



GLOBAL ENTREPRENEURSHIP CONGRESS 2015

Milan, Italy





LÁSZLÓ SZERB

University professor, University of Pecs Faculty of Business and Economics,
Global data scientist, Global Entrepreneurship and Development Institute



The Global Entrepreneurship and Development Institute and GEI

- The Global Entrepreneurship and Development Institute (GEDI) is a Washington, DC-based non-profit policy development organization that advances research on links between entrepreneurship, economic development and prosperity.
- Homepage: <http://www.thegedi.org/>
 - Three major projects:
 - Global GEI
 - Regional GEI
 - Gender GEI
- The GEI is the flagship product of GEDI. GEI:
 - measures the level of productive entrepreneurship in a country;
 - provides useful benchmarks based on 14 aspects of entrepreneurship
 - is a powerful tool for identifying the right policies and programs to accelerate growth and job creation
- Since 2014, GEI has become the official index of the Global Entrepreneurship Network



The setup of the seminar

- Basic aims: to familiarize participants with GEI research, dataset, methodology and application
- Three parts:
 - Theoretical setup
 - The National System of Entrepreneurship
 - Index building vs. traditional statistical methods
 - GEI methodology
 - The calculation of the GEI scores
 - Practical guide
 - Bottleneck sensitivity analysis
 - The interpretation and presentation of the results



National System of Entrepreneurship



Sources

- Acs, Z., Autio, E., Szerb, L. 2014: National Systems of Entrepreneurship: Measurement Issues and Policy Implications. *Research Policy* 43(3), 476-494 (also available through SSRN: http://papers.ssrn.com/sol3/papers.cfm?abstract_id=2008160)
- Acs, Z., Szerb, L., Autio, E. (2015.) The Global Entrepreneurship and Development Index 2015, CreateSpace Independent Publishing Platform, Seattle
- Free download from GEDI homepage
- <http://thegedi.org/2015-global-entrepreneurship-index/>

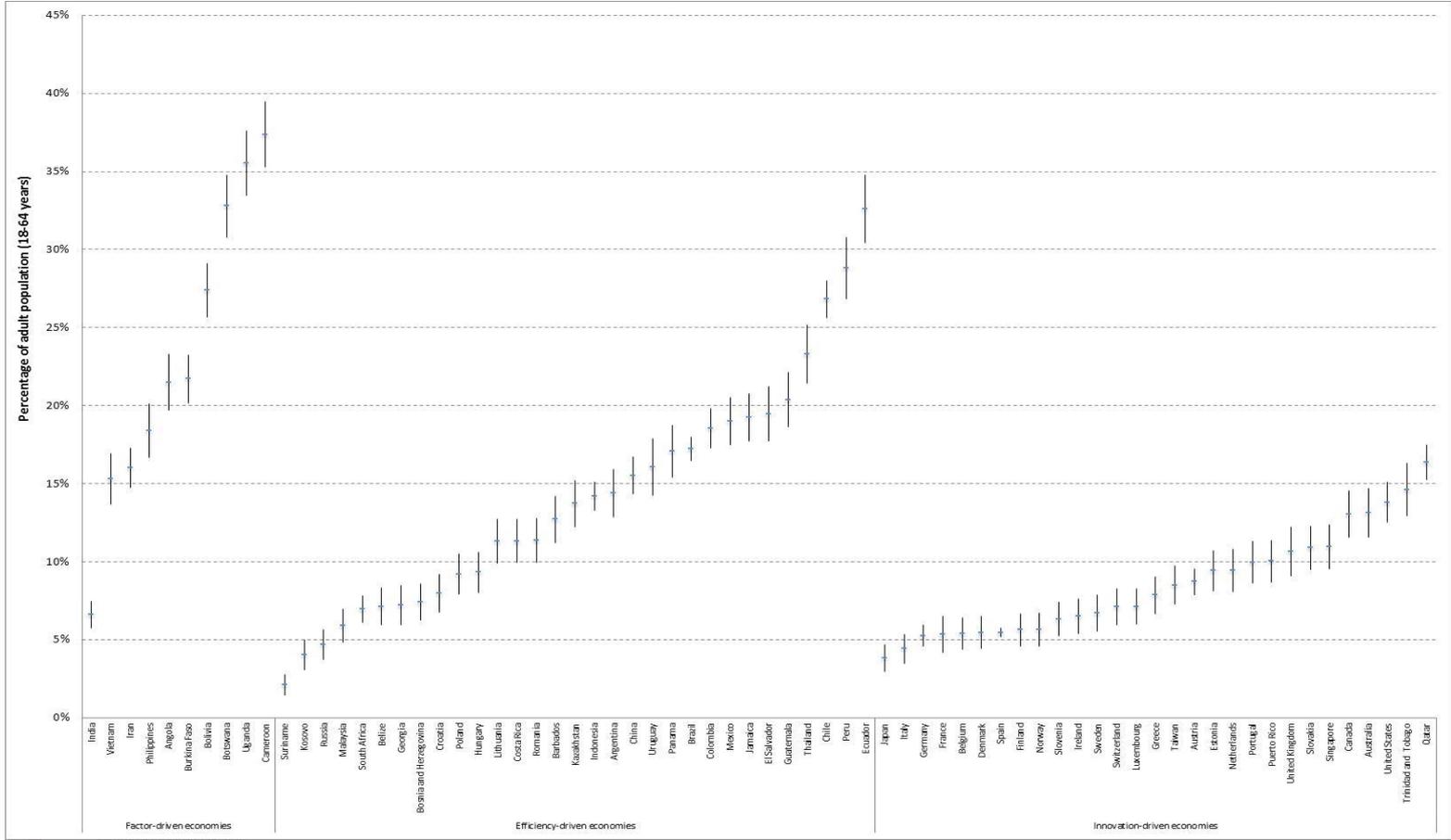


Entrepreneurship definitions and measures

- Entrepreneurship: one of the most studied and least understood societal phenomena
 - Different sciences (psychology, sociology, economics), aims (societal phenomenon, academic research, teaching), perspectives (process, context) and levels (individual, firm, country) use
 - A question is it a uni- or a multidimensional concept?
- Entrepreneurship measurements- GEM based data
 - A commonly used uni-dimensional measure: Total Early-phase Entrepreneurial Activity (TEA)
 - Measures the nascent and new business startup ratio as the percentage of 18-64 aged population



What is 'entrepreneurship' as a country-level phenomenon?



Note: Total Early-phased entrepreneurial activity in adult-age population (% of 18-64 years old) 2014



What kind of entrepreneurship should be measured?

- According to Baumol (1990) the supply of entrepreneurship is constant over time
- Entrepreneurship can be productive, unproductive or destructive
- The productivity of entrepreneurship depends on the development of institutions
- Productive entrepreneurship depends on the level of development
 - Factor driven economies
 - mostly unproductive and destructive entrepreneurship
 - Efficiency driven economies
 - productive entrepreneurship increases, getting rid of the destructive entrepreneurship
 - Innovation driven economies
 - productive entrepreneurship dominates
- GEM's TEA index measures total entrepreneurship, GEI measures productive entrepreneurship



Measuring entrepreneurship in countries and regions

- Output indicators
 - Counts of incorporations (World Bank Enterprise Survey)
 - Counts of individual-level entrepreneurial entries (GEM)
 - Self-employment rates (national statistics centers)
- Attitude indicators
 - Eurobarometer survey: Preference for 'entrepreneurship' as a career
 - World Values Survey
 - GEM attitude questions
- Framework indicators
 - Nordic Entrepreneurship Monitor
 - OECD Entrepreneurship Indicators Programme
 - World Bank Ease of Doing Business Index
 - (Index of Economic Freedom)
 - Legatum Prosperity Index subindex Entrepreneurship and opportunity



Problems with received measures

- Lack of contextualization of output indicators
 - Does a new firm formation have the same impact everywhere?
 - Is a new firm the same thing everywhere?
 - Where do the firms come from?
- Attitude measures do not link to activity
 - Do attitudes translate to action?
 - When do they drive action?
 - For whom?
- Framework indicators ignore processes
 - Does policy drive entrepreneurial outcomes?
 - When?
 - How?



How about National Systems of Innovation?

- "*...a set of institutions whose interactions determine the innovative performance ... of national firms*" (Rosenberg & Nelson, 1994:4-5)
- Purpose: debunk the 'linear' model of innovation
- Emphasis on the 'systemic' character of innovation
 - Interactions between organizations
 - Knowledge flows
 - Cumulativeness
 - Path dependency
- Key message: 'institutional structure' for innovation ultimately determines a country's innovation performance
- But: the Entrepreneur is absent in this theory!

