

# GEI 2018: Technical Annex

## Introduction

In previous GEI publications, we have described the Global Entrepreneurship Index methodology in detail.<sup>39</sup> Here we describe the structure of the dataset, and a short summary of the GEI methodology. As compared to the previous versions the institutional components of the GEI have been reviewed and changed. Here, we provide a description of the changes. As a result, the previous scores and rankings cannot be compared to this version.

## The Structure of the Index

We have defined country-level entrepreneurship as “the dynamic, institutionally embedded interaction between entrepreneurial attitudes, entrepreneurial abilities, and entrepreneurial aspirations by individuals, which drives the allocation of resources through the creation and operation of new ventures.”<sup>40</sup> According to this definition, we propose four-level index building: (1) variables, (2) pillars, (3) sub-indices, and, finally, (4) the super-index. All three sub-indices contain several pillars, which can be interpreted as the quasi-independent building blocks of this entrepreneurship index.

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

Sub-indices	Pillars	Variables (ind./inst.)	
GLOBAL ENTREPRENEURSHIP INDEX	ATTITUDES SUB-INDEX	OPPORTUNITY PERCEPTION	OPPORTUNITY RECOGNITION FREEDOM (ECONOMIC FREEDOM *PROPERTY RIGHTS)
		STARTUP SKILLS	SKILL PERCEPTION EDUCATION (TERTIARY EDUCATION*QUALITY OF EDUCATION)
		RISK ACCEPTANCE	RISK PERCEPTION COUNTRY RISK
		NETWORKING	KNOW ENTREPRENEURS AGGLOMERATION (URBANIZATION*INFRASTRUCTURE )
		CULTURAL SUPPORT	CAREER STATUS CORRUPTION
	ABILITIES SUB-INDEX	OPPORTUNITY STARTUP	OPPORTUNITY MOTIVATION GOVERNANCE (TAXATION*GOOD GOVERNANCE)
		TECHNOLOGY ABSORPTION	TECHNOLOGY LEVEL TECHNOLOGY ABSORPTION
		HUMAN CAPITAL	EDUCATIONAL LEVEL LABOR MARKET (STAFF TRAINING*LABOUR FREEDOM)
		COMPETITION	COMPETITORS COMPETITIVENESS (MARKET DOMINANCE*REGULATION)
		ASPIRATION SUB-INDEX	PRODUCT INNOVATION
PROCESS INNOVATION	NEW TECHNOLOGY SCIENCE (GERD*((AVERAGEQUALITY OF SCIENTIFICAL INSTITUTIONS +AVAILABILITY OF SCIENTISTS AND ENGINEERS))		
HIGH GROWTH	GAZELLE FINANCE AND STRATEGY (VENTURE CAPITAL*BUSINESS SOPHISTICATION)		
INTERNATIONALIZATION	EXPORT ECONOMIC COMPLEXITY		
RISK CAPITAL	INFORMAL INVESTMENT DEPTH OF CAPITAL MARKET		

\*Individual variables are colored with white background while institutional ones with light blue background.  
 Red letters show the changes in the index structure as compared to the previous GEI version

In this section, we describe the sub-indices and pillars. In the following section, we describe the variables. The three sub-indices of Attitudes, Abilities, and Aspirations constitute the entrepreneurship super-index, which we call the Global Entrepreneurship Index. The current structure of the index, which has remained unchanged since the 2017 GEI, is in **Table 1**.

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

Entrepreneurial abilities include some important characteristics of the entrepreneur that determine the extent to which new startups will have potential for growth, such as motivation based on opportunity as opposed to necessity, the potential technology-intensity of the startup, the entrepreneur’s level of education, the level of competition and digital startup capabilities. These individual factors coincide with the proper institutional factors of taxation and the efficiency of government operation (Governance), technology adsorption capability, the freedom of the labor market and the extent of staff training (Labor Market), and the dominance of powerful business groups as well as the effectiveness of antimonopoly regulation (Regulation).

Entrepreneurial aspiration refers to the distinctive, qualitative, strategy-related nature of entrepreneurial activity. The individual and institutional factors of product and process innovation such as technology transfer, the applied research potential of science, high growth expectations, venture capital availability and strategy sophistication (Finance and Strategy), internationalization and the availability of risk financing constitute entrepreneurial aspirations. **Table 2** provides a short description and interpretation of the pillars we apply.

