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MODELING THE INNOVATION ECOSYSTEM AND DEVELOPMENT OF A DYNAMIC INNOVATION INDEX

by

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A dissertation submitted in partial fulfillment of the requirements
for the degree of Doctor of Philosophy
in the Department of Industrial Engineering and Management Systems
in the College of Engineering and Computer Science
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ABSTRACT

The topic of innovation currently generates a tremendous amount of interest around the world. Innovation is considered an essential part of the solution to creating more jobs and improving the socio-economic conditions of many countries around the globe. Innovation comes about through the existence of many interrelated solutions to socio-economic problems in an extensively interconnected network, which create value for each other. Such a complex creativity and innovation value-creating network is here called an Innovation Ecosystem (IE).

The main objective of this dissertation research is to improve the current understanding of the IE by developing a simulation model that uses a broad set of relevant static and dynamic variables and incorporates the principles of system dynamics (SD). The proposed model, which is named the IECO-model is based on the relationships between 91 variables and the combined influences of the 43 parameters. Available data for 32 countries, representing a full span of GDP worldwide, was used to study the level of innovation in each of these countries.

The result of the developed IECO-model is a novel ranking of the level of innovation through a dynamic innovation index, called the DII. The DII is a new tool to evaluate the innovation and entrepreneurship level of a given country in the context of the global economy. The most significant differentiator from other existing indices of innovation is that the DII is focusing more on the entrepreneurship qualities in 19 of the 43 parameters by looking at cultural values and belief systems, the social context, existing entrepreneurial culture, innovation attitudes, and mentality of each of the considered countries.

According to DII-based ranking, the ten most innovative countries in the world are 1. Switzerland, 2. USA, 3. Finland, 4. Netherlands, 5. Iceland, 6. Sweden, 7. Germany, 8. Denmark, 9. The United Kingdom, and 10. Austria.

I dedicate this work especially to my dear parents, who always have inspired me to work hard, and never give up. They have been a constant support, and I have always felt their never-ending love and care. I am tremendously grateful to my whole family at home.

Special gratitude to the sweetest lady, Joy Tatlonghari, who always right from the beginning gave guidance and offered her friendship when I moved to the USA, and we started working together at University of Central Florida (UCF). Another outstanding person from the very beginning here in the U.S. is Dr. A. Sepulveda. When I started working for him in my first job in the U.S. at UCF Department of Industrial Engineering and Management Systems, he also soon became a dear person to me.

Additional gratitude goes to my second boss at UCF, Mark Calabrese, who also has his heart in the right place, and cared a lot about his employees, and spoiled us at holiday gatherings.

Along the writing process, immense gratefulness goes primarily to the lovely Soyler family, the Liebe family, the Douguet family, Dr. R. P. Strittmatter, and my dear cousin Elizabeth and best friend in Denmark, dear Marianne, who all had been there in my life at the right time. In the final phase, enormous gratitude goes to Dr. Maria Bull, Dr. Mikael Langthjem, Dr. Samantha Fonseca, and Dr. Rachelle Yankelevitz for stellar critique. Also, the Johnson family was instrumental with their caring love, and Woody Dolphin with lots of mental support. All were true gifts at such a critical time in my life.

This dissertation I dedicate to you all, who have all helped fuel my inner passion for looking into the innovation ecosystem research area from a novel perspective. I am eternally grateful for all your support and care and wish you all the best and lots of success in your careers. I sincerely hope all of our exclusive friendships will never end, while I treasure each one of you all so very dearly.

I hope this dissertation will be an enjoyable read for all interested in innovation.
I hope in a very humble way that I enriched the reader, and through the collection of words here could bring new insights that spurred innovative thoughts.

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I am eternally grateful to Dr. Waldemar Karwowski for his continuous inspiration and guidance, and during this time having the possibility to tap into his enormous wit and wealth of knowledge.

Thank you to all the committee members, the chair, Dr. Waldemar Karwowski, and mentioned in the alphabetical order, Dr. M. Ilhan Akbas, Dr. Robert Hoekstra, and Dr. Randall Shumaker, for guiding me through this research phase, and the result has a more excellent value due to your much-appreciated inputs.

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Additional gratitude goes to three extremely inspiring professors I met during my last semesters, whom I send all my best wishes: Dr. Richard Ajayi, Dr. Pradipkumar Ramanlal, and Dr. Petros Xanthopoulos.

I am incredibly grateful to all the above mentioned and hope we can continue collaborating in the coming years. I sincerely hope your current career trajectories will lead to more continued success in your future research and life endeavors.

Sincerely,

Henriette Schoen,

Summer 2018.

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LIST OF ACRONYMS/ABBREVIATIONS

- **CIGI** – Centre for International Governance Innovation
- **Entrepreneurial density** – the concentration of tech companies or tech workers per unit of space (per square mile, per city, per region) (Foldesy et al., 2018)
- **EU** – European Union – have created the EU Innovation Union Scoreboard since 2000 - 2017
- **GDP** – Gross Domestic Product, one of the primary indicators used to gauge the health of a country's economy. It represents the total dollar value of all goods and services produced over a specific time-period; it is the size of the economy (Investopedia, 2016).
- **GEI 2017** - Global Entrepreneurship Index 2017
- **GII 20XX** – Global Innovation Index 2007 – 2017. The Global Innovation Index ranks countries on their innovation capabilities and the results of this innovation.
- **GINI Index** – measures how much the distribution of income or consumption expenditure among individuals or households within an economy deviates from a perfectly equal distribution (OECD, 2018). A Gini index of 0 represents perfect equality, and an index of 100 implies absolute inequality.
- **INRIX 2017 Global Traffic Scorecard** - analyzed traffic congestion data in 1,064 cities in 38 countries on five continents. It is the most extensive study ever of its kind.
- **KBC – Knowledge-Based Capital** – investment in intangibles, such as more education, courses for employees, research and development (R&D), data, software, patents, new organizational processes, firm-specific skills, and designs.
- **NSF's I-Corps Program** – National Science Foundation's Innovation Corps Program created to support the innovation ecosystem in the United States of America.
- **OECD** – Organization for Economic Co-operation and Development
- **STEM education** – Science, technology, engineering, and mathematics education

- **UN** – United Nations
- **WEF** – World Economic Forum
- **WIPO –** World Intellectual Property Organization
- **WOTC** – "*World of Three Cultures – Honor, Achievement and Joy"* is a book written by Miguel E. Basáñez, who argues that the millions of micro-cultures in the world belong to one of three categories: honor, achievement, or joy. An axiological (a branch of philosophy that studies judgments about the value) diagnosis methodology is used, and data is retrieved from governments, NGOs, the World Values Survey and more, addressing over one hundred countries.

CHAPTER 1: INTRODUCTION

1.1 Research Background

Economies all over the world are trying various methods of investing in new areas of technology, supporting multiple organizations, funding more science, technology, engineering, and mathematics (STEM) education, creating new grant programs, all in the effort to support innovative ideas. A recent example is the National Science Foundation's initiative, the Innovation-Corps grant award program that has the purpose to nurture the innovation ecosystem of fundamental research, by supporting researchers, and providing them tools for commercializing their research. All these efforts are made in the hope of creating additional innovations and successful products to commercialize, improve productivity, create jobs, and ultimately have a positive socio-economic impact in the society.

Although innovation has recently become a very popular topic, especially in the U.S., it was not as popular before the last decade. In 2009 when Judith Estrin wrote her book, "Closing the Innovation Gap," the context was very different. There was a lack of interest in innovation, and she, therefore, requested more interest in the area from every level of U.S. society (Estrin, 2009).

Many inputs, flows, and outputs are ongoing for an innovation ecosystem (IE) to thrive. It comes in various forms and designs and is often based on some type of industry platform, which comprises a big physical network of interacting entities that are most often self-organized and generated within industry-specific market segments.

This dissertation proposes, a model of the ongoing interactions between the entities within the IE. The modeling approach used is system dynamics (SD), which can be used for understanding the nonlinear behavior of complex issues and problems, and additionally can analyze the stronger or weaker interactions in the network. SD is a conceptual modeling tool that allows studying indirect effects and

also enables for uncomplicated model design modifications, experimentation, and testing of the size of the actual parameter inputs. The proposed SD model will be referred to as the IECO-model.

The IECO-model is based upon the occurring relationships between innovation and activities, or factors that primarily affect innovation in society in positive or negative ways. These relationships are found in scholarly papers, reports, books, internet articles, and more. The IECO-model enhances understanding of the innovation level in a specific country by taking the existing entrepreneurial culture and the cultural values in the particular country into consideration. Research has shown that “the cultural environment is of utmost importance for countries to be innovative” (Vieira, Neira, & Ferreira, 2010, p. 161). According to Ezell and Marxgut (2015), “innovation is nothing less than the creation of new value for the world” (p. 157).

1.2 Problem Statement

There is a need to improve, through a simulation modeling approach, the understanding of what drives innovation and value creation in an innovation ecosystem and leads to economic impact in a city, region, and country.

1.3 Research Gap

A thorough research review indicated that no prior attempt had been made to develop a model of the IE as comprehensive and user-friendly for experimentation, as the proposed simulation model, the IECO-model. Some existing SD models look into parts of an IE, whereas the present IECO-model includes more of the many interconnected entities in the IE. The IE is such a complex system; therefore it makes it even harder to model in a proper fashion and attempting to find the “perfect” balance between too many and too little nodes is a constant challenge when dealing with simulation and complexity.

The IECO-model has been created with the main focus on simplifying the model design for experimentation and testing the impact of variables and parameters through entered data.

There is currently no other innovation model, as the IECO-model, with such a relatively simple conceptual structure which easily can be used to enhance innovation or economic growth discussions.

1.4 Research Objective

The goal of this dissertation is to improve the general understanding of the IE. The objectives to accomplish this goal are:

(i) to model an IE creating a modeling platform for experimentation;

(ii) to create a dynamic innovation index (DII) as the output of the model, which will serve as an index for evaluating the level of innovation and entrepreneurship in a given country.

1.5 Research Contribution

The IECO-model has been designed in system dynamics and uses the modeling platform Anylogic, which incorporates a user-friendly design. The IECO-model enables real-time experimentation with its variables and parameters, customizable to different innovation scenarios; thus, providing firmer grounds for future innovation discussions.

1.6 Document Outline

Chapter One provides a brief presentation of the dissertation and the results and the outline of the dissertation itself.

Chapter Two provides a comprehensive literature review that was done by the study of many different research areas in an effort to understand the important pillars of an innovation ecosystem, as

well as its wide-spanning interconnectedness and vital entities. Some of the research areas studied were the following: the global economy, invention, innovation, entrepreneurial characteristics/traits, entrepreneurship, current innovation indices, cultural values in different countries, entrepreneurial rankings, entrepreneurial index, simulation in general to find the best modeling method for this research, and system dynamics modeling of economic entities in the society.