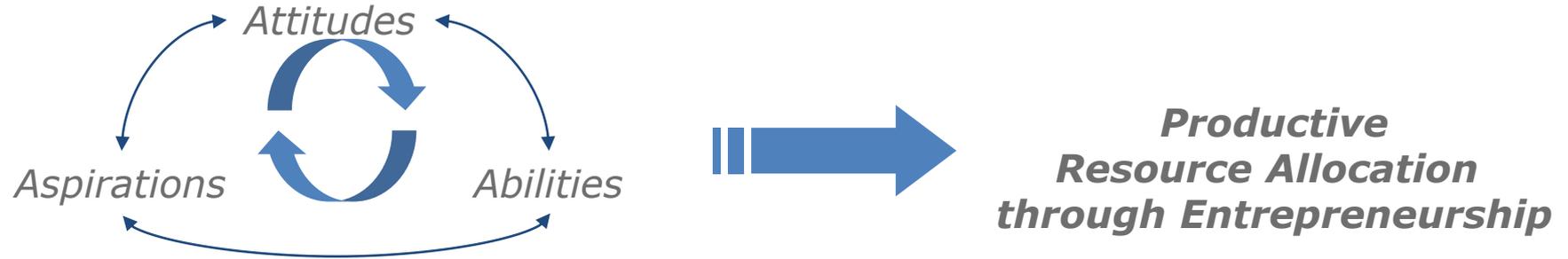


In summary

- NSI: 'Institutions' 'do' everything
 - But, the individual is nowhere to be seen (individual as an automaton)
 - Lundvall 2007: 'Structuralist mode of explanation that neglects the critical role of agency'
- Entrepreneurship research: Individual does everything
 - But, the context is almost fully ignored
- In reality, we know that:
 - Institutions matter because they regulate: (1) who acts; (2) with what motivation and ambition; (3) the link between actions and outcomes
 - Individuals matter because without action nothing moves



National Systems of Entrepreneurship Framework



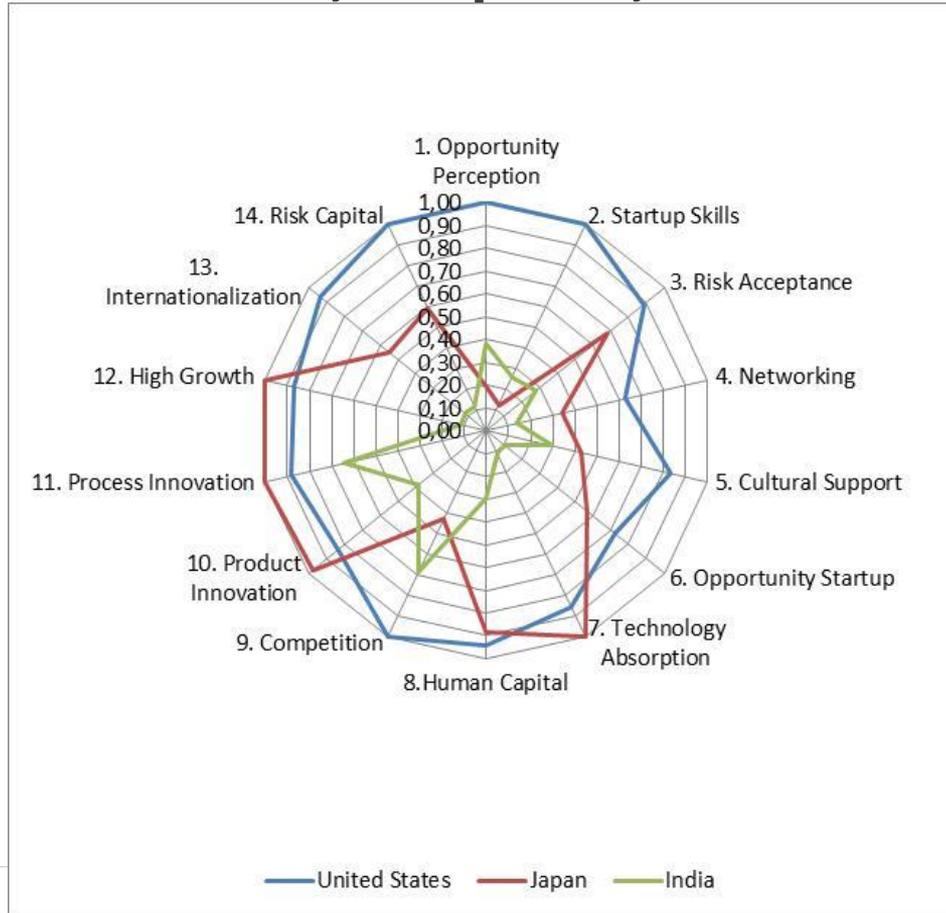
- At the country level, entrepreneurial performance is driven by a complex dynamic between Attitudes, Aspirations and Abilities
- System components co-produce system performance
- System performance may therefore be held back by 'bottleneck' factors
- Activity is embedded in a country's institutional context, which regulates individual-level actions and outcomes

The National System of Entrepreneurship and its measure

- Taking into account that
 - entrepreneurship is a multidimensional concept,
 - individual and environmental factors are both important,
 - the institutional setup determines the effectiveness of individual entrepreneurship effort and
 - the components of entrepreneurship constitute a system,
- We define national entrepreneurship as the dynamic, institutionally embedded interaction between entrepreneurial attitudes, abilities, and aspirations, by individuals, which drives the allocation of resources through the creation and operation of new ventures. Attitudes, abilities and aspirations are complex categories which include individual and institutional (contextual) measures
- GEI therefore reflects the quality of National Systems of Entrepreneurship (NSE)
 - Not the whole NSE but only a part is measured



Illustration: US, Japan, and India

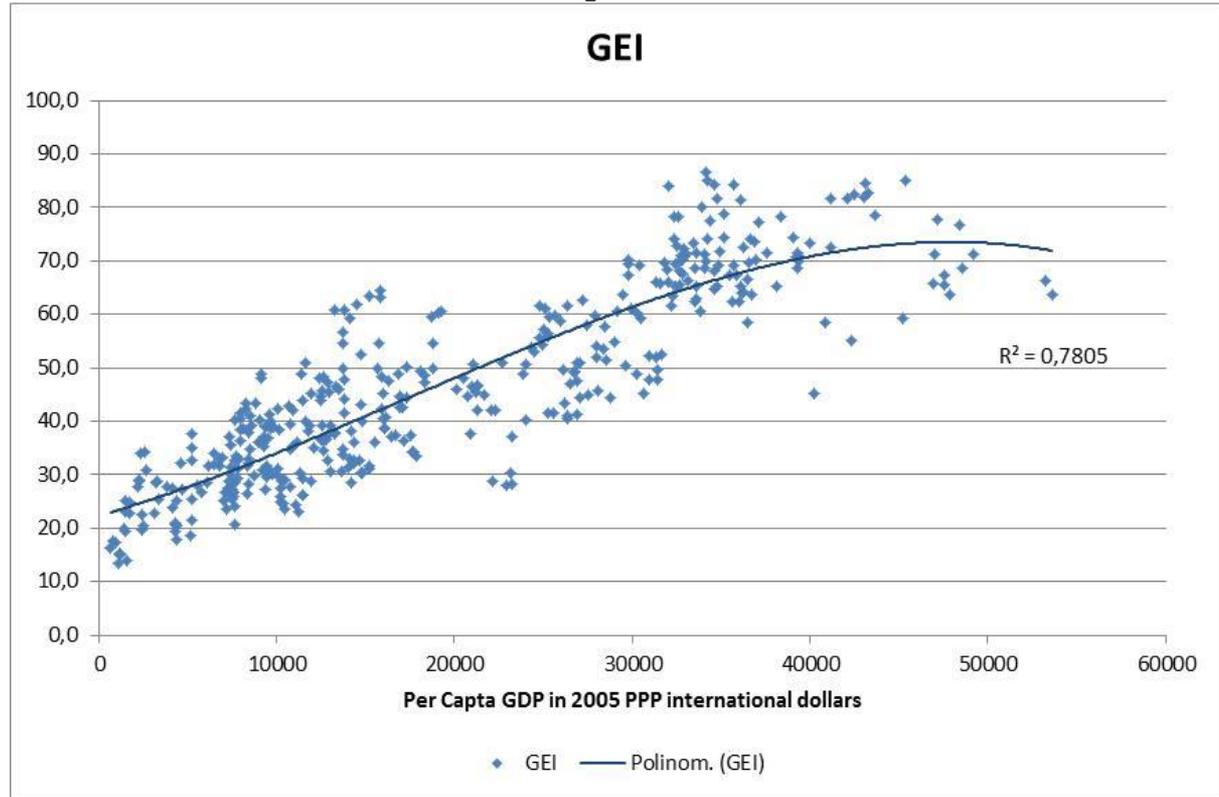


GEI predicts economic development

GEI vs GDP per capita

**Our analysis shows that
GEI predicts Total Factor
Productivity in
countries**

**The strongest effect is
with a 2-year time lag**



Index building vs. traditional statistical methods



Sources

- *Handbook of constructing composite indicators: Methodology and user guide 2008*: Organization for Economic Co-operation Development (OECD) Publishing. Paris
- Acs, Z. J., Rappai, G., & Szerb, L. (2011). Index-Building in a System of Interdependent Variables: The Penalty for Bottleneck. *GMU School of Public Policy Research Paper*, (2011-24).