**Table 2: The description of the GEI index pillars**

Pillar name	Description
Opportunity Perception	Opportunity Perception refers to the entrepreneurial opportunity perception potential of the population and weights this against the freedom of the country and property rights
Start-up Skills	Start-up Skill captures the perception of start-up skills in the population and weights this aspect with the quality of education
Risk Acceptance	Risk Acceptance captures the inhibiting effect of fear of failure of the population on entrepreneurial action combined with a measure of the country’s risk.
Networking	This pillar combines two aspects of Networking: (1) a proxy of the ability of potential and active entrepreneurs to access and mobilize opportunities and resources and (2) the ease of access to reach each other.
Cultural Support	The Cultural Support pillar combines how positively a given country’s inhabitants view entrepreneurs in terms of status and career choice and how the level of corruption in that country affects this view.
Opportunity Startup	The Opportunity Startup pillar captures the prevalence of individuals who pursue potentially better quality opportunity-driven start-ups (as opposed to necessity-driven start-ups) weighted with the combined effect of taxation and government quality of services.
Technology Absorption	The Technology Absorption pillar reflects the technology-intensity of a country’s start-up activity combined with a country’s capacity for firm-level technology absorption.

Human Capital	The Human Capital pillar captures the quality of entrepreneurs as weighing the percentage of start-ups founded by individuals with higher than secondary education with a qualitative measure of the propensity of firms in a given country to train their staff combined with the freedom of the labor market.
Competition	The Competition pillar measures the level of the product or market uniqueness of start-ups combined with the market power of existing businesses and business groups as well as with the effectiveness of competitive regulation.
Product Innovation	The Product Innovation pillar captures the tendency of entrepreneurial firms to create new products weighted by the technology transfer capacity of a country.
Process Innovation	The Process Innovation pillar captures the use of new technologies by start-ups combined with the Gross Domestic Expenditure on Research and Development (GERD) and the potential of a country to conduct applied research.
High Growth	The High Growth pillar is a combined measure of (1) the percentage of high-growth businesses that intend to employ at least ten people and plan to grow more than 50 percent in five years (2) the availability of venture capital and (3) business strategy sophistication.
Internationalization	The Internationalization pillar captures the degree to which a country's entrepreneurs are internationalized, as measured by businesses' exporting potential weighted by the level of economic complexity of the country.
Risk Capital	The Risk Capital pillar combines two measures of finance: informal investment in start-ups and a measure of the depth of the capital market. Availability of risk capital is to fulfill growth aspirations.

Source: Own creation

By applying the Penalty for Bottleneck approach, the GEI methodology captures the notion that systems, by definition, comprise multiple components, and that these components co-produce system performance. These are defining characteristics of any system, which simple summative indices fail to capture. In a simple summative index, each system component contributes directly and independently to system performance. In the context of entrepreneurship, this would mean, for example, that a national measure of education would, directly and independent of other system components, contribute to "national entrepreneurship," while in reality we know that education cannot contribute much to a country's entrepreneurial performance if individuals fail to act. On the other hand, if education were absent, the economic potential of entrepreneurial entries would be severely constrained. Moreover, even if both education and agency were present, country-level entrepreneurial performance would be constrained if, for example, growth aspirations were missing or if there were no financial resources available to feed the growth of new ventures. A simple summative index would fail to recognize such interactions, thereby ignoring crucial aspects of system-level performance.

### The Individual Variables and Dataset

As mentioned previously, an entrepreneurship index should incorporate both individual-level and institutional/environmental variables. All individual-level variables are from the GEM survey. The institutional variables are obtained from various sources. The full list and description of the applied GEM individual variables can be seen in **Table 3**.

**Table 3: The Description of the Individual Variables Used in the GEI**

Individual variable	Description
Opportunity Recognition	The percentage of the 18-64 aged population recognizing good conditions to start business next 6 months in area he/she lives,

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

For the 2018 GEI publication we used 2015-2016 or previous years' Global Entrepreneurship Monitor individual data. For the individual variable calculation, we include more than 500,000 individuals from 100 countries of the GEM Adult Population Survey; 65 countries' individual data are from the years 2015-2016, and 37 countries have individual data from the pre-2014 years. We estimated the individual variables for 35 countries by using nearby and similar countries' GEM Adult Population Survey data. It is important to note that any estimation involves a potential of higher error term as compared to those countries that participated in the regular GEM survey. Therefore, the pillar scores, the sub-indices and the GEI scores based on estimated individual data should be viewed with discretion.

Since the availability of the institutional data also limited the selection of the countries, we could involve only those nations that participated in the World Economic Forum 2015-2016 or 2016-2017 Global Competitiveness Report (GCR) survey. Some GCR countries were left out because of the lack of similar or nearby GEM countries. The size of the sample in different years, the participating countries and the calculation of the individual variables, including the 35 non-GEM countries, are also reported in **Table 4**. All analyses of countries having data older than 2014 and based on estimation should be handled with caution and cannot be used for any policy

suggestions. This is particularly true for countries with estimated individual data.<sup>41</sup> In fact, even GEM survey backed calculated variables and pillars are only the starting point of a detailed GEI based policy analysis.<sup>42</sup>