Chapter Three describes the research methodology and the modeling approach in a very intricate manner to ensure replicability.

Chapter Four describes the actual IECO-model results, and the calculations of the dynamic innovation index (DII) for each country are shown. The final DII-ranking is compared with several other innovation indices to create a foundation for evaluating the DII results.

Finally, Chapter Five, concludes the dissertation with a discussion of the research and the proposed future work, along with suggested ideas for how to extend the found research direction in this dissertation and go to the next level in the model development.

This dissertation is data intensive, and therefore several appendices are included, where examples of data sources or complete data sheets used to create the current IECO-model can be found.

CHAPTER 2: LITERATURE REVIEW

In this chapter, a rigorous literature review was conducted reviewing especially what the terms innovation and innovation ecosystem entail. Scholarly papers demonstrate the broad spectrum that should be studied to achieve an understanding of the interconnectedness of an IE. Durst and Poutanen (2013) referred to Mercan & Göktas (2011) who specified that an "innovation ecosystem consists of economic agents and economic relations as well as the non-economic parts such as technology, institutions, sociological interactions and the culture" (p. 102). Durst and Poutanen (2013) remarked that the "innovation ecosystem is a hybrid of different networks or systems" (p. 29), and then referred to Rubens et al. (2011) who suggested that "the ecosystem model has expanded the idea of local clustering, to encompass a global, networked economy and various independent actors" (Durst & Poutanen, 2013, p. 29).

The inspiration for using multiplication later in the model design as seen in Chapter 3 is given in the following by Ritala & Almpanopoulou, (2017), who mentioned "IEs are comprised of numerous actors in different layers; actor decisions may cause counter-responses from other actors. This behavior is **multiplied** in complex interdependencies across the ecosystem" (p. 39). Jucevicius & Grumadaite (2014) introduced "the approach of complexity theory to the development of an IE" (p. 125). These two points of view became foundational for this dissertation's model design.

Diverse research areas had to be investigated to conceptualize and model an entity as complex as an IE. The review begins with studying world-changing innovations, and the impact on the global economy and many various interconnected research areas follow.

2.1 Definition of creativity, innovation and the innovation ecosystem

In this dissertation which revolves around innovation, the concept of creativity is key. Creativity is the foundation for all innovations, and creativity and innovation are the basis for the creation of an IE. The definitions mentioned below are chosen after careful consideration of many other definitions, as will be demonstrated later in this chapter.

For this work, Andreasen's (2006) definition of creativity is used. It consists of three parts that demonstrate the full span of creativity.

Creativity consists of three essential components:

1. Originality (perceive new relationships, ways of observing, ways of portraying)
2. Utility (ability to evoke resonant emotions in others, inspire, or create a sense of being amazed by what the human brain can achieve)
3. Must lead to a product of some kind (creation of something - an end product)

The definition of innovation in this dissertation work is from OECD's Oslo Manual (2005). This inclusive definition of innovation allows for the complexity of many different types of business flows. The OECD (2005) defines **innovation** in the following way:

"An innovation is the implementation of a new or significantly improved product (good or service), a new process, a new marketing method, or a new organizational method in business practices, workplace organization, or external relations" (p.46).

This dissertation uses Nambisan and Baron's (2013) definition of the innovation ecosystem because it builds on Moore's definition of a business ecosystem from 1993 that was pretty broad and it describes the dependency of the many different entities in an IE. Nambisan and Baron (2013) defines an **innovation ecosystem** in the following way: "An innovation ecosystem is a loosely interconnected network of companies and other entities that coevolve capabilities around a shared set of technologies,

knowledge, or skills, and work cooperatively and competitively to develop new products and services" (p. 1071)

This definition is chosen because coevolution is a crucial characteristic of an IE. An IE has to be nurtured, and the various entities grow together. Energy and capital are infused, often from multiple sources, and collaboration is required for it to thrive. Also, this definition allows flexibility for interpretation and expansion.

To better understand entrepreneurs and their activities the following definitions are identified, and according to OECD (2010) the definitions are the following:

- **Entrepreneurs:** those persons (business owners) who seek to generate value, through the creation or expansion of economic activity, by identifying and exploiting new products, processes or markets.
- **Entrepreneurial activity**: the enterprising human action in pursuit of the generation of value, through the creation or expansion of economic activity, by identifying and exploiting new products, processes or markets.
- **Entrepreneurship** is the phenomenon associated with entrepreneurial activity.

To complement and expand the definition for entrepreneurship from OECD, an additional definition is added to describe entrepreneurship on a country level, a very dynamic and result-oriented definition is found in the Global Entrepreneurship Index (2017). **Entrepreneurship** is: "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." (GEI, 2017, p. 77).

Establishing these definitions is the starting point for studying the intricate parts of the IE. The literature review will begin with a historical perspective to create a foundation for modern, innovative developments.

2.2 Historical perspective on innovation

Today, it is highly relevant to consider the historical factors that led innovation to be such an important topic in understanding the world economy. Innovation is a cornerstone of many countries' economies. “Innovation is especially vital for future growth” (Braconier et al., 2014, p. 8).

Technological innovations have had an enormous impact on human survival and progress. In Miguel E. Basañez's (2016) book a A *World of Three Cultures: Honor, Achievement and Joy,* some world-changing technological innovations are divided into five main categories, which are:

1. **Food (6):** axe/spear/bow and arrow/agriculture/pottery/plough
2. **Energy (4):** fire domestication/steam engine/oil/ electricity
3. **Transportation (8):** animal domestication/wheel/sea shipping/horse wagon/railroad/automobile/air flying/cargo container
4. **Communications (10):** writing/printing press/mail system/radio broadcasting/telephone/cinema/TV/personal computers/Internet/GPS
5. **War (4):** sword/armor/firearms/atomic energy

Table 1 shows the chronology of the 32 innovations listed as world-changing

An example of a recent impactful innovation is the Internet. Now people worldwide can communicate with each other instantaneously, and news from the other side of the globe can spread in a matter of seconds, a remarkable advancement compared to the earlier Morse Code and the Electric Telegraph.

Table 1: Selected World-Changing Technological Innovations

Time m = millions of years, k = thousands of years	**Innovations**
2.6 m	Axe
1.7 m	Spear/fire domestication
8k BC	Bow and arrow/pottery/sea shipping/agriculture
3.5k BC	Animal domestication/plow/wheel
1440	Sword/armor/horse wagon/fire arms/printing press
1769	Steam engine
1811	Railroad
1840	Mail system
1850	Oil
1876	Telephone
1880	Electricity
1885	Automobile
1896	Cinema
1853 - 1908	Air flying
1909	Radio broadcasting
1945	Atomic energy
1936 - 1948	TV
1970	Cargo container
1976	Personal computer
1992	Internet
1996	GPS

Source: Author with data from Basañez (2016)

Many institutions, such as the World Innovation and Patents Office (WIPO), study how countries create wealth by fostering a flow of innovations. WIPO regularly releases publicly available reports on the world economy. According to WIPO (2015), at the beginning of the 19th century, technological innovation was primarily driven by individual inventors and small-scale entrepreneurs. Over the last 200 years, a few critical innovations enabled many others, and across this time frame, society and

technological advancements are directly related to personal wealth growth, as illustrated in Figure 1. As more advanced technologies appear such as artificial intelligence, it will be interesting to see whether this specific relationship holds.

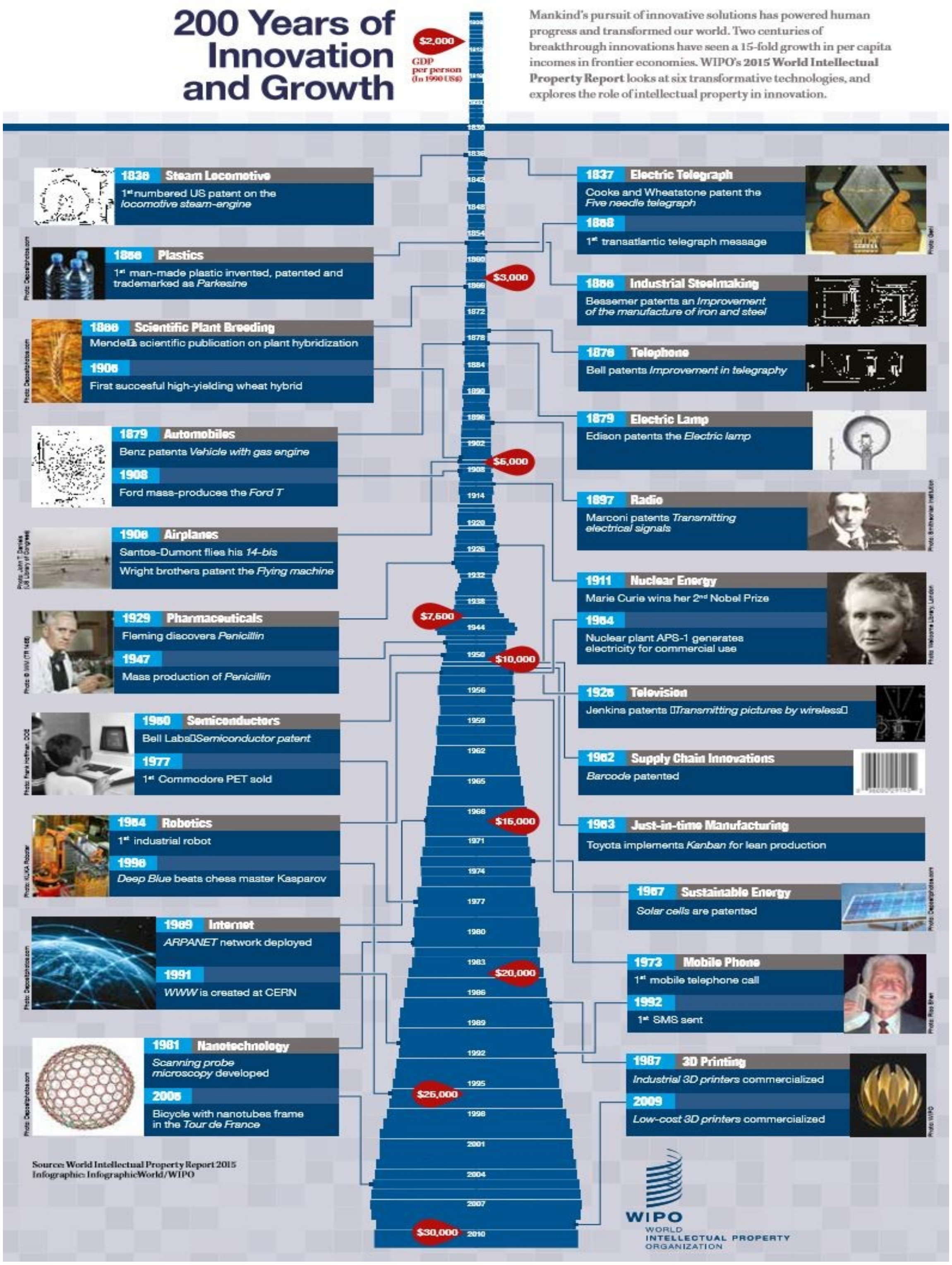
WIPO (2015) summarized the data in Figure 1 by stating, "Mankind's pursuit of innovative solutions has powered human progress and transformed our world. Two centuries of breakthrough innovation have seen a 15-fold growth in per capita incomes in frontier economies."