Statistics and regression techniques

- Statistics is sometimes called as the science of average
- Regression techniques: Answer the question what is the best predictor of explaining a certain variable (phenomenon)?
- Basic assumptions:
 1. Normal distribution of the dependent variables – OLS versus ML
 2. Normality – normal distribution of the error term – do not want to address here
 3. Equal variances – homoskedasticity – do not want to address here
 4. Independence of the independent variables – no multicollinearity
 5. Linear connection between the dependent and the independent variables – no structural breaks
- Point of reference (benchmark): refers to the average
- Outcome: BLUE, significant not significant, ceteris paribus
- Causality - independent variables (cause) explain dependent variable (effect)



Problems with regression techniques

- Are we interested in the presently most important predictor or want to know and understand the whole story?
 - The "Black swan" phenomenon: unpredicted and previously less important factors cause big problems later – dangerous if we are just interested in the most important, best predictor
 - Rogoff, K., & Reinhart, C. (2010): 90% rule of government debt and 60% rule of external debt (emerging markets) on GDP growth
- Independent variables do depend on each other – changing one variable has an effect on the other variable(s)
 - we are talking about systems where the mutual interdependence of the variables is the inherent characteristic and not a problem to eliminate
- Linear relationship does not hold – the relationship can be various and there are structural breaks
 - Linear connections or configurations?
 - there are different configurations and different efficient configurations that are very difficult to catch with regression based technique

Problems with regression techniques

- Point of reference: Are we interested in the average or rather benchmark the best?
 - Birch: the overwhelming majority of the new jobs are due to a small 2-4 percentages of the (new) firms: Statistically they are "the error term" or outliers.
- The problem of stability and robustness: adding/removing unimportant (control) variables changes the significance of other important dependent variables(s)
- Policy application: uniform policy suggestion – it is hard to believe that one size fits to all policy works – need for tailor made policy recommendations
 - Typical: increase new startups – independently of other factors
 - what about in Zambia? 30-40% of the population are "entrepreneurs" (Shane 2009)
 - Germany Ich AG project to create entrepreneurs out of unemployed – no success, as a consequence the average quality of firms dropped



Variable reduction models

- Come up to handle multicollinearity
- Most well-known: Principal Component Analysis – converts a set of (possibly) correlated variables into a set of linearly uncorrelated variables – eliminates but does not solve the multicollinearity problem
 - a combination of the variables with the maximum variance explained
 - the point of reference is still the average
 - linearity is still assumed
 - We lose control over the variables that constitute the components: have neither control nor information about the component variables
 - Policy recommendations (if any) are still general, one-size fits to all



Composite indices

- Come up to provide summary information about multi-dimensional phenomena
 - Dimension reduction methods by reducing the number of variables to basically one number
 - Answers the question: who is the best in terms of several correlated variables?
 - Point of reference: the best achieved score in each variable – more proper benchmarking to address excellence



Problems with composite indices

- Drawbacks

- Index scoring and the associated ranks are sensitive to theory assumptions and even small changes in different normalization, weighting or aggregation methods could lead to significant changes in rank, causing instability.
 - Weak theoretical setup - ad hoc selection of variables ("kitchen sink" approach)
 - Flawed methodology
 - Many redundant or wrong qualitative measures
- One ranking number and point cannot tell us anything about how to improve the index score.
 - Policy recommendation are vague, sometimes referring to the below or above average principle – does not help to optimize policy effort
- Arrow's theorem still valid: it is impossible to meet with all the conflicting criteria at one time – refers to the choice of incorporated variables
- The system perspective is not really addressed: the disharmonization/imbalance of the different variables is not handled
 - Except Tarabusi and Guarini (2013)



GEI methodology



GEI characteristics – methodological improvement

- The first complex country level entrepreneurship index aiming to measure and explain the role of entrepreneurship in economic development
 - 31 original variables, 14 individual, 14 institutional variables, 14 pillars, three sub-indexes
- Incorporates the individual and the institutional contextual factors of entrepreneurship
 - Technically multiplies the individual and the proper institutional variables
- Equates the average pillar values
 - Equalizes the marginal improvements over the pillars – vital for entrepreneurship policy recommendations
- Takes into account the mutually dependent nature of the pillars of entrepreneurship -
 - Developed the Penalty for Bottleneck methodology that is based on the assumption that the weakest link is the most important determinant of the performance of the system
- Provides an opportunity for public/entrepreneurship policy use
 - Developed the bottleneck sensitivity analysis technique to optimize the effect of additional resources aiming to increase GEI scores.



GEI methodology

- GEI incorporates individual as well as institutional data
 - All individual data (16) are from the GEM adult population survey, taken from published GEM global reports
 - All institutional data (15) are from non-GEM sources like World Economic Forum, OECD, UNO etc.
 - Individual and institutional data are combined together (multiplied) resulting the 14 pillars and the three sub-indices of entrepreneurship

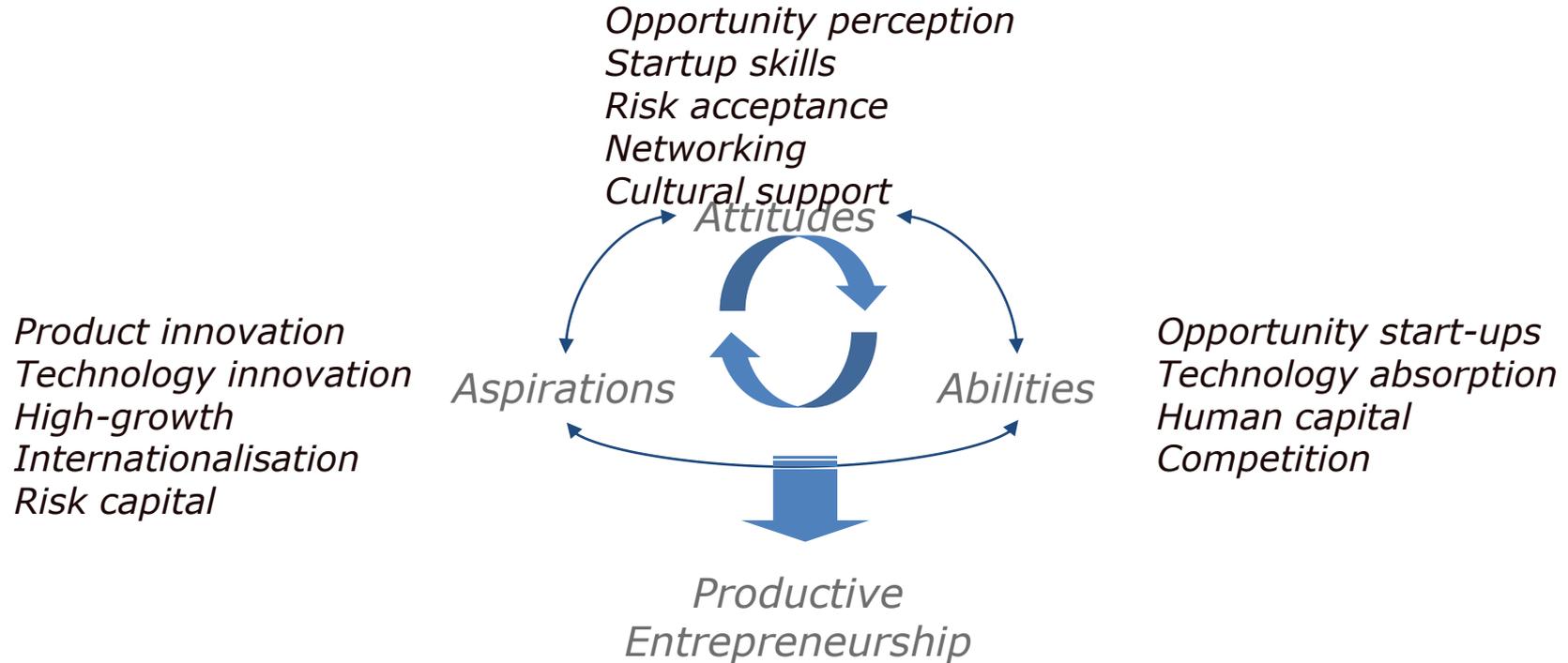


Index building – the building blocks

- The Building Blocks
 - *Entrepreneurial attitudes* is defined as a population's general attitudes about entrepreneurship including opportunity recognition, networking, start-up skills, taking risk, acceptance of entrepreneurs with high status – five pillars.
 - *Entrepreneurial ability* is defined as the quality of startup including the motivation of start-up, the level of education of the entrepreneur, the sector (high or medium), and the potential not to have too many competitors - four pillars.
 - *Entrepreneurial aspiration* is defined as the early-stage entrepreneur's effort to introduce new products and/or services, develop new production processes, penetrate foreign markets, substantially increase their company's number of employees, and finance the business with formal and/or informal venture capital – five pillars.