**Table 4: The Distribution of the Sample by Countries and the Calculation of the Individual Variables**

Country	2009	2010	2011	2012	2013	2014	2015	2016	Years/estimation of missing data
Albania									Average of Bosnia 2014 and Macedonia 2016
Algeria			4984	2497					Average of 2012-2013
Angola					2049	2028			Average of 2013-2014
Argentina							2519	1679	Average of 2015-2016
Armenia									Average of Georgia and Russia
Australia							1770	1593	Average of 2015-2016
Austria						4554		4581	Average of 2014-2016
Azerbaijan									Average of Georgia and Turkey
Bahrain									Same as Qatar 2016
Bangladesh			1932						2011
Barbados						2000	2000		Average of 2014-2015
Belgium						2004	2022		Average of 2014-2015
Belize								2267	Average of 2014 and 2016
Benin						2000			2014
Bolivia						2590			2014
Bosnia and Herzegovina					2004	2015			Average of 2013-2014
Botswana						2146	2200		Average of 2014-2015
Brazil							2000	2000	Average of 2015-2016
Brunei Darussalam									Average of Malaysia 2016 and Singapore 2014
Bulgaria							2001	2000	Average of 2015-2016
Burkina Faso							2325	2325	Average of 2015-2016
Burundi									Average of Burkina Faso and Cameroon
Cambodia									Average of Vietnam 2015 and Thailand
Cameroon							2397	2413	Average of 2015-2016
Canada							2933	1767	Average of 2015-2016
Chad									Average of Burkina Faso and Cameroon
Chile							5407	7961	Average of 2015-2016
China							3365	3513	Average of 2015-2016
Colombia							3686	2069	Average of 2015-2016
Costa Rica				2041		2057			Average of 2012-2014
Côte d'Ivoire									Average of Burkina Faso and Cameroon
Croatia						2000	2000		Average of 2015-2016
Cyprus								2000	Only 2016
Czech Republic					5009			2001	2013
Denmark				2217		2008			Average of 2012-2014
Dominican Republic	2007								2009
Ecuador							1931	1841	Average of 2015-2016
Egypt				2501			2512	2528	Average of 2015-2016
El Salvador						2014		1753	Average of 2014 and 2016
Estonia							2002	1993	Average of 2015-2016
Ethiopia				3003					2012
Finland							2007	2018	Average of 2015-2016
France					1567	1567		1541	Average of 2014 and 2016
Gabon									Average of Namibia 2014 and Botswana 2015
Gambia, The									Average of Burkina Faso and Cameroon
Georgia						1648		1579	Average of 2014 and 2016
Germany							3842	3944	Average of 2015-2016
Ghana				2213	2100				Average of 2012-2013
Greece							2000	2000	Average of 2015-2016

Country	2009	2010	2011	2012	2013	2014	2015	2016	Years/estimation of missing data
Guatemala							2181	2219	Average of 2015-2016
Guinea									Average of Burkina Faso and Cameroon
Guyana									Same as Suriname 2014
Honduras									Average of Guatemala and Panama
Hong Kong								1783	Only 2016
Hungary							2000	2011	Average of 2015-2016
Iceland		1684							2010
India							3413	3400	Average of 2015-2016
Indonesia							5620	3464	Average of 2015-2016
Iran							3234	3295	Average of 2015-2016
Ireland							2001	2004	Average of 2015-2016
Israel							2055	2516	Average of 2015-2016
Italy							2000	2045	Average of 2015-2016
Jamaica					2246	2637		2020	Average of 2014 and 2016
Japan					2000	2006			Average of 2013-2014
Jordan								1830	Only 2016
Kazakhstan							2101	2086	Average of 2015-2016
Kenya									Average of Burkina Faso and Cameroon
Korea							2000	2000	Average of 2015-2016
Kuwait									Same as Qatar
Kyrgyz Republic									Average of Kazakhstan and Russia
Lao PDR									Average of Vietnam 2015 and Thailand
Latvia							2004	1625	Average of 2015-2016
Lebanon							2600	2600	Average of 2015-2016
Liberia									Average of Burkina Faso and Cameroon
Libya					2246				2013
Lithuania					2000	2000			Average of 2013-2014
Luxembourg							2016	2024	Average of 2015-2016
Macedonia							1998	1991	Average of 2015-2016
Madagascar									Average of Burkina Faso and Cameroon
Malawi				1847	2094				Average of 2012-2013
Malaysia							2000	2005	Average of 2015-2016
Mali									Average of Burkina Faso and Cameroon
Mauritania									Average of Burkina Faso and Cameroon
Mexico							4643	5111	Average of 2015-2016
Moldova									Average of Romania 2015 and Russia
Montenegro		2000							2010
Morocco							2061	2005	Average of 2015-2016
Mozambique									Average of Burkina Faso and Cameroon
Myanmar									Average of Vietnam 2015 and Thailand
Namibia				1959	1938				Average of 2012-2013
Netherlands							1754	1768	Average of 2015-2016
Nicaragua									Average of Guatemala and Panama
Nigeria				2651	2604				Average of 2012-2013
Norway						2000	2000		Average of 2014-2015
Oman									Same as Qatar 2016
Pakistan			2002	2000					Average of 2011-2012
Panama							2000	2015	Average of 2015-2016
Paraguay									Average of Ecuador and Peru
Peru							2078	2080	Average of 2015-2016
Philippines						2000	2000		Average of 2014-2015
Poland							2000	1623	Average of 2015-2016
Portugal							2005	2003	Average of 2015-2016
Puerto Rico							1999	1998	Average of 2015-2016
Qatar							4269	2980	Average of 2014 and 2016