Figure 1 illustrates several significant innovations which saw their light in the time-period of 1800-1880, where the GDP per capita was only in the range of 2000-3000$. Table 2 lists the GDP per capita interval-ranges seen in Figure 1 along with the corresponding innovations for that specific GDP range and time-period. It is interesting to notice that after WWII and 1952 the personal wealth growth is approximately $5,000 per 15 years.

Table 2: Innovations Created in The World Within GDP per Capita Ranges, Based on 1990 US$ Value

Year	GDP per capita ranges	Innovations
~ 1800 - 1866	2,000 – 3,000$	Steam Locomotives, Electric Telegraph, Plastics, and Industrial Steelmaking
~ 1866 - 1906	3,000 – 5,000$	Scientific Plant Breeding, Telephone, Automobile, Electric Lamp, and Radio
~ 1906 - 1940	5,000 – 7,500$	Nuclear Energy, Airplanes, and Pharmaceuticals
~ 1940 - 1952	7,500 - 10,000$	Telephone, Mass production of Penicillin, Semiconductors
~ 1952 - 1969	10,000 - 15,000$	Robotics, Supply Chain Innovations, Just-In-Time Manufacturing, Sustainable Energy
~ 1969 - 1984	15,000 - 20,000$	Nanotechnology, Internet, and Mobile Phones,
~ 1984 - 1996	20,000 - 25,000$	1st SMS sent, Commercial 3D printers
~ 1996 - 2010	25,000 - 30,000$	Bicycle with nano-tube frames in Tour de France; Non-commercial 3D printer

Source: Author and data from WIPO (2015)

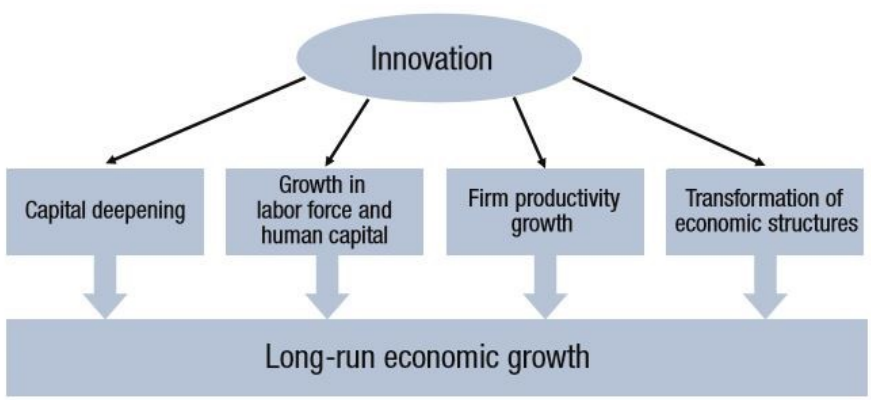


Source: WIPO (2015)

Figure 1: 200 years of innovation and growth

In the 20th century, many groundbreaking innovations occurred in rapid succession. One reason for this is that global connectivity increased when the steam engine was developed in 1769, and the steam locomotive and railroad systems came to life in 1811. This new technology created a basis for many new technological developments and kick-started entrepreneurial endeavors. Higher GDP per capita and the widespread adoption of soap decreased disease prevalence, enabling exponential population growth. Next, penicillin took care of the more serious diseases that before had been almost impossible to cure. People started to have a higher quality of life and lived longer.

By the 20th century, modern innovation systems emerged, whereby a variety of organizations collectively started pushing the knowledge frontier. These included scientific institutions, large R&D intensive firms, and entrepreneurial startups. Figure 2 depicts that innovation leads to long-term economic growth through four mechanisms: capital deepening, growth in labor force and human capital, productivity growth in companies, and the transformation of economic structures.



Source: WIPO (2015)

Figure 2 Innovation spurs long-term growth

Today according to Akbas, Gunaratne, Garibay, Garibay & O'Neal (2015) "entrepreneurial support organizations are among the most successful approaches to economic growth. There are multiple dimensions of entrepreneurial support activities such as resource provision, funding, and networking support" (p. 3112). These support organizations and value-creating networks are a vital part of the innovation ecosystem.

The Global Innovation Index (2016) explains why studying IEs is essential in the current global economy:

> Arguably, everyone stands to gain from global innovation. More resources are now spent on innovation and related factors globally than at any other given point in human history. Thus far, however, innovation has sometimes not been portrayed as a global win-win proposition. Two factors explain this state of affairs: First, evidence regarding the organization and outcomes of the new global innovation model is lacking. Second, governments and institutions need to approach global innovation as a positive-sum proposition and tailor policies accordingly. (p. v)

The modern economy relies on innovation and economic growth. According to Cappiello (2015), in order "to be innovative and meet the challenges posed by market capitalization and globalization, a geographical area must possess a strong entrepreneurial culture" (p. 8). As first argued by Schumpeter in 1911, innovation, and entrepreneurship are closely related.

2.3 Highlighting the interconnectedness in the world economy

This research highlights today's reality that there are differences in wealth, and the innovation level in a country is a reliable predictor of the country's GDP. Further, the interrelatedness of innovation and GDP suggests that interventions to increase innovation can decrease poverty. Melinda Gates mentions in an article in Bloomberg Business Week (Murphy, 2017, p. 48-49), "World poverty the last 25 years has been cut in half," which she says is an underappreciated message which signals "that the

world is getting to be a better place to live." Melinda Gates further points out that "all the investments that the governments are doing to assist the developing countries are making a difference. The people in these countries gain a better life in their own community and then stay there and help it grow." Improved economics in developing nations affects the global economy. Global interconnectedness means there are no isolated events; a natural disaster can affect financial markets worldwide. Social media enables information flow that creates and moves markets in ways that did not exist until recently.

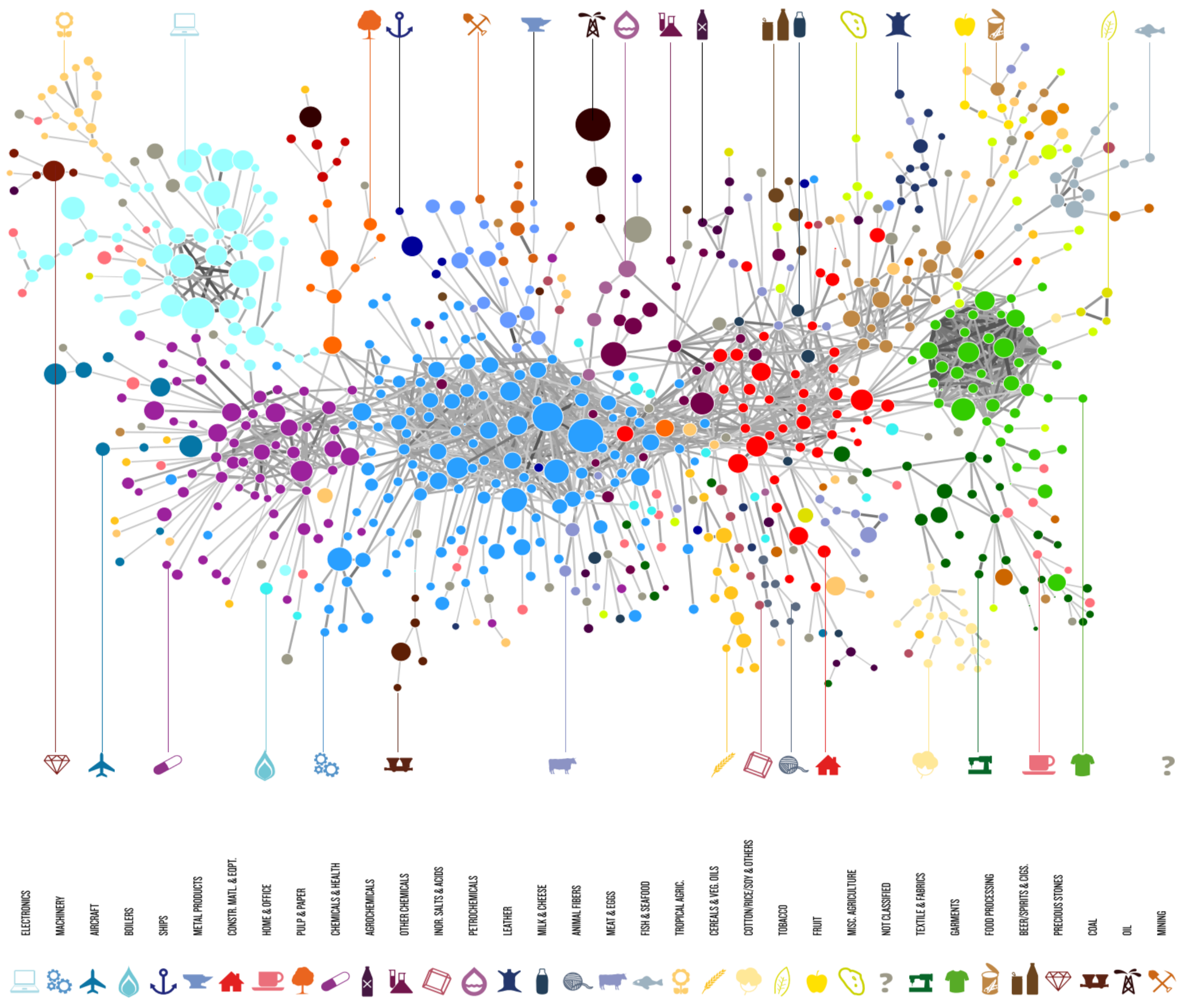
The following discussion illustrates the connectedness of IEs with world events by illustrating some of the interwoven parameters. As stated by Investopedia (2017), "Trends in national economies are both motivating factors and products of global events as well as business and investment decisions. The ebb and flow of a country's GDP is a reflection of its well-being in relation to the rest of the world" (p. 14.).