Measuring NSEs: The GEI Approach



Individual variables

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



Institutional variables

Domestic Market	Domestic market size that is the sum of gross domestic product plus value of imports of goods and services, minus value of exports of goods and services, normalized on a 1–7 (best) scale data are from the World Economic Forum Competitiveness.
Urbanization	Urbanization that is the percentage of the population living in urban areas, data are from the Population Division of the United Nations, 2011
Market Agglomeration	The size of the market: A combined measure of the domestic market size and the urbanization that later measures the potential agglomeration effect. Calculated as Domestic market*Urbanization
Tertiary Education	Gross enrolment ratio in tertiary education, 2011 or latest available data.
Business Risk	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 favorable to intercompany transactions" (http://www.trading-safely.com/). It is a part of the Country Risk Rate. The alphabetical rating is turned to a seven point Likert scale from 1 ("D" rating) to 7 (A1 rating). 30 December 2012 data.
Internet Usage	The number Internet users in a particular country per 100 inhabitants, 2012 data
Corruption	The Corruption Perceptions Index (CPI) measures the perceived level of public-sector corruption in a country. "The CPI is a "survey of surveys", based on 13 different expert and business surveys." (http://www.transparency.org/policy_research/surveys_indices/cpi/2009) Overall performance is measured on a ten point Likert scale. Data are from 2012.



Institutional variables

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."
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)".
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)".
Market Dominance	Extent of market dominance: "Corporate activity in your country is (1 = dominated by a few business groups, 7 = spread among many firms)".



Institutional variables

Technology Transfer	These are the innovation index points from GCI: a complex measure of innovation including investment in research and development (R&D) by the private sector, the presence of high-quality scientific research institutions, the collaboration in research between universities and industry, and the protection of intellectual property.
GERD	Gross domestic expenditure on Research & Development (GERD) as a percentage of GDP, year 2011 or latest available data Puerto Rico, Dominican Republic, United Arab Emirates, and some African countries are estimated
Business Strategy	Refers to the ability of companies to pursue distinctive strategies, which involves differentiated positioning and innovative means of production and service delivery.
Globalization	A part of the Globalization Index measuring the economic dimension of globalization.
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. <i>Note that there were some methodological changes over the 2006-2012 time period so previous years comparison is not perfect. The data set is provided by Alexander Groh.*</i>



GEI 2015 (based on 2013 individual data)

Rank	Country	GDP 2012	GEI	Rank	Country	GDP 2012	GEI	Rank	Country	GDP 2012	GEI
1	United States	45336	85,0	22	Israel	27882	59,9	44	Bulgaria	12176	42,7
2	Canada	36067	81,5	23	Luxembourg	65798	57,2	45	Hungary	17073	42,7
3	Australia	35608	77,6	24	Qatar	71931	56,2	46	Cyprus	23452	42,5
4	United Kingdom	32514	72,7	25	Turkey	13737	54,6	47	Greece	21275	42,0
5	Sweden	34926	71,8	26	Lithuania	18785	54,6	48	Uruguay	13821	41,4
6	Denmark	32291	71,4	27	Latvia	15757	54,5	49	Italy	26920	41,3
7	Iceland	33819	70,4	28	Korea	27991	54,1	50	Lebanon	12592	40,7
8	Taiwan	34817	69,1	29	Slovenia	24495	53,1	51	Croatia	16002	40,6
9	Switzerland	39294	68,6	30	Portugal	21056	50,8	52	South Africa	9655	40,0
10	Singapore	53266	68,1	31	Saudi Arabia	27346	49,6	53	Malaysia	14822	40,0
11	Germany	35453	67,4	32	Spain	26089	49,6	54	Montenegro	10602	39,1
12	France	29819	67,3	33	Japan	31429	49,5	55	Costa Rica	11156	37,7
13	Netherlands	36466	66,5	34	Puerto Rico	30248	48,9	56	Argentina	16425	37,2
14	Finland	31611	65,7	35	Czech Republic	23824	48,9	57	Moldova	2951	37,2
15	Norway	47517	65,6	36	Colombia	9143	47,9	58	Macedonia	9323	37,1
16	Belgium	32680	65,5	37	Kuwait	40637	47,7	59	Barbados	23205	37,1
17	Ireland	36102	65,3	38	Poland	18307	47,4	60	Brunei Darussalam	45979	36,9
18	Austria	36340	64,9	39	Oman	39665	47,3	61	China	7958	36,4
19	Chile	15848	63,2	40	Hong Kong	44770	45,9	62	Paraguay	5290	36,0
20	United Arab Emirates	36267	61,6	41	Slovakia	21185	45,4	63	Tunisia	8442	35,5
21	Estonia	19070	60,2	42	Romania	11946	45,3	64	Ukraine	6394	33,6
				43	Bahrain	21543	45,1				



GEI 2015 (based on 2013 individual data)

Rank	Country	GDP 2012	GEI	Rank	Country	GDP 2012	GEI	Rank	Country	GDP 2012	GEI
65	Jordan	5289	33,3	87	Nicaragua	3510	28,4	108	Tanzania	1380	23,6
66	Botswana	14109	33,0	88	Kazakhstan	11978	28,4	109	Myanmar	6677	23,1
67	Panama	14320	32,2	89	Trinidad & Tobago	23260	28,4	110	Zambia	1474	23,0
68	Thailand	8463	32,1	90	Ecuador	8443	28,2	111	Angola	5262	22,7
69	Namibia	6520	31,9	91	Egypt	5795	28,1	112	Venezuela	11623	22,6
70	Russia	15177	31,7	92	Bolivia	4552	28,0	113	Mali	1055	22,5
71	Sri Lanka	5384	31,1	93	Gabon	13811	27,7	114	Burkina Faso	1298	22,1
72	Lao PDR	2522	31,1	94	Iran	10754	27,7	115	Cameroon	2025	22,0
73	Libya	10073	31,0	95	Philippines	3801	27,7	116	Madagascar	843	22,0
74	Peru	9431	30,9	96	Senegal	1671	27,3	117	Sierra Leone	1171	21,6
75	Mexico	13067	30,7	97	Jamaica	7528	27,2	118	Swaziland	4522	21,4
76	Albania	8123	30,6	98	Cambodia	2150	26,3	119	Mauritania	2244	21,1
77	Dominican Republic	8794	30,6	99	Rwanda	1167	26,2	120	Indonesia	4272	21,0
78	Serbia	9683	30,6	100	Brazil	10264	25,8	121	Suriname	7641	20,7
79	Algeria	7400	30,2	101	Gambia, The	1667	25,6	122	Guatemala	4397	20,3
80	Honduras	3657	29,8	102	Benin	1364	25,6	123	Pakistan	2402	20,1
81	El Salvador	6125	29,6	103	Liberia	560	25,5	124	Burundi	483	18,4
82	Morocco	4573	29,4	104	India	3390	25,3	125	Ethiopia	971	17,2
83	Bosnia	7356	28,9	105	Ghana	1764	24,8	126	Chad	1870	16,6
84	Nigeria	2295	28,9	106	Mozambique	882	24,3	127	Guyana	2930	16,2
85	Vietnam	3318	28,8	107	Côte d'Ivoire	1757	24,1	128	Malawi	660	15,6
86	Kenya	1522	28,5					129	Uganda	1165	15,1
								130	Bangladesh	1622	14,4