Country	2009	2010	2011	2012	2013	2014	2015	2016	Years/estimation of missing data
Romania						1998	2002		Average of 2014-2015
Russia						2001		2007	Average of 2014 and 2016
Rwanda									Average of Burkina Faso and Cameroon
Saudi Arabia								4049	Only 2016
Senegal							2363		2015
Serbia	1766								2009
Sierra Leone									Average of Burkina Faso and Cameroon
Singapore					1998	2004			Average of 2013-2014
Slovakia							2003	2000	Average of 2015-2016
Slovenia							2009	1621	Average of 2015-2016
South Africa							2765	2862	Average of 2015-2016
Spain							24300	22000	Average of 2015-2016
Sri Lanka									Same as India
Suriname					2074	2006			Average of 2013-2014
Swaziland									Average of Namibia 2014 and Botswana 2015
Sweden							3716	3663	Average of 2015-2016
Switzerland							1886	2834	Average of 2015-2016
Taiwan							2000	2000	Average of 2015-2016
Tajikistan									Average of Kazakhstan and Russia
Tanzania									Average of Burkina Faso and Cameroon
Thailand							3000	2693	Average of 2015-2016
Trinidad & Tobago					1787	1769			Average of 2013-2014
Tunisia							1946		2015
Turkey					32945			2411	Average of 2013 and 2016
Uganda					2513	2112			Average of 2013-2014
Ukraine									Average of Romania 2015 and Russia
United Arab Emirates								2011	Only 2016
United Kingdom							7886	8224	Average of 2015-2016
United States							2683	2573	Average of 2015-2016
Uruguay							1742	1615	Average of 2015-2016
Venezuela			1888						2011
Vietnam						2000	2000		Average of 2014-2015
Zambia				2155	2099				Average of 2012-2013

## The Institutional Variables and Dataset

Since the GEM lacks the necessary institutional variables, we complement individual variables with other widely used relevant data from Transparency International (Corruption Perception Index), UNESCO (tertiary education enrollment, GERD), World Economic Forum (infrastructure, regulation, scientific institutions, availability of scientists, business sophistication, technology absorption and technology transfer capability, staff training, market dominance, venture capital), United Nations (urbanization), The Heritage Foundation and World Bank (economic freedom, property rights, labor freedom), the World Bank (taxation, good governance), the Observatory of Economic Complexity (economic complexity), OECD (country risk), and the Venture Capital & Private Equity Country Attractiveness Index (depth of capital market<sup>43</sup>).

In this version, we apply the most recent institutional variables available on January 31, 2017. The full description of the institutional variables, their sources, and the year of the survey can be found in **Table 5**.

**Table 5: The Description and Source of the Institutional Variables Used in the GEI**

Institutional Variable	Description	Source of Data	Data Availability
Economic Freedom	“Business freedom is a quantitative measure of the ability to start, operate, and close a business that represents the overall burden of regulation, as well as the efficiency of government in the regulatory process. The business freedom score for each country is a number between 0 and 100, with 100 equaling the freest business environment. The score is based on 10 factors, all weighted equally, using data from the World Bank’s Doing Business study”.	Heritage Foundation/ World Bank	<a href="http://www.heritage.org/index/explore.aspx">http://www.heritage.org/index/explore.aspx</a>
Property Rights	( <a href="http://www.heritage.org/index/pdf/Index09_Methodology.pdf">http://www.heritage.org/index/pdf/Index09_Methodology.pdf</a> ). Data are collected from 2015. “The property rights component is an assessment of the ability of individuals to accumulate private property, secured by clear laws that are fully enforced by the state. It measures the degree to which a country’s laws protect private property rights and the degree to which its government enforces those laws. It also assesses the likelihood that private property will be expropriated and analyzes the independence of the judiciary, the existence of corruption within the judiciary, and the ability of individuals and businesses to enforce contracts.”	Heritage Foundation/ World Bank	<a href="http://www.heritage.org/index/explore.aspx">http://www.heritage.org/index/explore.aspx</a>
Freedom and Property	Economic Freedom * Property Rights	Own calculation	
Tertiary Education	Gross enrolment ratio in tertiary education, 2015 or latest available data.	World Bank	<a href="http://data.worldbank.org/indicator/SE.TER.ENRR">http://data.worldbank.org/indicator/SE.TER.ENRR</a>
Quality of Education	Answers to the question: “In your country, how do you assess the quality of math and science education? [1 = extremely poor – among the worst in the world; 7 = excellent – among the best in the world]”		The Global Competitiveness Report 2015–2016, p. 377
Education	Tertiary Education * Quality of Education	Own calculation	
Country Risk	The country risk classifications are meant to reflect country risk. Under the Participants’ system, country risk is composed of transfer and convertibility risk (i.e. the risk a government imposes capital or exchange controls that prevent an entity from converting local currency into foreign currency and/or transferring funds to creditors located outside the country) and cases of force majeure (e.g. war, expropriation, revolution, civil disturbance, floods, earthquakes).	OECD	<a href="http://www.oecd.org/tad/xcred/crc.htm">http://www.oecd.org/tad/xcred/crc.htm</a>