The Organisation for Economic Cooperation and Development (OECD)'s 2030 agenda outlines 17 priorities for worldwide development, and the list emphasizes harnessing science, technology, innovation, and knowledge. UNESCO (2017) has also set 17 sustainable development goals, and "for the first time, the priority of science, technology, and innovation (STI) is explicitly and universally recognized by the global community as critical drivers for sustainable development" (p. 11).

The GINI index characterizes the world's income equality, and a GINI index of 0 represents perfect income equality. According to OECD (2017), income is defined as household disposable income in a year. It consists of earnings, self-employment and capital income, and public cash transfers; income taxes and social security contributions paid by households are deducted. Very few countries have income equality. Germany, the Scandinavian countries, and several European countries have the best economic income equality.

Each country has specialized production expertise. Often, being the best is a result of the sustained focus on a product or product category, and the country's government supports creating

advantageous policies, regulation, or monetary benefits for this product. Hausmann et al. (2011) studied this product specialization and produced *The Atlas of Economic Complexity.* Part of this work is a representation of economic complexity which is a model of the product space, shown in Figure 3. Links in the model connect products with a high probability of being co-exported. The model shows that the product space is heterogeneous, and many goods group naturally into highly connected communities. According to Hausmann et al. (2011), “this suggests that products in these communities use a similar set of capabilities” (p. 46)



Source: Hausmann et al. (2011, p. 45)

Figure 3: Product space

Hausmann et al. (2011) give a thorough explanation for why economic complexity helps to explain differences in countries' GDP and predicts future economic growth. Economic complexity within a country comes from producing a large number of products, which requires a high knowledge level, which is difficult to achieve, but the rewards are large. Economic complexity, therefore, is related to a country's level of prosperity. According to this view, "economic complexity is not just a symptom or an expression of prosperity: it is a driver" (p. 27), and it reflects the amount of knowledge that is embedded in the productive structure of an economy within a country.

"Innovation is interpreted as a tool enabling economic development, growth and international competition" (Kose & Topca, 2016, p. 245). Innovation is the building block for a country to be competitive. According to Kose and Topcu (2016), "innovation conceptualization and innovation measurement are not standardized" (p. 245). Many innovation and entrepreneurial indices exist, and prominent players such as the World Bank, World Economic Forum, and the European Union, freely provide information in this domain.

OECD and many prominent consulting houses have innovation research departments which also generate innovation-focused reports. "There are several indices and scoreboards published by institutions, and measurement differences lead to different rankings" (Kose & Topca, 2016, p. 245).

The Global Edge web-portal created by the International Business Center at Michigan State University has compiled indices characterizing countries' business environments. Potential entrepreneurs can use these indices to evaluate the prospect of locating their business in given countries. The Global Edge (2018) web-portal is a useful tool for market research, and have scored countries on the indices, and the results are compared in a visually compelling way here: http://bit.ly/2CaZ1UF. Table 3 presents the Global Edge web-portal's compilation of twenty-three indices.

Table 3: List of 23 Useful Indices to Evaluate a Country Before Starting a Business

No.	Name of Index/ Ranking
1	Corruption Perception Index
2	DHL Global Connectedness Index
3	World Bank's - Ease of Doing Business Rank
4	Economic Complexity Index
5	Financial Secrecy Index
6	Freedom of the Press
7	Global Competitiveness Index
8	Global Enabling Trade Index
9	Global Entrepreneurship Index
10	Global Manufacturing Competitiveness Index (GMCI)
11	Global Opportunity Index
12	Global Services Location Index
13	ICT Development Index (IDI)
14	Index of Economic Freedom
15	International Logistics Performance Index (LPI)
16	International Property Rights Index
17	KOF Index of Globalization
18	ND – Gain Country Index
19	Networked Readiness Index (NRI)
20	Open Budget Index
21	Overall Best Countries Rank
22	Paying Taxes Indicator
23	Price of a Big Mac in Dollars

Source: Author adapted Global Edge (2018)

After having studied the list of indices a better understanding of the economic standing of any country can be evaluated. In addition to the indices, The Global Edge web-portal also provides a list of other rankings which go into more in-depth and can provide an extensive global assessment of the

current market situation: https://globaledge.msu.edu/global-resources/rankings. Table 4 presents the sixty-four rankings including some additional indices found by the author of this dissertation.

Table 4: Additional List With 66 Rankings and Indices

No.	Name of Index/ Ranking
1	Fortune: Global 500
2	MSU-CIBER: Market Potential Index (MPI)
3	Cornell University, INSEAD, and WIPO: Global Innovation Index
4	A.M. Best: Country Risk Ratings
5	A.T. Kearney: Foreign Direct Investment (FDI) Confidence Index
6	A.T. Kearney: Global Cities Index
7	A.T. Kearney: Global Services Location Index
8	A.T. Kearney: The Global Retail Development Index
9	Advertising Age: Advertising and Marketing Rankings Data Center
10	AON: Crisis Management Web Analytics
11	Bloomberg Innovation Index
12	Cato Institute: Economic Freedom of the World Annual Report
13	Center for Global Development: Commitment to Development Index
14	Coface: Country Risk Assessments
15	Consumer Trade Association: International Innovation Scoreboard 2018
16	Columbia Center on Sustainable Investment: Emerging Market Global Players (EMGP)
17	Delcredere – Ducroire: Country Risks
18	Deloitte: Global Powers of Consumer Products
19	DHL: Global Connectedness Index
20	Doing Business: Economy Rankings
21	Engineering News-Record (ENR): Top 250 International Contractors
22	Entrepreneur Magazine: Top Global Franchises
23	Euler Hermes: International Debt Collection
24	Financial Times: FT Global 500
25	Fitch: Sovereign Ratings

26	Forbes: Best Countries for Business
27	Forbes: Global 2000
28	Fortune: Fortune 500
29	Fortune: World's Most Admired Companies
30	Freedom House: Freedom on the Net
31	FutureBrand: Country Brand Index
32	Global-Production Research: Global Production Scoreboard
33	Heritage Foundation: Index of Economic Freedom
34	IAOP: The Global Outsourcing 100
35	Inc. 5000
36	IndustryWeek: IW 1000 – World's Largest Manufacturers
37	Innovation Cities Program: Top 100 World Cities for an Innovation Economy
38	Interbrand: Best Global Brands
39	Mercer: Cost of Living City Rankings
40	Milken Institute: Global Opportunity Index (GOI)
41	New Economics Foundation: Happy Planet Index
42	Observatory of Economic Complexity (MIT): Economic Complexity Ranking
43	OECD: country Risk Classification
44	OECD: Indicators of Employment Protection
45	PwC: Ease of Paying Taxes
46	RobecoSAM: Country Sustainability Ranking
47	Stores: Top 250 Global Retailers
48	Swiss Federal Institute of Technology Zurich: KOF Index of Globalization
49	Tax Justice Network: Financial Secrecy Index
50	The Economist Intelligence Unit: Microscope on Microfinance Index and Report
51	The Good Country: Good Country Index
52	Transparency International: Corruption Perceptions Index
53	U.S. News & World Report: Best Countries to Invest In
54	U.S. News & World Report: Overall Best Countries Ranking
55	United Nations Conference on Trade and Development (UNCTAD0: Largest Transnational Corporations

56	United Nations Development Programme (UNDP): Human Development Reports
57	University of Notre Dame: Global Adaptation Index
58	University of Seville: Top 250 Multinational Family Firms
59	World Bank: Logistics Performance Index (LPI)
60	World Bank: Worldwide Governance Indicators (WGI)
61	World Economic Forum: Global Competitiveness Report
62	World Economic Forum: Global Enabling Trade Report
63	World Economic Forum: Global Information Technology Report
64	World Wide Web Foundation: Open Data Barometer
65	World Wide Web Foundation: The Web Index
66	Yale: Environmental Performance Index

Source: Author adapted Global Edge (2018)

Depending on what type of information is needed, one or several of the above rankings or indices could be chosen to evaluate the country. A newer index is the INRIX 2017 Global Traffic Scorecard, which ranks traffic congestion. As the most extensive study of its kind, this index evaluates traffic congestion in 1,064 cities in 38 countries on five continents. Los Angeles has for the sixth year been designated the city with the most gridlocked traffic on earth. The congestion in Los Angeles causes a person to spend more than four days per year in queues and to be stuck in traffic for 102 hours. Moscow and New York share the second place, with 91 hours stuck in traffic, then Sao Paolo (86 hours) and then San Francisco (79 hours). According to INRIX 2017 (2018), the U.S. contains ten of the 25-worst traffic congested and gridlocked cities in the world. Congestion costs U.S. drivers a total of $305 billion per year, which is $1,245 per year per driver. This is relevant to an IE because congestion affects productivity. If people cannot meet, this affects the quality of an IE around the city. According to a Boston Consulting Group team, Los Angeles has high entrepreneurial density, and the Greater, Los Angeles area, is seen as the next Silicon Valley (Foldesy et al., 2018). However, many entrepreneurial

ventures near Los Angeles must rely on remote communication and other technology to overcome the growing infrastructure problems.

Innovators must stay up to date on societal and global trends in order to understand consumers' priorities. Companies must match their product types to what they can sell given consumer demands. Competitive advantage comes from, in part, watching tastemakers such as celebrities, politicians, and the press to see what the next trend will be. The interaction between a trend, cultural values, and other psychological factors determines whether a trend will catch on or fade.

Companies rely on market research to target their products. Market research is increasingly data-rich and technologically based. Gartner is a U.S. company that uses big data to make market evaluations and research people's interests. Gartner developed the Hype Cycle that consists of five phases: Innovation Triggers, Inflated Expectations, Trough of Disillusionment, Slope of Enlightenment, and Platform of Productivity.