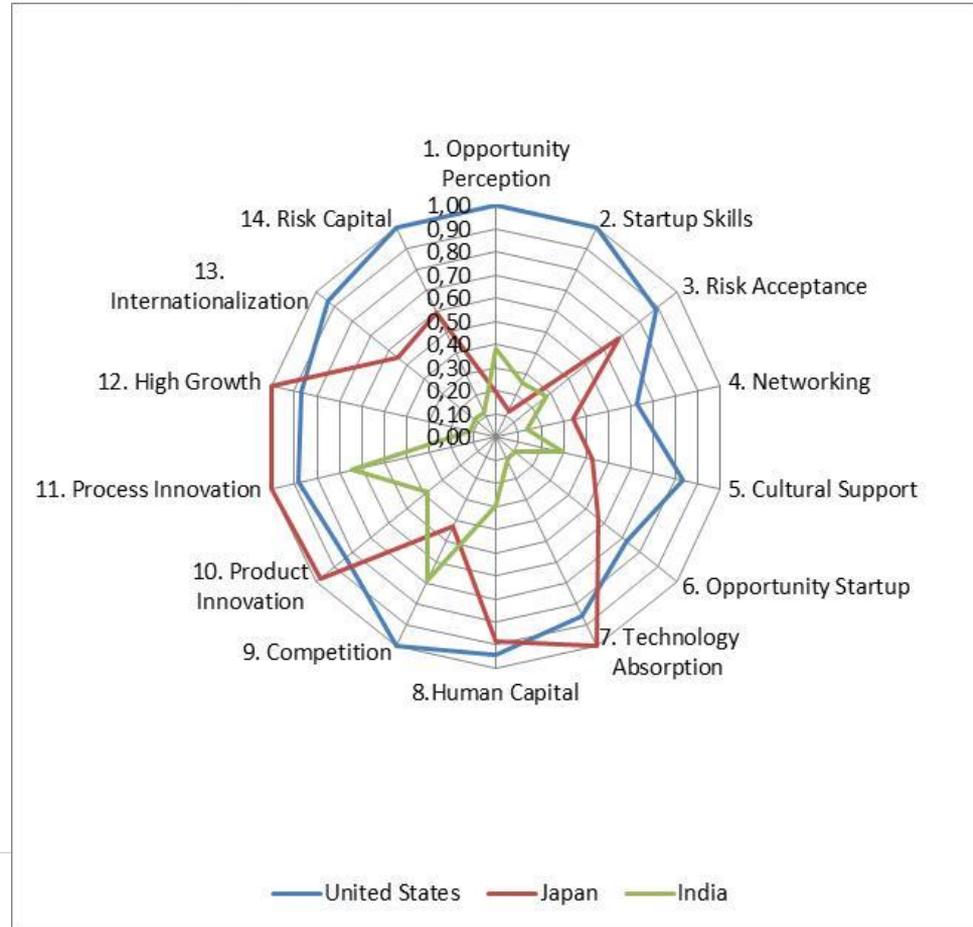


Profiling NSEs: US, Japan, and India

US profile is round,
suggesting absence of
bottlenecks

Japan's profile suggests
bottlenecks in, e.g.,
Opportunity Perception, Startup Skills,
Internationalisation, Networking,
Competition, Risk Capital

By alleviating these bottle-
necks, Japan can expect a
major improvement in
entrepreneurial dynamic



A practical guide to create your own report

Associated Excel file: GEI_2015_tool_GEN

Find: worksheet Dataset (automatically popping up)



Index building steps

- Going through the eight steps of index building:
 1. The selection of variables
 2. ***The construction of the pillars***
 3. ***Normalization***
 4. ***Outlier handling – Capping***
 5. ***Average pillar adjustment***
 6. ***Penalizing: the calculation of penalized weight***
 7. Subindex calculation
 8. GEI calculation



1. The selection of the 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), which are from the GEM Adult Population Survey or the institutional/environmental level, which are from various other sources. Altogether we use 16 individual and 15 institutional variables.
- Individual data are calculated from the years 2006-2013, using the two year moving average principle. Where data are insufficient to apply this principle, a single year value is applied. In the case of the institutional variables we applied single year data.
- We estimate individual data for those countries that were not in the GEM survey.



2. The construction of the pillars

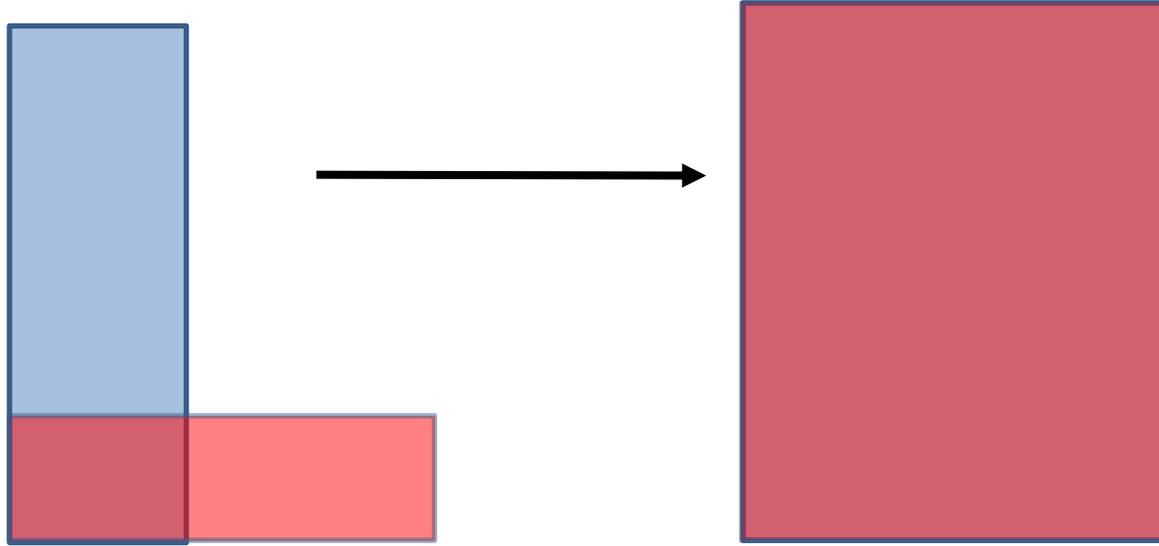
- We calculate all pillars from the variables using the interaction variable method; that is, by multiplying the individual variable with the proper institutional variable. s.

$$z_{i,j} = IND_{i,j} * INS_{i,j} \quad (F1)$$

- for all $j= 1 \dots k$, the number of individual and institutional variables
- $IND_{i,j}$ is the original score value for country i and variable j individual variable averaged for two years (single year in the case of missing variable)
- $INS_{i,j}$ is the original score value for country i and variable j institutional variable
- $z_{i,j}$ is the original pillar value for country i and pillar j

2. Pillar calculation

- Like interaction variable: individual * institutional
- Acts like a specific weight does in some indices



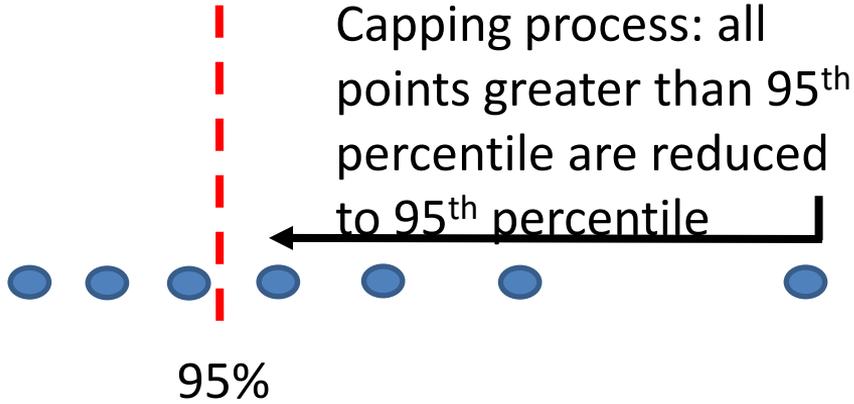
3. Outlier handling: 95% Capping

- All index building is based on a benchmarking principle. In our case we selected the 95th percentile score adjustment, meaning that any observed values higher than the 95th percentile are lowered to the 95th percentile. Since this calculation includes all the observation units, the change of the pillar values of a particular county over time can be tracked.
- Provides a useful benchmark: not one single country performance determines the benchmark but at least 5% of the seven years and all country observations
- Stabilizes benchmarks over time