Institutional Variable	Description	Source of Data	Data Availability
Urbanization	Urbanization that is the percentage of the population living in urban areas, data are from the Population Division of the United Nations, 2010 estimate	United Nations	<a href="http://data.worldbank.org/indicator/SP.URB.TOTL.IN.ZS">http://data.worldbank.org/indicator/SP.URB.TOTL.IN.ZS</a>
Infrastructure	Pillar 2, Infrastructure and connectivity in the World Competitiveness Report: "(...) in addition to assessing the quality of the transport infrastructure, the pillar also measures the quality of domestic and international transport networks."	World Economic Forum	The Global Competitiveness Report 2015-2016, p. 47
Connectivity	Urbanization * Infrastructure	Own calculation	
Corruption	The Corruption Perceptions Index (CPI) measures the perceived level of public-sector corruption in a country. "The CPI is a "survey of surveys", based on 13 different expert and business surveys." ( <a href="http://www.transparency.org/policy_research/surveys_indices/cpi/2009">http://www.transparency.org/policy_research/surveys_indices/cpi/2009</a> ) Overall performance is measured on a ten point Likert scale. Data are collected over the last 24 months.	Transparency International	<a href="http://files.transparency.org/content/download/702/3015/file/CPI2013_DataBundle.zip">http://files.transparency.org/content/download/702/3015/file/CPI2013_DataBundle.zip</a>
Taxation	Paying taxes scores, "(...) addresses the taxes and mandatory contributions that a medium-size company must pay or withhold in a given year, as well as measures the administrative burden in paying taxes." ( <a href="http://www.doingbusiness.org/data/exploretopics/paying-taxes">http://www.doingbusiness.org/data/exploretopics/paying-taxes</a> )	World Bank	<a href="http://www.doingbusiness.org/data/distance-to-frontier">http://www.doingbusiness.org/data/distance-to-frontier</a>
Good Governance	The effectiveness of the government "the capacity of the government to effectively formulate and implement sound policies" ( <a href="http://info.worldbank.org/governance/wgi/#home">http://info.worldbank.org/governance/wgi/#home</a> )	World Bank	<a href="http://qog.pol.gu.se/data/datadownloads/gogbasicdata">http://qog.pol.gu.se/data/datadownloads/gogbasicdata</a>
Taxgovern	Measures the effectiveness of using the taxes by combining together the level of the tax by the quality of government services, Taxation * Good Governance	Own calculation	
Tech Absorption	Firm level technology absorption capability: "Companies in your country are (1 = not able to absorb new technology, 7 = aggressive in absorbing new technology)".	World Economic Forum	The Global Competitiveness Report 2015-2016-. p. 379
Labor Freedom	Measures the freedom of the labor as "(...) that considers various aspects of the legal and regulatory framework of a country's labor market, including regulations concerning minimum wages, laws inhibiting layoffs, severance requirements, and measurable regulatory restraints on hiring and hours worked." ( <a href="http://www.heritage.org/index/labor-freedom">http://www.heritage.org/index/labor-freedom</a> )	Heritage Foundation	<a href="http://www.heritage.org/index/download">http://www.heritage.org/index/download</a>