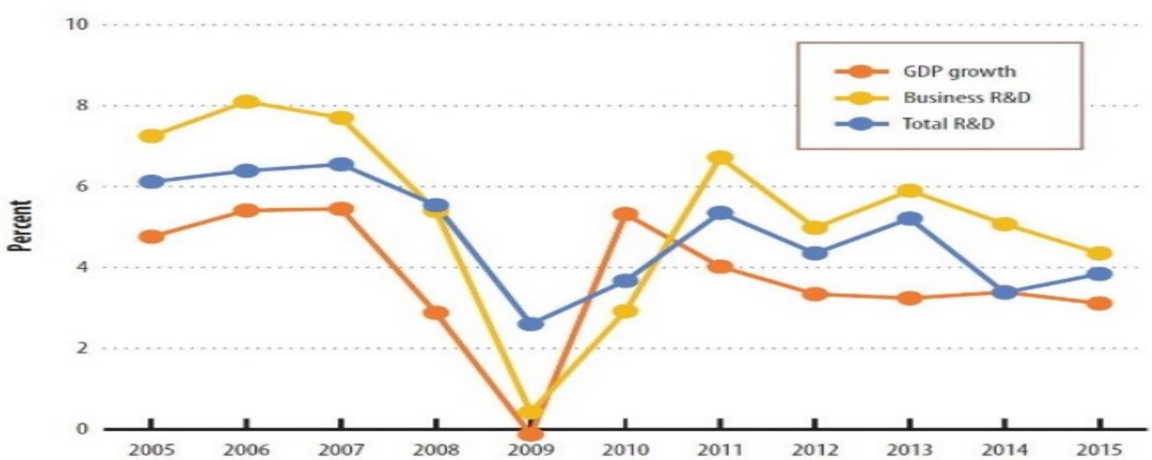
In *Top Trends in the Gartner Hype Cycle for Emerging Technologies 2017,* Gartner (2017) predicted emerging technologies that will have an effect on society. This is what the dissertation author calls an "innovation barometer," giving a sense of the current or coming trends. Gartner predicts how long various technologies will hold interest and when their plateau-level will be reached. For the following technologies Gartner predicted the number of years before the technology will plateau:

- Machine Learning: 2-5 years;
- Autonomous Vehicles: more than 10 years;
- Nanotube Electronics: 5-10 years;
- Software-Defined Anything: 2-5 years;
- Natural-Language Question Answering: 2-5 years;
- Enterprise Taxonomy and Ontology Management: more than 10 years;
- Software-Defined Security: 5-10 years;
- Augmented Reality: 5-10 years, and finally
- Virtual Reality: 5-10 years.

The Hype Cycle is, therefore, an excellent tool to enhance the understanding of upcoming technologies and how long their markets will take to reach maturity.

In the Global Innovation Index (GII) (2017) evaluated the current state of global economic growth as illustrated by Gross Domestic Expenditure on R&D (GERD), Business Enterprise Expenditure on R&D (BERD), and Gross Domestic Product (GDP), is illustrated in Figure 4. In this figure, the effect of the 2009 U.S. financial market crash on the world economy is evident. Research and development and innovation have recovered significantly since 2009 but have not returned to 2005 levels.

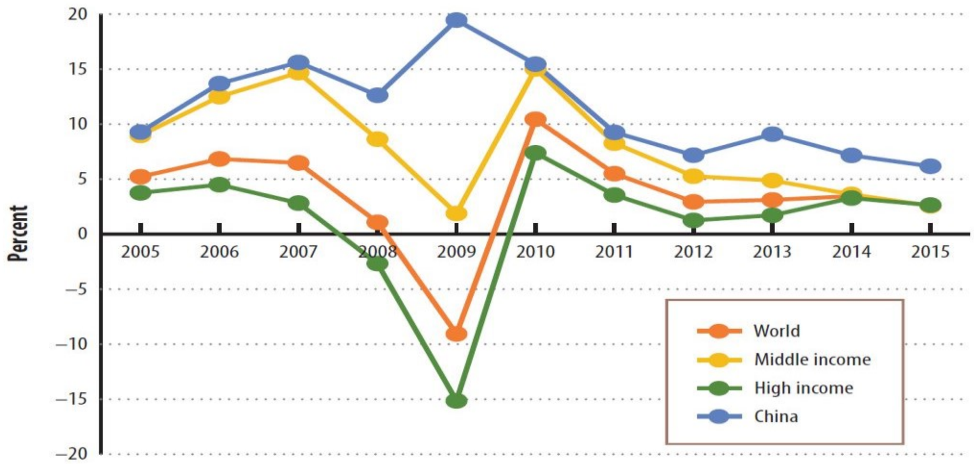
According to the GII (2017), the global effects of the U.S. financial market crash illustrate the interconnectedness of the world economy. While most investments decreased as a result of the crash, in contrast, China increased global investment.



Source: GII (2017)

Figure 4: Global R&D expenditures compared with GDP

China saw the opportunity the crisis presented in the world market, as shown in Figure 5. Instead of being conservative with their investments like other countries, China invested more than ever before and had continued to invest more than the rest of the world.



Source: GII (2017)

Figure 5: Investments in The World

Nothing happens in a vacuum, particularly in regards to innovation. While it is evident that customers, suppliers, competitors and the economy affect us daily, we also periodically interact with government, world events, communities, and families. These interactions form the context for business activities and innovation.

Many questions could be posed regarding the innovation ecosystem's creation. If it is viewed as a network, what processes and entities characterize its creation? What entities have most importance in this creation and what roles do they play, and how much value does the interaction between those parties have for a prosperous existence, taking universities, governments, companies and talented people into the equation? When does an IE create value for the entrepreneurs?

When does an IE create value for society? How significant are an excellent geographic location and access to an entrepreneurial community? What policies, tax advantages, simplifications to company creation, and funding opportunities will help? The IE is a dynamic entity, and what are the best strategies for nurturing its growth? In the network how are the connections set up, and how does the IE communicate with the national and global economy? How is knowledge shared within and outside of

the IE? How can we study the relationship between the many entities and activities the IE consist of, and demonstrate their effects? These questions illuminate the issues that confront IE research.

2.4 Entrepreneur/Innovation related literature review

The following chapter sections examine several research areas in order to characterize the essential entities involved in an IE.

2.4.1 The beginning of the research field "Innovation."

Including innovation as a fundamental field of study seems obvious today, but 100 years ago it was not apparent. According to Fagerberg, Martin, and Andersen (2013), Joseph Schumpeter was one of the first innovation theorists, and Schumpeter asserted that "innovation was the ultimate source of economic growth and therefore should be studied in detail" (p. 2). After WWII a modest research effort in the topic emerged.

In the 1950s interest was spurred, and in the U.S. the RAND Corporation hired the pioneers in the field, Kenneth Arrow, Richard Nelson and Sidney Winter, to work in the area of the economics of R&D and Innovation. In Britain, Fagerberg et al. (2013) continue:

> Christopher Freeman was recruited by the Federation of British Industries to collect data on R&D activities in British firms. A few years later the Organization for Economic Co-operation and Development (OECD) employed Freeman as a consultant to create a unified framework for collecting statistics on R&D activities on an international scale, which later resulted in the very well-known Frascati Manual from 1962 (p. 2).

The Frascati Manual is up to this day still the basis for the collection of R&D statistics worldwide.

Today's diverse innovation community has developed across decades and now consists of several thousand researchers with numerous interdisciplinary research projects. This area is now

receiving increased attention from the outside. It is now considered critical to further develop the scientific field by intentionally structuring interdisciplinarity to be able to develop this research area fully.

2.4.2 Pioneers in the field of innovation studies

Schumpeter (1934) started the current thoughts on innovation. According to Autio et al. (2014), “since Schumpeter’s early work, the concept of ‘entrepreneurship’ and ‘innovation’ have been strongly related” (p. 1097). The terms continue to be used interchangeably, even though they are not the same. “Not all entrepreneurs innovate” (Autio et al., 2014, p. 1097). According to Groen, Jenniskens, & Sijde (2005) is entrepreneurship defined by Schumpeter as creating a new combination of already existing materials or products leading to something new and innovative. Schumpeter (1934) sees technology as one of the driving forces for entrepreneurship.

Richard R. Nelson, who currently is at Columbia University, has been one of the most cited scholars in this area of study during his career of more than fifty years. Judith Estrin is another pioneer, and she was focused on the effect of innovation on a national level. She wrote about the national IE in her 2009 book, *Closing the Innovation Gap,* and stated, “innovation is not important just to the business community. The quality of life that we are accustomed to, financially and socially, is dependent on growth” (Estrin, 2009, p. 151).

Eunika Mercier-Laurent published *Innovation Ecosystem* in 2011, and she was one of the first women who entirely concentrated on this field in her research. This sampling of researchers demonstrates that there has been scholarly research on innovation for decades, and despite that fact, there is still confusion about what innovation entails.

2.4.3 Economic Development and the Influence on Innovation

Innovation has for the last 50 years been a much-debated subject. According to Fagerberg et al. (2013), “innovation is increasingly recognized as a vitally important social and economic phenomenon worthy of serious research study” (p. 1). Firms and politician both consider innovation abilities from their perspectives, while innovation is presumed to be the driver of economic development and welfare in a society. Fagerberg et al. state that “to learn more about how a community can benefit from innovation, one needs to understand all the innovation processes within firms, and how these processes interact with broader social, institutional, and political factors” (p. 1).

Recent literature has pointed out that the timing of innovation activities relative to those of competitors’ plays an essential role in innovation outcomes (Katila & Chen, 2008). Specifically, when firms conduct innovation out of sequence from their competition, they introduce more products and more innovative products (Katila & Chen, 2008). According to Watts & Gilbert (2014b, p. 190), “the innovation literature does distinguish between incremental and radical innovations involving minor improvements in existing technological approaches, and radical innovations involving a complete switch to a new method.”

Another important point is that “some innovations may form the components of further innovations, or they may by their emergence and diffusion change the functionality and desirability of other innovations” (Watts & Gilbert, 2014b, p. 191).

Today, governments commonly have a department of innovation development. According to Rothwell and Zegveld (1988), it was the late 1970s when governments started implementing specific innovation policies to stimulate scientific and technological progress. Rothwel and Zegveld (1988) compiled a list of known facts about technological innovation processes which is presented in Table 5.

Table 5: Known Facts About Technological Innovation Processes

1	Innovation is a highly complex and high-risk process involving many inputs – financial, economic, technical and social – and many actors. The most crucial actors are those involved in managing innovations in companies.
2	Technological innovation often requires organizational innovation for its successful implementation (as well as for its optimal use in adopter companies). In other words, industrial innovation involves not just technological change but sometimes also institutional, procedural and behavioral changes. In this respect, we can point to the various 'new venture" initiatives undertaken by large companies in the USA (Roberts, 1977)
3	The process of innovation can be different in different sectors of industry. Between some sectors, however there exist strong technological interdependencies (Rothwell and Zegveld, 1984)
4	The innovation process can be different in firms of different sizes. In very large corporations, for example, it is often a highly planned and structured process; in many small firms it is often a more ad hoc process (Rothwell, 1983a)
5	Innovation can be a markedly regional or 'local' phenomenon (Oakey, 1980). This is especially the case with small firms which are often 'locked' into local markets (Rothwell and Zegveld, 1982)
6	Innovation can progress differently in different countries. In this respect, we can point to the role new technology-based firms played in the evolutionary dynamics of the US semiconductor and computer-aided design (CAD) industries, which was rather different from the situation in Europe and Japan where established large organizations played the major role (Rothwell, 1983b).
7	From a large number of empirical studies of actual innovations and innovative companies, we can claim to understand a great deal about the factors associated with successful and unsuccessful innovation and about the characteristics of technically progressive firms. One important fact to emerge from these studies is that innovations rarely fail for technical reasons (failure to solve basic technical problems) but mainly for management and marketing reasons.
8	Despite all we do know concerning technological innovation, it nevertheless remains an imperfectly understood process. This implies that governments should not only implement policies towards innovation but should at the same time initiate studies to improve our understanding of the process of innovation and of its economic, social and other impacts.

