodology.pdf). Data are from 2008, except for 2009 countries that are from 2009	Heritage Foundation/World Bank	http://www.heritage.org/index/explore?view=by-region-country-year/
<i>TECHABSORP</i>	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 2007 to 2008, except for 2009 countries that are from 2008 to 2009 Spain's regional data are proxied by the technological readiness data from the EU Regional Competitiveness index and rescaling it to the original seven-point scale (see Appendix A for details)	World Economic Forum ANNIONI and KOZOVSKA (2010)	SCHWAB and PORTER (2008), p. 461, SCHWAB (2009), p. 441 Based on ANNIONI and KOZOVSKA (2010), p. 176
<i>STAFFTRAIN</i>	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 2007 to 2008, except for 2009 countries that are from 2008 to 2009 Spain's regional data are proxied by the higher education and lifelong learning sub-index data from the EU Regional Competitiveness index and rescaling it to the original seven-point scale (see Appendix A for details)	World Economic Forum ANNIONI and KOZOVSKA (2010)	SCHWAB and PORTER (2008), p. 419, SCHWAB (2009), p. 401 Based on ANNIONI and KOZOVSKA (2010), p. 126
<i>MARKDOM</i>	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 2007 to 2008, except for 2009 countries that are from 2008 to 2009	World Economic Forum	SCHWAB and PORTER (2008), p. 423, SCHWAB (2009), p. 405
<i>TECHTRANSFER</i>	Country-level data: 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. Data are from 2007 to 2008, except for 2009 countries that are from 2008 to 2009 Spain's regional data are proxied by the Innovation sub-index data from the EU Regional Competitiveness index and rescaling it to the original seven-point scale (see Appendix A for details)	World Economic Forum ANNIONI and KOZOVSKA (2010)	SCHWAB and PORTER (2008), p. 18, SCHWAB (2009), p. 20 Based on ANNIONI and KOZOVSKA (2010), p. 204
<i>GERD</i>	Country-level data: gross domestic expenditure on R&D (<i>GERD</i>) as a percentage of gross domestic product (GDP), year 2009 or the latest available data. Puerto Rico, the Dominican Republic and the United Arab Emirates are estimated Spain's regional data: same content, regional-level application	UNESCO EUStat	http://stats.uis.unesco.org/unesco/TableViewer/tableView.aspx?ReportId=2656/ http://epp.eurostat.ec.europa.eu/tgm/table.do?tab=table&init=1&language=en&pcode=tgs00042&plugin=1/

(Continued)

Table B1. Continued

Institutional variable	Description	Source of data	Data availability
<i>BUSS STRATEGY</i>	Country-level data: refers to the ability of companies to pursue distinctive strategies that involve differentiated positioning and innovative means of production and service delivery. Data are from 2007 to 2008, except for 2009 countries that are from 2008 to 2009. Spain's regional data are proxied by the Business strategy sophistication sub-index data from the EU Regional Competitiveness index and rescaling it to the original seven-point scale (see Appendix A for details)	World Economic Forum	SCHWAB and PORTER (2008), p. 18, SCHWAB (2009), p. 20
<i>GLOB</i>	Country- and regional-level data sources are the same: a part of the Globalization Index measuring the economic dimension of globalization. The variable involves the actual flows of trade, foreign direct investment, portfolio investment and income payments to foreign nationals as well as restrictions of hidden import barriers, mean tariff rate, taxes on international trade and capital account restrictions (http://globalization.kof.ethz.ch/static/pdf/variables_2009.pdf). Data are from the 2010 report and based on the 2007 survey	ANNIONI and KOZOVSKA (2010)	Based on ANNIONI and KOZOVSKA (2010), p. 188
<i>DCM</i>	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. This variable is a complex measure of the size and liquidity of the stock market, level of initial public offering (IPO), merger and acquisition (M&A), and debt and credit market activity. Note that there were some methodological changes over the 2006–12 period, so previous years' comparison is not perfect. The dataset is provided by Alexander Groh	KOF Swiss Economic Institute EMLYON Business School France and IESE Business School, Barcelona, Spain	DREHER (2006) GROH <i>et al.</i> (2012) (http://blog.iese.edu/vcpeindex/about/)

APPENDIX C: RESCALING OF THE REGIONAL VARIABLES FOR THE LEVEL AND RANGE OF THE COUNTRY LEVEL VARIABLE

Example: *MARKETSIZE*

MARKETSIZE = Spain's average market size from World Economic Forum (WEF) = 5.34

Maximum *MARKETSIZE* = 7. Country maximum market size from WEF

MARKETSIZE = applied market size variable for the *j*th Spanish region

REGMARKETSIZE = *j*th region market size from the Regional Competitiveness score $j = 1, \dots, k$, where *k* is the number of regions in Spain

Maximum *REGMARKETSIZE* = 100

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

$MARKETSIZE = AVMARKETSIZE + (REGMARKETSIZE - AVREGAMARKETSIZE) \cdot (7 - 5.34) / (100 - AVREGAMARKETSIZE)$

NOTES

1. For a review of the literature, see ACS (2010).
2. For further discussion, see ACS *et al.* (2014).
3. For the description of the full methodology, see SZERB and ACS (2011) and ACS *et al.* (2014).
4. NUTS is Nomenclature des Unités Territoriales Statistiques. For the Eurostat regional homepage, see: http://epp.eurostat.ec.europa.eu/portal/page/portal/region_cities/introduction/.
5. For more information on the NUTS classification, see: http://epp.eurostat.ec.europa.eu/portal/page/portal/nuts_nomenclature/introduction/.
6. The *URBANIZATION* variable is not used on its own in GEDI; rather it is combined with the *MARKETDOM* variable to make up the *MARKETAGGLOM* institutional variable used by GEDI.
7. Since Ceuta and Melilla are no more than small Spanish enclave towns, they are not included in the further analysis.
8. Innovation-driven economies are defined according to the World Competitiveness Survey categorization (SCHWAB and PORTER 2008).
9. The source is SCHWAB and PORTER (2008), p. 9. The list of innovation-driven countries is: Australia, Austria, Belgium, Canada, Cyprus, Czech Republic, Denmark, Finland, France, Germany, Greece, Hong Kong, Iceland, Ireland, Israel, Italy, Japan, Korean Republic, Luxemburg, Malta, the Netherlands, New Zealand, Norway, Portugal, Puerto Rico, Singapore, Slovenia, Spain, Sweden, Switzerland, United Arab Emirates, UK, and the United States. 2008 data exist for countries shown in italics.
10. 'Optimal' in the sense of maximizing the GEDI value.

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