Institutional Variable	Description	Source of Data	Data Availability
Staff Training	The extent of staff training: "To what extent do companies in your country invest in training and employee development? (1 = hardly at all; 7 = to a great extent)".	World Economic Forum	The Global Competitiveness Report 2015-2016, p. 377
Labor Market	Labor Freedom * Staff Training		
Regulation	Effectiveness of anti-monopoly policy, answering to the question: "In your country, how effective are anti-monopoly policies at ensuring fair competition? [1 = not effective at all; 7 = extremely effective]"	World Economic Forum	The Global Competitiveness Report 2015-2016, p. 395
Market Dominance	Extent of market dominance: "Corporate activity in your country is (1 = dominated by a few business groups, 7 = spread among many firms)".	World Economic Forum	The Global Competitiveness Report 2015-2016, p. 471
Competition	Regulation * Market Dominance		
Technology Transfer	These are the innovation index points from GCI: a complex measure of innovation including investment in research and development (R&D) by the private sector, the presence of high-quality scientific research institutions and the collaboration in research between universities and industry, and the protection of intellectual property.	World Economic Forum	The Global Competitiveness Report 2015-2016, p. 22
GERD	Gross domestic expenditure on Research & Development (GERD) as a percentage of GDP, year 2014 or latest available data Puerto Rico, Dominican Republic, and United Arab Emirates are estimated	UNESCO	<a href="http://stats.uis.unesco.org/unesco/TableViewer/tableView.aspx?ReportId=2656">http://stats.uis.unesco.org/unesco/TableViewer/tableView.aspx?ReportId=2656</a>
Scientific Institutions	Quality of scientific research institutions. Answering to the question: "In your country, how do you assess the quality of scientific research institutions? [1 = extremely poor – among the worst in the world; 7 = extremely good – among the best in the world]"	World Economic Forum	The Global Competitiveness Report 2015-2016, p. 381
Availability of Scientist	Availability of scientists and engineers. Answering to the question: "In your country, to what extent are scientists and engineers available? [1 = not at all; 7 = widely available]"	World Economic Forum	The Global Competitiveness Report 2015-2016, p. 381
Science	GERD* Average of Scientific Institutions and Availability of Scientist	Own calculation	

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

\*Special thanks to Alexander Groh and his team for providing the Depth of Capital Market data.

## Missing Variables and Data Imputations

Since our basic individual data are provided by the GEM, participation in the GEM survey determines the potential list of countries and sample size. However, there is another potential limitation, the availability of institutional data. Because seven out of our fourteen institutional variables are from the GCI, it is particularly important to have these variables. While there were five additional countries in the GEM 2014 surveys, we had to cancel out Tonga, Vanuatu, the West Bank and Gaza Strip, Yemen, and Syria because of the lack of proper institutional variables.<sup>44</sup>

A few variables are missing for some countries. Since we did not want to drop any more countries from the sample, we estimated the missing data using expert techniques, as follows: the GERD measure lacked data for Angola, Bangladesh, Belize, Benin, Cameroon, Chad, Côte d'Ivoire, Guinea, Libya, Malawi, Mauritania, Namibia, Oman, Qatar, Rwanda, Sierra Leone, Suriname, Swaziland, Tanzania, and Venezuela. In these cases, other government sources and data from similar nearby countries provided adequate estimates. Economic complexity data for Armenia, Azerbaijan, Brunei Darussalam, Guinea, Kyrgyz Republic, Montenegro, Myanmar, Swaziland, and Tajikistan are estimated similarly to the GERD, by applying nearby country data points. Puerto Rico's business freedom dataset is the same as the US. All the other data are available for all countries; therefore, we believe that these rough estimates do not influence our results noticeably.<sup>45</sup>

## Calculating the Scores

The GEI scores for all the countries are calculated according to the following eight points.

1. **The selection of variables:** We start with the variables that come directly from the original sources for each country involved in the analysis. The variables can be at the individual level (personal or business) that are coming from the GEM Adult Population Survey, or the institutional/environmental level that are coming from various other sources. Altogether we use 16 individual and 15 institutional variables.
2. **The construction of the pillars:** We calculate all pillars from the variables using the interaction variable method; that is, by multiplying the individual variable with the proper institutional variable.

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

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

3. **Normalization:** Pillar values were first normalized to a range from 0 to 1, according to equation 1:

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

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

4. **Capping:** All index building is based on a benchmarking principle. We selected the 95<sup>th</sup> percentile score adjustment, meaning that any observed values higher than the 95<sup>th</sup> percentile are lowered to the 95<sup>th</sup>

percentile. For the 132 countries in our dataset, we use the benchmarks values from the full dataset, which contains all the 629 observations made over the 2002-2014 time period.

5. **Average pillar adjustment:** The different averages of the normalized values of the indicators imply that reaching the same indicator values requires different effort and resources. Since we want to apply the GEI for public policy purposes, the additional resources for the same marginal improvement of the indicator values should be the same for all indicators. Therefore, we need a transformation to equate the average values of the components. Equation 2 shows the calculation of the average value of pillar j:

$$\bar{x}_j = \frac{\sum_{i=1}^n x_{i,j}}{n} . \quad (3)$$

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

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

where  $k$  is the “strength of adjustment”, the  $k$ -th moment of  $X_j$  is exactly the needed average,  $\bar{y}_j$ . We have to find the root of the following equation for  $k$

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

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

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

then  $k$  is thought of as the strength (and direction) of adjustment.