Source: Author with info from Rothwell & Zegveld (1988)

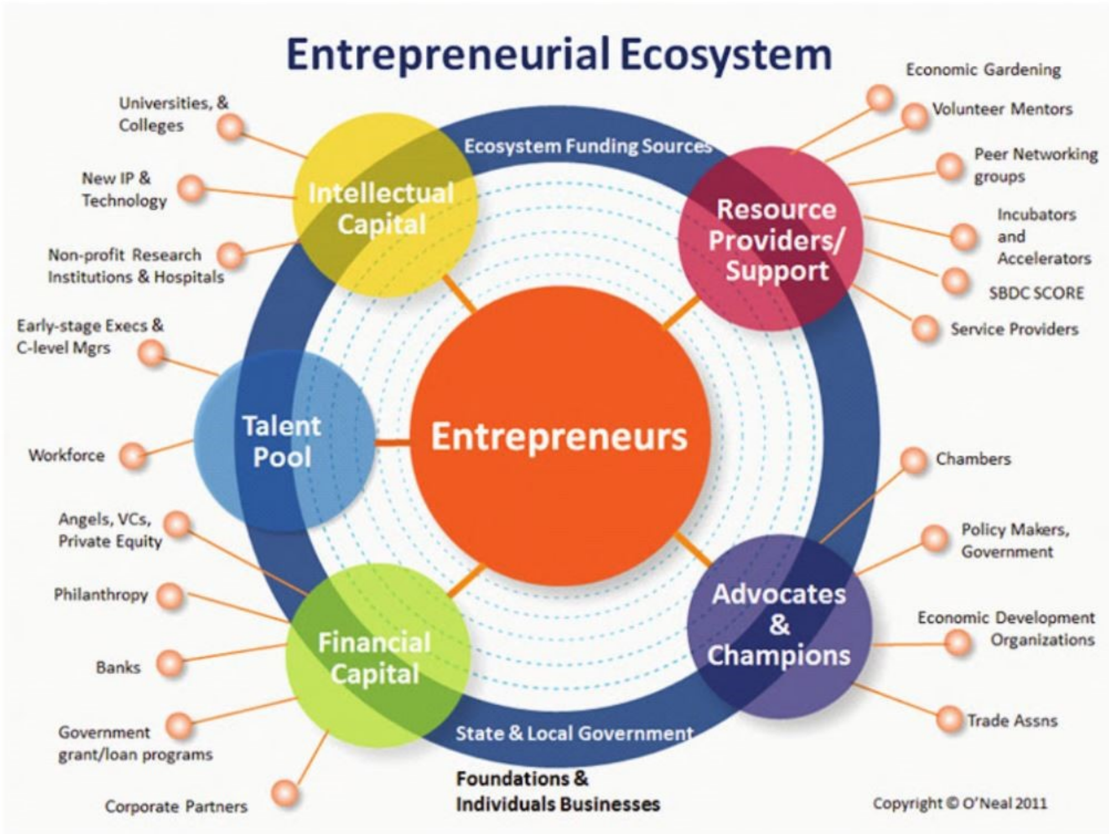
Table 5 item 8 is a part of the justification for this dissertation's objective to further the understanding of technological innovations through studying IEs. Rothwell and Zegveld (1981) delineated policy-level tools that affect innovation, which are presented in Table 6.

Table 6: Various Policy Tools

Policy tool	Examples
Public Enterprise	Innovation by publicly owned industries, setting up new industries, pioneering use of new techniques by public corporations, participation in private enterprise
Scientific and technical	Research laboratories, support for research associations, learned societies, professional associations, research grants.
Education	General education, universities, technical education, apprenticeship schemes, continuing and further education, retraining
Financial	Grant loans, subsidies, financial sharing arrangements, provision of equipment buildings or services, loan guarantees, export credits
Taxation	Company, persona, indirect and payroll taxation, tax allowances
Legal and regulatory	Patents, environmental and health regulations, inspectorates, monopoly regulations
Political	Planning, regional policies, honor or awards for innovation, encouragement of mergers of join consortia, public consultation.
Procurement	Central or local government purchases and contracts, public corporation's R & D contracts, prototype purchases.
Public services	Purchases, maintenance, supervision and innovation in health service, public building, construction, transport, telecommunications.
Commercial	Trade agreements, tariffs, currency regulations
Overseas agent	Defense sales organizations

Source: Reproduced by the author with info from Rothwell & Zegveld (1981)

The literature does not describe strict definitions of the inventor, innovation, and IEs, and does not differentiate between an IE and entrepreneurial ecosystem (EE). Figure 6 shows O'Neal and Schoen's (2013) depiction of an EE. The EE is centered around the entrepreneur, who is surrounded by the elements necessary for a successful startup.



Source: O'Neal & Schoen (2013)

Figure 6: Components in the entrepreneurial ecosystem

The EE above is found in the book chapter called *Universities' Role as Catalysts for Venture Creation*, by O'Neal & Schoen (2013) and is based on the University of Central Florida's EE. It emphasizes that the entrepreneurs should be the center of all activities and that entrepreneurs vary from one another, and therefore the support should be customized and tailored to fit the individual's specific need.

There are systematic differences in how members of each country talk about IEs. A report created by The Economist Intelligence Unit and Barclays (Lawlor, 2014) investigated mapping innovation, by looking into what eight countries (US, UK, France, China, India, Israel, Brazil, and Nigeria)

say about IEs. The researchers mined tens of thousands of news and blog sources online over a period of 3.5 months. There are almost 100K conversations in the U.S. about the IE, whereas in the UK there are only 27K followed by China with 25K conversations. Within most countries, the most frequent topic of discussion is their own country's entrepreneurial hotspots, except for Brazil, which speaks about their own IEs second-most behind the most frequent topic of the entrepreneurial hotspots in the U. S.

The U.S. speaks most about its own domestic entrepreneurial hotspots. This is likely because the U.S. excels at promoting locations and new developments through a very active press, and also the country has many marketing channels.

The primary national-level driver for innovation is a desire for economic growth and an improved situation for the country's population. Economic growth in the developed world is, according to Teece (2014.), "primarily driven by a nations ability to innovate both technologically and organizationally" (p. i.).

Many prominent global organizations are focused on understanding and measuring innovation. Below are listed some of the most prominent actors contributing to the body of knowledge about innovation. They are listed starting with those with the largest global span of activities, and additionally having one of their many programs listed too:

- United Nations (UN) - The 2030 Agenda for Sustainable Development
- The World Bank – collects all kinds of essential data from all around the world
- World Economic Forum (WEF) – Global Competitive Index until 2017-2018
- Organization for Economic Co-operation and Development (OECD) – The Innovation Policy Platform
- UNESCO –The 2030 Agenda for Sustainable Development
- European Union (EU) – Innovation Scoreboard 2000 - 2017
- Cornell/WIPO/INSEAD – Global Innovation Index 2007 - 2017

- The Heritage Foundation – Index of Economic Freedom
- The Legatum Institute – The Legatum Prosperity Index 2016. Bringing Prosperity to Life
- NSF's I-Corps Program – National Science Foundation's Innovation Corps created to support the IE in the U.S., especially those based at universities. The purpose of the program is to bring innovations out of labs and into the hands of the public. This process helps the scientist realize the value of their inventions, by having interviews with potential customers which leads to useful insights.
- CIGI – Centre for International Governance Innovation
- The biggest consulting houses: AT Kearney, Boston Consulting Group, Deloitte, McKinsey, KPMG, Price Waterhouse and many more.

The big consulting firms are interested parties that see an advantage in understanding and managing innovation development and being a part of the consulting opportunities, it creates. They have already established strategies for developing their understanding of innovation. One of the most prominent consulting firms, KPMG, released a survey in March 2016 asking 800 technology leaders about innovation-related questions. The KPMG report (2016) delivered many exciting results, and Tim Zanni, KPMG Global, and U.S. Technology Sector Leader, concluded by saying:

> What we have seen emerge over time is the result of countries and cities striving to replicate and build on the Silicon Valley tech innovation blueprint and their increasing degree of success. The spread of tech innovation development is being fueled by growing ecosystems as technology innovation has permeated all industries and become a strategic business imperative for cross-industry leaders (p. 31).

Innovation is ongoing in every level of society, and when Deloitte wins "America's Tax Innovator of the Year" awarded by the International Tax Review, two consecutive years in a row in 2016 and 2017, then it

is clear that innovation has a huge priority at Deloitte (Deloitte, 2017). At the 2016 award ceremony, Carl Allegretti, chairman and chief executive officer, Deloitte Tax LLP, stated: “Innovation is a top priority for our tax practice. We are doubling our investment in innovation over the next three years and deepening our commitment, anticipating the next generation of solutions in a dynamic global landscape.” (Deloitte, 2016).

2.5 Innovation model evolution

According to Forsman et al. (2013), it is through innovation that companies aim at transforming ideas into products that can be commercialized, to stay competitive and to generate profits and growth.

The focus of studies on innovation has changed significantly over the years. Table 7 presents a chronology of major innovation models since 1950.

Table 7: Innovation Models’ Evolution in Historical Perspective

Generation	Period	Authors of fundamental ideas	Innovation Model	The essence of the model
1	1950s – late 1960s		Technology push	Linear process
2	Late 1960s – first of 1970s	Myers and Marquis, 1969	Market (need) pull	R&D on customer wishes
3	Second half of 19070s – to end of 1980s	Mowery and Rosenberg, 1979	Coupling model	Interaction of different functions
		Rothwell and Zegveld, 1985	Interactive model	Interaction with research institutions and market
4	End of 1980s – early 1990s	Kline and Rosenberg, 1986	Integrated model	Simultaneous process with feedback loops; “Chain-linked” model
5	1990s	Rothwell, 1992	Networking model	System integration and networks (SIN)

6	2000s	Chesbrough, 2003	Open innovation	Innovation collaboration and multiple exploitation paths
7 (not fully emerged yet)	2010s		Open innovator	Focus on the individual and framework conditions under which to become innovative

Source: Author with Kotsemir & Meissner's (2013) adaptation; Camodall'Orto and Ghiglione (1997); Rothwell (1992).

Fostering innovation has according to Rabelo and Bernus (2015) more or less become a mandated task on the agenda of most governments, universities, companies, professionals and the civil society, the question is how to in reality to get more innovation. According to Steel, Rinne, and Fairweather (2012) (Shalley, Zhou, & Oldham, 2004) "have pointed out that one of the principal factors in innovation is creativity" (p. 6). Thus, the study of innovation also connects to studying personality. Lawson and Samson (2001) examined creativity and idea management in organizations. They defined creativity as the process of generating new ideas, and they stated that creativity operates along a continuum. Creativity requires divergent thinking about what may be unrealized, unproven or untested.