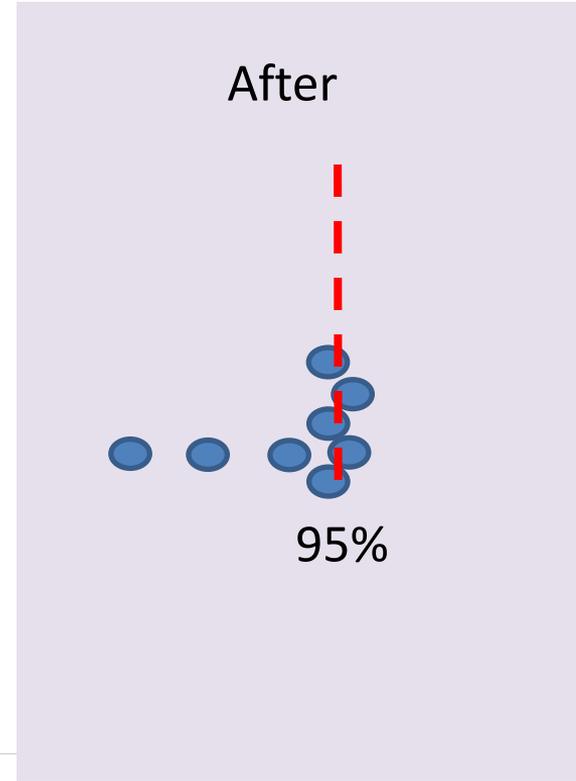


3. Capping

Before



After



Skewness of pillars

Pillar	Original pillars	Capped pillars
Opportunity Perception	0,60	0,42
Start-up Skills	0,13	-0,03
Risk Acceptance	0,01	-0,07
Networking	0,82	0,27
Cultural Support	0,44	0,33
Opportunity Startup	0,14	0,09
Gender	-0,02	-0,16
Technology Absorption	0,90	0,53
Human Capital	0,47	0,26
Competition	0,62	0,45
Product Innovation	0,07	-0,14
Process Innovation	1,64	0,76
High Growth	1,30	0,20
Internationalization	0,12	-0,05
Risk Capital	1,10	0,90



4. Normalization

- Pillars values were first normalized to a range from 0 to 1:

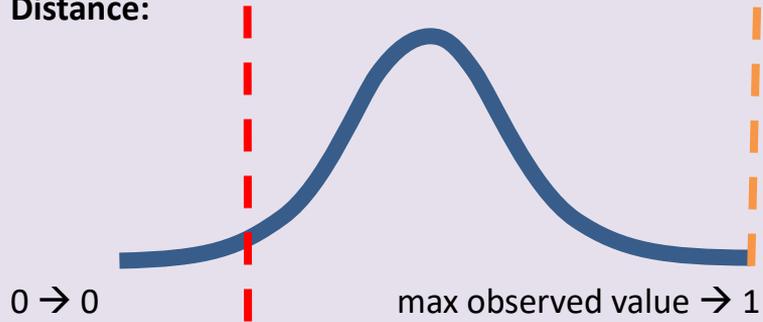
$$x_{i,j} = \frac{z_{i,j}}{\max z_{i,j}} \quad (\text{F2})$$

- 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
- $z_{i,j}$ is the pillar value for country i and pillar j
- $\max z_{i,j}$ is the maximum value for pillar j



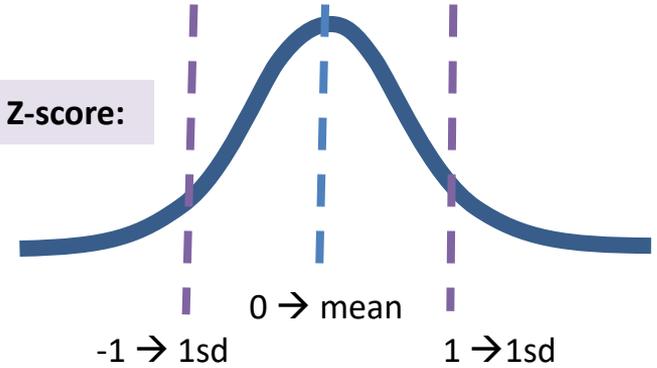
4. Normalization

Distance:

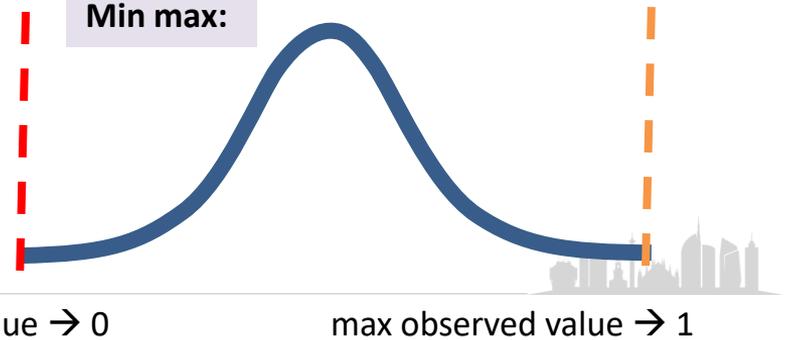


$$\text{min observed value} \rightarrow \frac{\text{min} - \text{max}}{\text{max}}$$

Z-score:



Min max:



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 equalize the average values of the components.

$$\bar{x}_j = \frac{\sum_{i=1}^n x_{i,j}}{n} \quad (\text{F3})$$



5. Average pillar adjustment

- We want to transform the values such that the potential minimum value is 0 and the maximum value is 1:

$$y_{i,j} = x_{i,j}^k \quad (\text{F4})$$

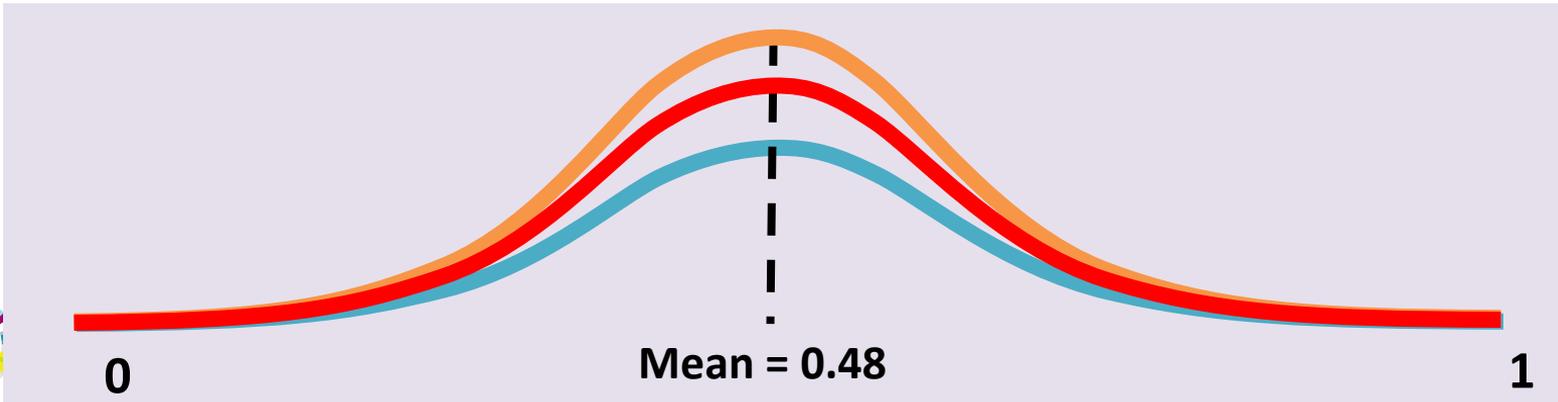
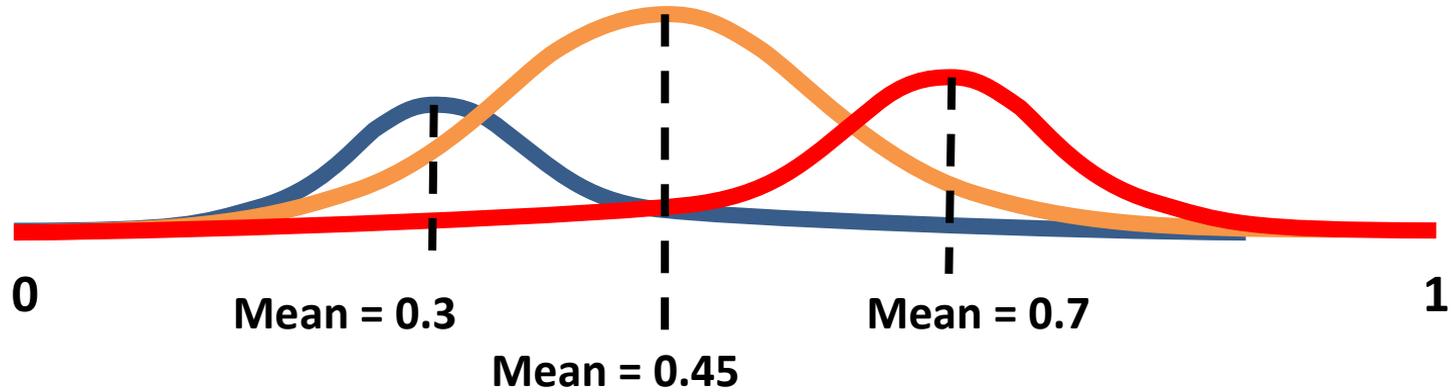
- where k is the "strength of adjustment", the k -th moment of X_j is exactly the needed average. We have to find the root of the following equation for

$$\sum_{i=1}^n x_{i,j}^k - n\bar{y}_j = 0 \quad (\text{F5})$$

- 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.