The adjusted pillar values are calculated for all the 2002-2014 time period; these values and this distribution are applied for the 132 countries in the GEI 2016 edition. It means that the average adjusted pillar values of the countries that participated in the 2014 GEM cycle are exactly same in the 2002-2014 dataset and in the 2016 GEI edition. Note that, of the individual variables of the 132 countries in the GEI 2016 edition, 69 are from the 2013 survey, 29 are from earlier GEM surveys, and 34 are estimates.

The distribution of the average adjusted pillars can be found in the Appendix.

6. **Penalizing:** After these transformations, the PFB methodology was used to create indicator-adjusted PFB values. We define our penalty function as follows:

$$h_{(i),j} = \min y_{(i),j} + (1 - e^{-(y_{(i),j} - \min y_{(i),j})}) \quad (6)$$

where  $h_{i,j}$  is the modified, post-penalty value of pillar j in country i  
 $y_{i,j}$  is the normalized value of index component j in country i  
 $y_{min}$  is the lowest value of  $y_{i,j}$  for country i.

$i = 1, 2, \dots, n$  = the number of countries

$j = 1, 2, \dots, m$  = the number of pillars

7. The pillars are the basic building blocks of the sub-index: Entrepreneurial Attitudes, Entrepreneurial Abilities, and Entrepreneurial Aspirations. The value of a sub-index for any country is the arithmetic average 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 in a particular sub-index.

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

$$ABT_i = 100 \sum_{j=6}^9 h_j \quad (7b)$$

$$ASP_i = 100 \sum_{j=10}^{14} h_j \quad (7c)$$

where  $h_{i,j}$  is the modified, post-penalty value of pillar  $j$  in country  $i$

$i = 1, 2, \dots, n$  = the number of countries

$j = 1, 2, \dots, 14$  = the number of pillars

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

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

where  $i = 1, 2, \dots, n$  = the number of countries

Starting last year, we report not only the GEI scores but also the associated measurement error terms for those countries that have participated in the GEM survey (see Chapter 2). It is impossible to make an error calculation for the countries that have only estimated individual data. The report of the confidence intervals is important in two respects. First, when comparing different countries, we can see if the differences in the two countries' GEI scores are significant or not. Based on the 2017 GEI scores, the GEI scores of the first six countries—the United States, Switzerland, Canada, Sweden, Denmark, Iceland and Australia—do not differ significantly. However, the GEI score difference is significant between the US in first place and the United Kingdom in seventh. Second, from year to year we can see if changes in the GEI scores are significant, or if they perhaps are due to measurement error.

The confidence interval calculation is based on the error terms of the Total Early-Phased Entrepreneurship Activity index, as reported by the GEM each year. An important note is that the real measurement error is unknown, since we use many data from different sources for which confidence intervals are not currently available. Keep in mind that the real measurement errors are higher than the values reported here.

### **The Underlying Structure of the Data (reflecting the full 2006-2016 dataset)**

While the number of composite indicators has been increasing over the last few decades, some index creators pay little attention to the interrelationship between the different variables. Although the PFB methodology provides a practical solution for how to take this interrelationship into account, it does not save us from examining the underlying structure of the data. It is particularly important to have a well-defined nested structure of the whole index. The arbitrary selection of the variables—in our case the pillars—would cause confusion, false

interpretation, and, finally, a misleading policy interpretation. The OECD handbook of composite indicators recommends analyzing the dataset in two dimensions, pillars and countries.<sup>46</sup> We have already provided detailed analyses at the country level; here we are presenting a pillar-level analysis by calculating the common (Pearson) correlation coefficients. Since we have only estimated data from 35 countries, it is better to examine not the 137 countries involved in our analysis but the full 2006–2016 dataset, with 619 data points excluding the estimated country data.

We report correlations between the normalized and average equalized pillars, shown in **Table 6**, and the correlations between the normalized indicators after applying the PFB methodology, shown in **Table 7**. In general, significant and medium to high correlations exist between the pillars in both cases. The lowest correlation is between Startup Skills and High Growth (0.314) and the highest is between Opportunity Perception and Cultural Support (0.831).

The PFB pillars, as can be expected, improved the correlation, implying a closer relationship between the entrepreneurial features. The positive connection between the entrepreneurship pillars is vital for proper policy interpretation and suggestions. If the connection between the pillars were negative, it would have implied that one pillar can only be improved at the cost of the other pillar. In this case, the improvement of the weakest pillar value would not necessary to improve the GEI value. This is not the case.

There are other ways to check out the consistency of the dataset and the potentially strong connection between the pillars. Both the Kaiser-Meyer-Olkin measure of sampling adequacy and Bartlett's test of sphericity reinforce the fact that the 14 GEI pillars are closely correlated, and it is worth looking for a single complex measure.<sup>47</sup> The most popular test of the internal consistency of the pillars is based on the Cronbach Coefficient Alpha (c-alpha). The c-alpha value for the 14 pillars is 0.95 with the original data, and 0.97 after applying the PFB methodology; both are well above the critical 0.7 threshold value.<sup>48</sup> In sum, all of these tests support the internal consistency of the structure as described with the 14 selected pillars.