The originator of the idea or widget is the *inventor*. Although the inventor is integral to the process, he or she generally requires assistance from several diverse sources if the invention is to be successful (Adams, Bessant, & Phelps, 2006). According to Steel, Rinne, and Fairwater (2012):

> Success in innovation is one of the means by which nations and businesses make their mark in the world. In a world of globalized trade, nations have an 'innovation imperative' in which success in innovation is considered necessary for national growth and survival. It occurs at an individual, business, and national level and has concomitant costs and rewards at each level. (p. 5)

Chris Harris (2002) continues to say: "If we open our eyes, we will begin to see the collateral convergence, divergence, paralleling, planning, customizing, real-time and accelerated pace of innovation" (p. xiii), and he continues, "that the new industry structures, and the innovative products

and services that emerge, are not simply a result of convergence, but literally the multidimensional interconnection of ideas" (p. xiii).

2.6 Difference between invention and innovation definitions

Kotsemir & Abroskin (2013) reviewed the literature comparing invention and innovation. Table 8 presents a summary of their review.

Table 8: Comparing the Invention and Innovation Concept in the Scientific Literature

Author(-s) of literature	Invention	Innovation
Freeman (1982)	Invention is the creation of a new device or process	Innovation is the introduction of change via something new
Senge (1990)	An idea has been 'invented' when it is proven to work in the laboratory	An idea becomes an innovation only when it can be replicated on a meaningful scale at practical costs
Rouse (1992)	An invention is the creation of a new device or process	Innovation is the introduction of change via something new
O'Sullivan & Dooley (2009)	Invention need not fulfill any useful customer need and need not include the exploitation of the concept in the marketplace	Innovation is more than the creation of something novel. Innovation also includes the exploitation for benefit by adding value to customers. Innovation is often measured as the ability to patent an idea

Source: Author adapted info from Kotsemir & Abroskin (2013)

Table 8 shows that definitions of invention and innovation are highly related, which is why the terms are not standardized.

Kirzner (1973) points out that in the space between invention and innovation there is a missing link, which is made of three essential entrepreneurial components:

a) Alertness to information

b) Awareness of newly existing opportunities, waiting to be noticed

c) Responsiveness to possibilities offered by the market system

This requirement for alertness and responsiveness is why entrepreneurship is not a routine activity (Heertje, 2006).

The personal characteristics of the individual entrepreneur are important in predicting the success of the venture. Timmons (1999) reviewed the research summarizing personality characteristics of entrepreneurs. Table 9 items 1-8 are Timmons's findings, and items 9-12 are from the scholars indicated in the Author column, encountered during the literature review.

Table 9: Entrepreneur Characteristics/Skillsets

No.	Entrepreneur characteristics	Positive/Negative for the innovation process	Author
1	Risk-bearing	Positive	Mill (1848)
2	Source of formal authority	Positive	Weber (1917)
3	Innovation; initiative	Positive	Schumpeter (1934)
4	Need for achievement	Positive	McClelland (1961)
5	Drive	Positive	Pickle (1964)
6	Communication ability; technical knowledge	Positive	Pickle (1964)
7	Networking with resource providers	Positive	Aldrich & Zimmer (1987)
8	Recognizing and seizing opportunities	Positive	Timmons et al. (1987)
9	Tendency for Solo-performance	Can be negative	McGrath et al. (1992)
10	Difficulties in delegating tasks	Can be negative	McGrath et al. (1992)
11	Avoidance of insecurity	Can be negative	McGrath et al. (1992)
12	Tech E. do not see value in maintaining network	Can be negative	Deschamps & Nayak (1995)

Source: Author adapted info no. 1-8 from Timmons (1999); no. 9-12 from authors indicated in table

Groen, Jenniskens, and Sijde (2005) recognized that the entrepreneurial process is a social system which includes multiple actors and multiple levels of aggregation, where actors interact and create new technologies that have the potential for starting a business. A fundamental axiom of entrepreneurship "is that entrepreneurs act purposefully in interaction with other actors" (Groen,

Jenniskens, & Sijde, 2005, p. 3). Groen at al. (2005) applied Parsons's (1964) work on social systems theory to entrepreneurship. Parsons's original definition of a social system was:

> A social system consists in a plurality of individual actors interacting with each other in a situation which has at least a physical or environmental aspect, actors who are motivated in terms of a tendency to the "optimization of gratification," and whose relation to their situations, including each other, is defined and mediated in terms of culturally structured and shared symbols (pp. 5-6).

This definition was the basis for selecting *A World of Three Cultures – Honor, Achievement and Joy* (WOTC) as a dataset for the model developed in this dissertation, because the datasets represents this social networking and interaction component, which is interesting to study further than done in previous indices. The argument used by this dissertations' author is that all ideas start with a creative person developing an idea into an invention, which, with work, can become an innovation or business pillar. The entrepreneur is the driver through the entire process, and their cultural heritage and personal values matter for a successful outcome. Several researchers support these arguments, and McGrath et al. (1992) point out that Shapero and Sokol (1982) and Huisman (1985) had looked into this subject. Shapero and Sokol (1982) observed that business formation rates vary from society to society and that this is so because different cultures carry different beliefs about the desirability and feasibility of beginning a new enterprise. Additionally, Huisman (1985) conducted an extensive survey of entrepreneurial activity across cultures and concluded that values influence entrepreneurial behavior.

2.7 The numerous innovation definitions

In reference to chapter 2.1 where a brief introduction to the used definitions in this dissertation are presented, here in chapter 2.6 the background for all the selections are given.

“It is generally understood that innovation is a process that creates value” (Engel, 2014, p. 6). Smorondinskaya et all. (2017) point out that innovation in the Global Competitiveness Index, developed by the World Economic Forum, is more than technological innovation; “it is an ecosystem or environment conducive to the generation of ideas and their implementation in the form of new products, services, and processes in the global marketplace.”(p. 5245). In a survey that shows the diversity of views on what innovation is or is defined as, fifteen thought leaders in the business world were asked to give their definition of innovation (Skillicorn, 2016). The responses are presented in Table 10, and they show that these leaders’ definitions were more customer-centric and less systemic. Table 11 summarizes the main themes of the responses. These responses can be contrasted with scholarly definitions of innovation discussed below.

Table 10: Innovation Definitions by 15 Innovation Thought Leaders in the Business World

No.	Name	Occupation	Definition – Innovation is:
1	Nick Skillicorn	Innovation consultant, Innovation blogger	Turning an idea into a solution that adds value from a customer’s perspective
2	David Burkus	Author, pod-caster, Associate Professor	The application of ideas that are novel and useful
3	Stephen Shapiro	Innovation Instigator, Author	Staying relevant
4	Pete Foley	Consultant, Innovator, Artist, Scientist, Photographer, and Blogger	A great idea executed brilliantly and communicated in a way that is both intuitive and fully celebrates the magic of the initial concept
5	Gijs van Wulfen	LinkedIn influencer, and Author	A feasible relevant offering such as a product, service, process or experience with a viable business model that is perceived as a new and is adopted by customers.
6	Kevin McFarthing	Voted #1 innovation blogger in 2015. Focus on R&D, Innovation Management, and Open Innovation	Introduction of new products and services that add value to the organization

7	Robert Brands	Serial Entrepreneur, Author, and Speaker	Any variation goes, as long as it includes "new" and it addresses customer needs and wants
8	Paul Hobcraft	Innovation consultant, and top innovation blogger	The fundamental way the company brings constant value to their customer's business or life, and consequently their shareholders and stakeholders
9	Mike Shipulski	Innovation improvement consultant	Work that delivers new goodness to new customers in markets, and does it in a way that radically improves the profitability equation
10	Paul Sloane	Speaker, Facilitator, and Author	Creativity is thinking of something new. Innovation is the implementation of something new.
11	Jeffrey Baumgartner	Author, Keynote speaker, and Writer of the industry newsletter Report 103	The implementation of creative ideas in order to generate value, usually through increased revenues, reduced costs or both
12	Stefan Lindegaard	Author, Speaker, and Advisor	"I try not to define "innovation" as we should tone down our use of the word and term?
13	Drew Boyd	Author, Professor, Blogger, and Speaker	Anything that is new, useful and surprising
14	Michael Graber	Co-Founder, and Managing Partner at Southern Growth Studio	New, organic value creation by applying creativity, in-depth relationships with consumers and customers, and new thinking
15	Jorge Barba	Innovation consultant, and Innovation insurgent, and Partner at Blu Maya	The Future Delivered

Source: Author with the adaption of info from Skillicorn (2016)

Combining all the responses from Skillicorn's survey yields a single definition of innovation given in the following sentence:

Executing an idea which addresses a specific challenge and achieves value for both the company and customer.

Table 11: Innovation Definitions by 15 Innovation Thought Leaders Survey Data Results

Areas of focus	%
Having an idea	60%
Executing the idea	60%
Addresses a real challenge	40%
Add value to the company	40%
Add value to the customer	40%
Different perspective / thinking	27%

Source: Author with info from Skillicorn (2016)

The OECD has chosen an inclusive definition of innovation, and it is the primary definition for this dissertation, because it includes the complexity of many different types of business flows. The OECD (2005) defines innovation in the following way:

> An innovation is the implementation of a new or significantly improved product (good or service), a new process, a new marketing method, or a new organizational method in business practices, workplace organization, or external relations (p. 46).

One business consultant, Braden Kelley (2014), expresses that innovation is dependent upon three value processes. Kelley's formula is the following: **Innovation = Value creation * Value Access * Value Translation**. This formula is multiplicative. Value access is the ability to gain access to this new product; value translation is the producer's ability to make the user understand the product's value, and value creation is how it fits into their lives.

This equation is useful because it emphasizes that innovation is a result of many processes coming together. It is an illustrative example of an innovation network, a mini innovation ecosystem, and as will be seen it will align with the IECO-model being created here and introduced later, which also builds on the premise of multiplication.

The literature affirms that invention is a recombination process. This concept was underlined by Schumpeter (1939) formulating innovation combines components in a new way, or that it consists in carrying out new combinations. Likewise, Nelson and Winter (1982) stated "that the creation of any sort of novelty consists to a substantial extent of a recombination of conceptual and physical materials that were previously in existence" (p. 130). According to Fleming (2001), recombination usually occurs between components that are available for the inventor. Hence, the set of potential elements and combinations to create something that is useful is limited.

A human factors medical innovation consultant Dr. Eric Shaver (2016) has compiled 62 definitions of innovation in order to show the lack of clarity in regards to the word "innovation." Table 12 lists all the academic definitions of innovation from Dr. Shaver's list and some additional, which this dissertation's author found during the literature review phase. Many of the 43 definitions come from Shaver (2016), and some come from the broader review. This is not an exhaustive list.