5. Average pillar adjustment (in the case of normal distribution)



6. Penalizing

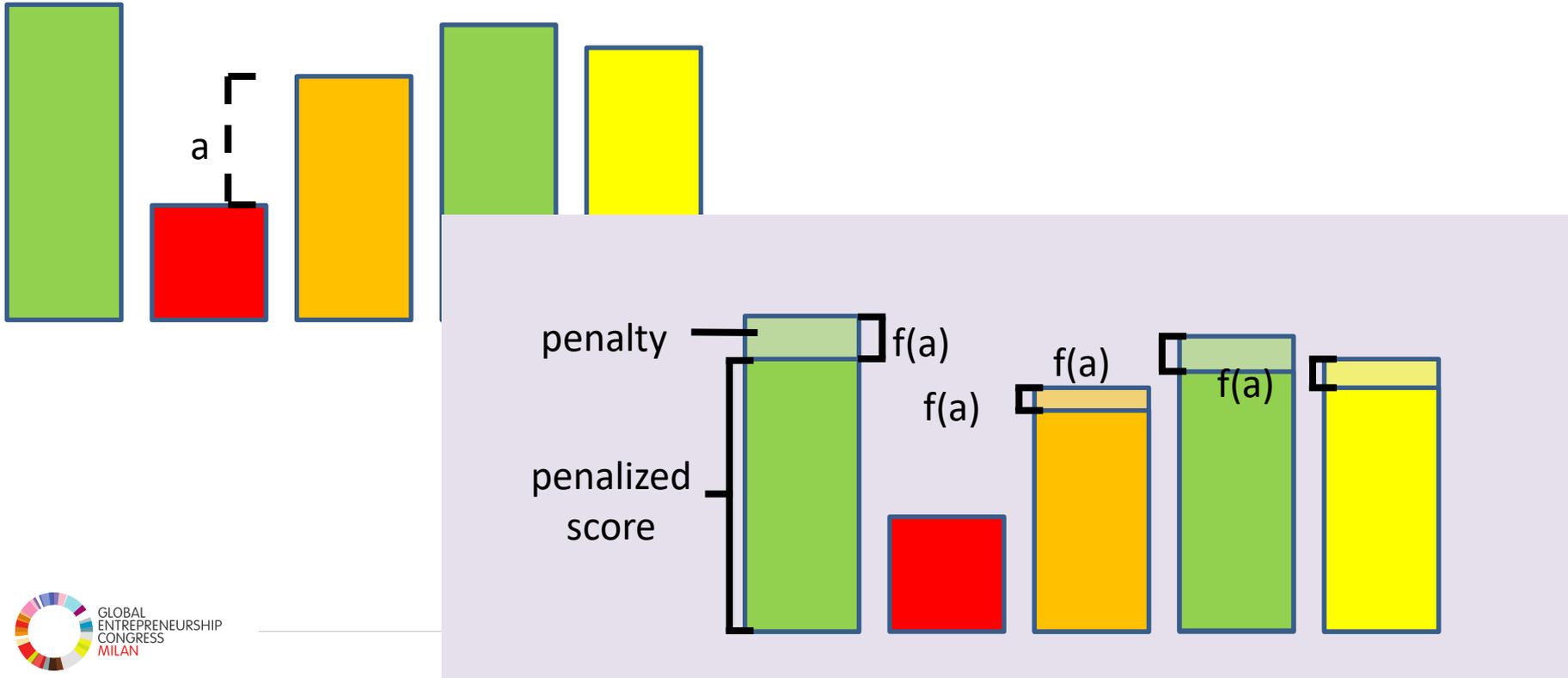
- After these transformations, the PFB methodology is applied to create the PFB adjusted values. We define our penalty function following as:

$$h_{(i),j} = \min y_{(i),j} + a(1 - e^{-b(y_{(i),j} - \min y_{(i),j})}) \quad (F6)$$

- 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
- $0 \leq a, b \leq 1$ are the penalty parameters, the basic setup is $a=b=1$



6. Penalizing



7- Sub-index calculation

- 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 penalized pillar values for that sub-index multiplied by a 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

$$ATT_i = 100 \sum_{j=1}^5 y_{i,j} \quad (F7a)$$

$$ABT_i = 100 \sum_{j=6}^9 y_{i,j} \quad (F7b)$$

$$ASP_i = 100 \sum_{j=10}^{14} y_{i,j} \quad (F7c)$$



8. GEI score calculation

- 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 efficiency of the entrepreneurship resources

$$GEI_i = \frac{1}{3} (ATT_i + ABT_i + ASP_i) \quad (F8)$$

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



Bottleneck sensitivity analysis

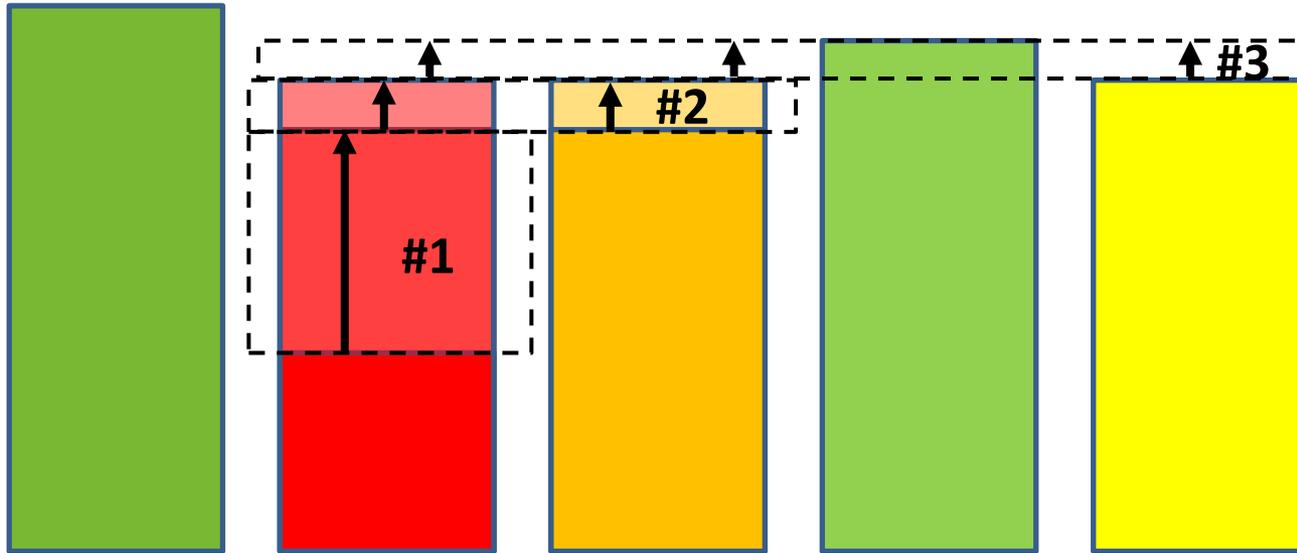


Policy optimization of resources

- Basic assumption of the model: the harmonization of the pillars (equal pillar values) is the optimal configuration based on available resources.
- The best way to increase the GEI is to reduce the differences between the pillars by enhancing the weakest GEI pillar.
- However, another pillar then becomes the weakest link constraining the performance in entrepreneurship. This system dynamic leads to the problem of "optimal" allocation of the additional resources.
 - Relaxes the "ceteris paribus" assumption
- Let's assume that we would like to increase the average GEI index points by 5
- The PFB method calculation implies that the greatest improvement can be achieved by alleviating the weakest performing pillar. Once the binding constraint has been eliminated then the remaining resources should be distributed to improve the next most binding pillar and so on, until the additional resources are exhausted