**Table 6: The Correlation Matrix between the Normalized and Average Equated Pillars (2006-2016 dataset)**

	1	2	3	4	5	6	7	8	9	10	11	12	13	14
1 Opportunity Perception	1	0.513**	0.620**	0.578**	0.831**	0.741**	0.516**	0.456**	0.672**	0.450**	0.412**	0.467**	0.387**	0.464**
2 Startup Skills		1	0.473**	0.424**	0.554**	0.551**	0.520**	0.390**	0.424**	0.312**	0.414**	0.308**	0.423**	0.473**
3 Risk Acceptance			1	0.520**	0.702**	0.773**	0.641**	0.579**	0.681**	0.528**	0.688**	0.518**	0.557**	0.620**
4 Networking				1	0.612**	0.604**	0.419**	0.361**	0.490**	0.514**	0.480**	0.401**	0.283**	0.476**
5 Cultural Support					1	0.821**	0.627**	0.519**	0.733**	0.535**	0.572**	0.572**	0.514**	0.643**
6 Opportunity Startup						1	0.701**	0.651**	0.764**	0.558**	0.699**	0.559**	0.623**	0.709**
7 Technology Absorption							1	0.534**	0.609**	0.527**	0.712**	0.578**	0.616**	0.654**
8 Human Capital								1	0.554**	0.471**	0.542**	0.638**	0.517**	0.602**
9 Competition									1	0.505**	0.616**	0.481**	0.552**	0.577**
10 Product Innovation										1	0.634**	0.637**	0.465**	0.605**
11 Process Innovation											1	0.574**	0.655**	0.686**
12 High Growth												1	0.573**	0.635**
13 Internationalization													1	0.655**
14 Risk Capital														1
	** Correlation is significant at the 0.01 level (2-tailed).													
	* Correlation is significant at the 0.05 level (2-tailed).													
	The number of observations= 619													

Table 7: The Correlation Matrix between the Indicators, Sub-Indices, and the GEI Super-Index after Normalizing and Applying the PFB Method (2006-2016 dataset)

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
1 Opportunity Perception	1	0.628**	0.715**	0.676**	0.869**	0.896**	0.801**	0.635**	0.597**	0.761**	0.785**	0.588**	0.560**	0.605**	0.538**	0.591**	0.658**	0.815**
2 Startup Skills		1	0.609**	0.565**	0.671**	0.804**	0.679**	0.655**	0.557**	0.579**	0.696**	0.491**	0.575**	0.502**	0.575**	0.621**	0.635**	0.745**
3 Risk Acceptance			1	0.648**	0.780**	0.879**	0.830**	0.725**	0.674**	0.765**	0.842**	0.652**	0.763**	0.634**	0.662**	0.709**	0.784**	0.875**
4 Networking				1	0.707**	0.816**	0.704**	0.568**	0.510**	0.616**	0.675**	0.628**	0.610**	0.540**	0.445**	0.603**	0.646**	0.745**
5 Cultural Support					1	0.931**	0.864**	0.727**	0.642**	0.810**	0.856**	0.662**	0.692**	0.685**	0.644**	0.733**	0.781**	0.896**
6 ATTINDEX						1	0.899**	0.770**	0.694**	0.819**	0.895**	0.698**	0.745**	0.688**	0.669**	0.756**	0.814**	0.945**
7 Opportunity Startup							1	0.770**	0.736**	0.823**	0.936**	0.673**	0.781**	0.663**	0.713**	0.776**	0.827**	0.930**
8 Technology Absorption								1	0.647**	0.702**	0.883**	0.638**	0.783**	0.690**	0.705**	0.746**	0.816**	0.863**
9 Human Capital									1	0.664**	0.848**	0.600**	0.643**	0.718**	0.636**	0.707**	0.754**	0.803**
10 Competition										1	0.893**	0.629**	0.718**	0.610**	0.657**	0.680**	0.755**	0.862**
11 ABTINDEX											1	0.714**	0.824**	0.752**	0.763**	0.818**	0.887**	0.972**
12 Product Innovation												1	0.719**	0.711**	0.599**	0.703**	0.850**	0.791**
13 Process Innovation													1	0.672**	0.736**	0.771**	0.896**	0.862**
14 High Growth														1	0.675**	0.724**	0.858**	0.804**
15 Internationalization															1	0.740**	0.862**	0.803**
16 Risk Capital																1	0.904**	0.867**
17 ASPINDEX																	1	0.945**
18 GEI																		1
** Correlation is significant at the 0.01 level (2-tailed).																		
The number of observations = 619																		