Policy tool



Examples of bottleneck sensitivity analysis

Pillar	Austria				Peru				Malawi			
	1	2	3	4	1	2	3	4	1	2	3	4
Opportunity Perception	0.66	0	0%	0.66	0.93	0	0%	0.93	0.14	0	0%	0.14
Start-up Skills	0.75	0	0%	0.75	0.65	0	0%	0.65	0.01	0.11	22%	0.12
Risk Acceptance	0.60	0	0%	0.60	0.40	0	0%	0.40	0.09	0.03	6%	0.12
Networking	0.84	0	0%	0.84	0.53	0	0%	0.53	0.08	0.04	8%	0.12
Cultural Support	0.64	0	0%	0.64	0.42	0	0%	0.42	0.43	0	0%	0.43
Opportunity Startup	0.62	0	0%	0.62	0.50	0	0%	0.50	0.13	0	0%	0.13
Gender	0.66	0	0%	0.66	0.65	0	0%	0.65	0.91	0	0%	0.91
Technology Absorption	0.99	0	0%	0.99	0.31	0.05	12%	0.36	0.11	0.01	2%	0.12
Human Capital	0.56	0	0%	0.56	0.35	0.01	2%	0.36	0.03	0.09	18%	0.12
Competition	0.85	0	0%	0.85	0.38	0	0%	0.38	0.46	0	0%	0.46
Product Innovation	0.88	0	0%	0.88	0.64	0	0%	0.64	0.68	0	0%	0.68
Process Innovation	0.75	0	0%	0.75	0.21	0.15	35%	0.36	0.86	0	0%	0.86
High Growth	0.32	0.15	100%	0.47	0.32	0.03	7%	0.36	0.02	0.1	20%	0.12
Internationalisation	0.89	0	0%	0.89	0.27	0.09	21%	0.36	0.09	0.03	6%	0.12
Risk Capital	0.79	0	0%	0.79	0.25	0.1	23%	0.36	0.04	0.08	16%	0.12
Sum		0.15	100%			0.43	100%			0.49	100%	
Number of pillars changed		1				6				8		
GEI score	64.0			69.1	41.3			46.4	20.9			25.9



Creating and Interpreting Custom GEI Reports

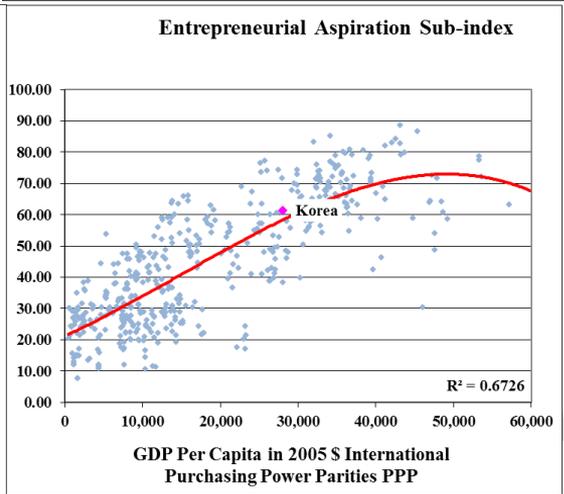
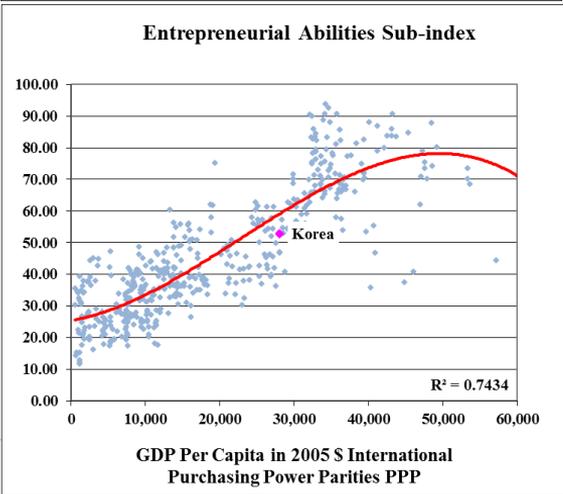
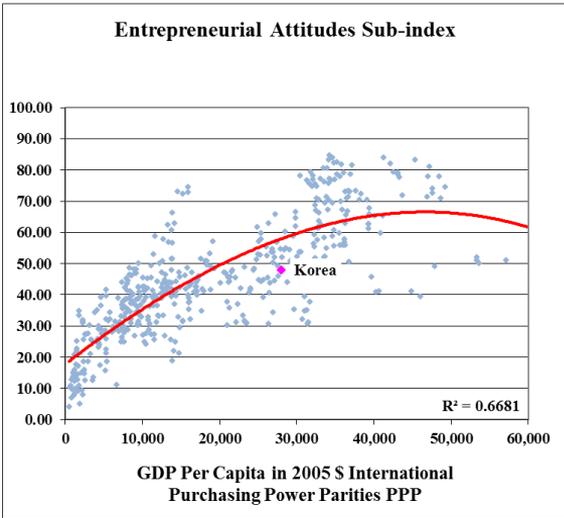
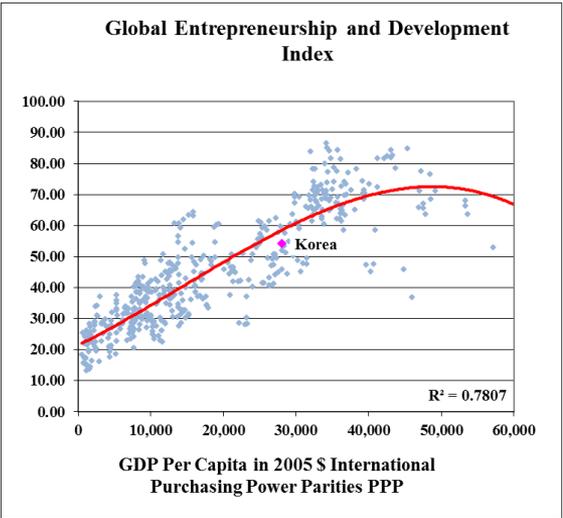


Basic questions to be addressed

- **How are we doing?**
 - How does the Italy compare to the rest of the world on the pillar level?
- **Why?**
 - What specific variables contribute to Italy's' score?
- **What can we do about it?**
 - How should policy effort be allocated to produce the greatest improvement in score?
- **How do we compare?**
 - How does Italy compare to specific countries/country groups?



How are we doing?



Why?

	PILLARS		INSTITUTIONAL VARIABLES		INDIVIDUAL VARIABLES	
Entrepreneurial Attitudes	Opportunity perception	0.28	Market Agglomeration	0.94	Opportunity Recognition	0.30
	Start-up skills	0.60	Tertiary Education	1.00	Skill Perception	0.39
	Risk acceptance	0.62	Business Risk	0.86	Risk Perception	0.55
	Networking	0.69	Internet Usage	0.98	Know Entrepreneurs	0.52
	Cultural support	0.49	Corruption	0.70	Career Status	0.54
	Entrepreneurial Attitudes	48.2				
Entrepreneurial Abilities	Opportunity startup	0.58	Economic Freedom	0.96	Opportunity Motivation	0.52
	Technology absorption	0.83	Tech Absorption	0.84	Technology Level	0.89
	Human capital	0.81	Staff Training	0.66	Educational Level	0.96
	Competition	0.22	Market Dominance	0.49	Competitors	0.43
	Entrepreneurial Abilities	52.3				
Entrepreneurial Aspirations	Product innovation	0.84	Technology Transfer	0.85	New Product	0.77
	Process innovation	0.87	GERD	1.00	New Tech	0.52
	High growth	0.64	Business Strategy	0.76	Gazelle	0.75
	Internationalization	0.49	Globalization	0.55	Export	0.74
	Risk capital	0.82	Depth of Capital Market	0.90	Informal Investment	0.85
	Entrepreneurial Aspirations	61.5				
	GEI	54.0	Institutional	0.82	Individual	0.62

What can we do about it?

Pillar	Required Increase in Pillar	Percentage of total new effort
<i>Opportunity Perception</i>	0.07	35%
<i>Start-up Skills</i>	0.00	0%
<i>Risk Acceptance</i>	0.00	0%
<i>Networking</i>	0.00	0%
<i>Cultural Support</i>	0.00	0%
<i>Opportunity Startup</i>	0.00	0%
<i>Technology Absorption</i>	0.00	0%
<i>Human Capital</i>	0.00	0%
<i>Competition</i>	0.13	65%
<i>Product Innovation</i>	0.00	0%
<i>Process Innovation</i>	0.00	0%
<i>High Growth</i>	0.00	0%
<i>Internationalisation</i>	0.00	0%
<i>Risk Capital</i>	0.00	0%



How do we compare?

Based on three comparison countries of your choice