Table 12: Scholarly Definitions of Innovation

No.	Definition	Reference
1	"…the successful conversion of new concepts and knowledge into new products, services, or processes that deliver new customer value in the marketplace."	(American Society for Quality- ASQ)
2	"Innovation is the multi-stage process whereby organizations transform ideas into new/improved products, service or processes, in order to advance, compete and differentiate themselves successfully in their marketplace."	(Baregheh, Rowley, & Sambrook, 2009, p. 1334)
3	"Innovation represents the core renewal process in any organization. Unless it changes what it offers the world (product/service innovation) and the ways in which it creates and delivers those offerings (process innovation) it risks its survival and growth prospects."	(Bessant, Lamming, Noke, & Phillips, 2005, p. 1366)
4	"…the development and intentional introduction of new and useful ideas by individuals, teams, and organizations…"	(Bledow, et al., 2009, p. 305)

5	"…the creation of a new product-market-technology-organization-combination."	(Boer & During, 2001, p. 84)
6	"…innovation is the process that turns an idea into value for the customer and results in sustainable profit for the enterprise."	(Carlson & Wilmot, 2006, p. 4)
7	"…production or adoption, assimilation, and exploitation of a value-added novelty in economic and social spheres; renewal and enlargement of products, services, and markets; development of new methods of production; and the establishment of new management systems. It is both a process and an outcome."	(Crossan & Apaydin, 2010, p. 1155)
8	"…adoption of an internally generated or purchased device, system, policy, program, process, product, or service that is new to the adopting organization."	(Damanpour, 1991, p. 556)
9	"…the search for, and the discovery, experimentation, development, imitation, and adoption of new products, new production processes, and new organizational set-ups."	(Dosi, 1988. p. 222)
10	"Innovation is change that creates a new dimension of performance."	(Drucker, 2018)
11	"The design, invention, development and/or implementation of new or altered products, services, processes, systems, organizational structures, or business models for the purpose of creating new value for customers and financial returns for the firm.''	(Federal Register, 2007, p. 18627)
12	"The novel idea, the invention by itself, is not an innovation."	(Freeman & Engel, 2007)
13	"The extent to which entrepreneurs are introducing products that are new to some or all customers, and that is offered by few or no competitors."	(Global Entrepreneurial Monitoring, 2017-2018)
14	"Innovation: successful implementation of new ideas."	(Harris, 2002)
15	"…a product, process or service new to the firm, not only new to the world or marketplace."	(Hobday, 2005, p. 122)
16	"A new idea, method, or device. The act of creating a new product or process, which includes invention and the work required to bring an idea or concept to final form."	(Kahn, 2012, p. 454)
17	"…a viable offering that is new to a specific context and time, creating user and provider value."	(Kumar, 2013, p. 1)
18	"…innovation is the conversion of a new idea into revenues and profits."	(Lafley & Charan, 2008, p. 21)

19	"…any novel product, service, or production process that departs significantly from prior product, service, or production process architectures." (McKinley, Latham, & Braun, 2014, p. 91)	(McKinley, Latham, & Braun, 2014, p. 91)
20	"The act or process of introducing new ideas, devices, or methods" (Merriam-Webster)	(Merriam-Webster)
21	"…the function of an interaction among the motivation to innovate, the strength of obstacles against innovation, and the availability of resources for overcoming such obstacles."	(Mohr, 1969, p. 111)
22	"…any policy, structure, method or process, product or market opportunity that the manager of the innovating unit perceived to be new." (Nohri & Gulati, 1996, p. 1251)	(Nohri & Gulati, 1996, p. 1251)
23	"Innovation is the process of making changes, large and small, radical and incremental, to products, processes, and services that result in the introduction of something new for the organization that adds value to customers and contributes to the knowledge store of the organization." (O'Sullivan & Dooley, 2009, p. 5)	(O'Sullivan & Dooley, 2009, p. 5)
24	"Innovation = Creativity + Exploitation"	(O'Sullivan & Dooley, 2009, p. 8)
25	"…is the implementation of a new or significantly improved product (good or service), or process, a new marketing method, or a new organizational method in business practices, workplace organization or external relations."	(OECD, 2005, p. 46)
26	"…the transformation of knowledge into new products, processes, and services…"	(Porter & Stern, 1999, p. 12)
27	"A new idea, method, or device. The act of creating a new product or process, which includes invention and the work required to bring an idea or concept to final form."	(Kahn, 2012, p. 454)
28	"…directed creativity implemented."	(Plsek, 2014, p. 12)
29	"…a change that breaks trade-offs." (Raynor, 2011, p. 168)	(Raynor, 2011, p. 168)
30	"Innovation = Invention + Exploitation" (Roberts, 1988, p. 13)	(Roberts, 1988, p. 13)
31	"…an idea, practice, or object that is perceived as new by an individual or another unit of adoption." (Rogers, 2003, p. xx)	(Rogers, 2003, p. xx)

32	"The commercialization of any new product, process, or idea, or the modification and recombination of existing ones." (Rothaermel, 2013, p. 172)	(Rothaermel, 2013, p. 172)
33	"…the practical implementation of an idea into a new device or process." (Schilling, 2013, p. 18)	(Schilling, 2013, p. 18)
34	"…the act of generating more value for the customer and the business by fulfilling a job to be done better than anyone else." (Silverstein, Samuel, & DeCarlo, 2009, p. xviii).	(Silverstein, Samuel, & DeCarlo, 2009, p. xviii).
35	"…innovation is a process of turning opportunity into new ideas and of putting these into widely used practice." (Tidd & Bessant, 2009, p. 16)	(Tidd & Bessant, 2009, p. 16)
36	"Innovation = theoretical conception + technical invention + commercial exploitation"	(Trott, 2012, p. 15)
37	"Innovation is the management of all the activities involved in the process of idea generation, technology development, manufacturing and marketing of a new (or improved) product or manufacturing process or equipment."	(Trott, 2012, p. 15)
38	"Innovation is the successful exploitation of new ideas."	(United Kingdom Department of Trade and Industry, 2007)
39	"…an invention which has reached market introduction in the case of a new product, or first used in a production process, in the case of a process innovation."	(Utterback, 1971, p. 77)
40	"…the process of developing and implementing a new idea."	(Van de Ven, et al., 1999, p. 9)
41	"…is anything new that is actually used ('enters the marketplace') – whether major or minor."	(Eric von Hippel, 2005)
42	"…the intentional introduction and application within a role, group or organization of ideas, processes, products or procedures, new to the relevant unit of adoption, designed to significantly benefit the individual, the group, the organization or wider society."	(West & Farr, 1990, p. 9)
43	"…any idea, practice, or material artifact perceived to be new by the relevant unit of adoption."	(Zaltman, Duncan, & Holbek, 1973, p. 10)

Source: Author created with the adaption of info from Shaver (2016)

Kotsemir and Abroskin (2013) have studied innovation concepts and typology, and they defined innovation subtypes, which helps describe different kinds of innovation activity. Table 13 lists their categories.

Table 13: Various Innovation Types

Classical	New	Innovativeness Degree	Dichotomical
Product Innovation	**Frugal innovation**	**Weak Innovation** • Incremental • Routine • Minot • Regular • Non-drastic • Basic Innovation	**User-driven/Supply-side innovation**
Process Innovation	**Red Ocean Innovation**		**Open/Closed Innovation**
Service Innovation	**Blue Ocean Innovation**		**Product/Process Innovation**
Marketing Innovation	**Experience Innovation**	**Medium Strength** • Architectural • Niche(creation) • Modular • Fusion • Evolutionary • Sustaining innovation	**Incremental/Radical Innovation**
Organizational Innovation	**Value – Migration Innovation**		**Continuous/Discontinuous Innovation**
Design Innovation	**Business Model Innovation**		**Instrumental/Ultimate Innovation**
Supply Chain Innovation	**Organic Innovation**	**Strong Innovation** • Radical • Major • Breakthrough • Disruptive • Revolutionary • Paradigm • Fundamental • Discrete Innovation	**True/Adoption Innovation**
			Original/ Reformulated Innovation
			Innovation/Re-innovations

Source: Reproduced by author data from Kotsemir and Abroskin (2013)

2.7.1 Newest development of Innovation in EU – Innovation Management System Standard

In Europe innovation is now taken so seriously that a standard for innovation has been created. The tool development began in 2009, and it was released in 2016. It consists of 7 documents. The standard for an innovation management system is referred to as UNE-CEN/TS (16555-1:2013), (Kollerup, 2017).

S. Joe Bhatia, President and CEO of the American National Standards Institute, comments that innovation, and innovation standards, are important: “As innovation fuels economies, standards smooth

the ride. In fact, standards are strategic tools that can spur innovation and drive business growth.” (Bhatia, 2015, p. 2)

2.8 Methods for spreading Innovation

2.8.1 Clusters of Innovation

The IE is an expansion of the industry cluster concept. A business cluster is a geographic concentration of interconnected businesses, suppliers, and associated institutions in a specific industry area. Cluster development is considered to increase the productivity in which companies compete, nationally and globally. An IE is an extension of the cluster concept because it includes social factors, and an IE can have several different industry clusters included in a geographical area or city. Teece (2014) expands by saying “that clusters of innovations are concentrations of interconnected companies that both compete and collaborate” (p. i.). Human talent (scientific engineering and entrepreneurship) is essential, as well as venture capital. Teece mentions that Porter proposed focusing on major research universities and on the role of demand, whereas Saxenian (1994) emphasized people, connections and labor mobility, both domestically and internationally. According to Teece, the reason why all the clusters of startups have emerged in Silicon Valley “is that the minds, the money, and the mojo (startup culture) are present” (p.i.). As a final comment Teece (2014) “emphasizes that genuinely successful global clusters of innovation are geared towards globally scalable companies that are inclined to radical, and not only incremental innovation” (p. i)

Harris (2002) introduces a new concept: hyperinnovation, which describes that suddenly here in the twenty-first century we are faced with fundamentally different industry structures, configurations and patterns like none seen before.

2.8.2 Innovation Diffusion and Creating a Thriving Innovation Ecosystem

Because IEs are very complex entities, it seems difficult to create one. Many believe it would be more efficient to replicate an existing structure in a new location or context and hope that it takes hold. In looking for a model structure, the clear choice is Silicon Valley.

Haines's (2015) Ph.D. dissertation investigates the Silicon Valley phenomenon. Haines describes that many ventures appropriate the name Silicon Valley in attempting to achieve success. These new ecosystem designers aim to emulate the traits known as Silicon Valley, and then make people subconsciously feel like they are in a similar environment.

Table 14 presents all the Silicon-inspired EEs existing in 2015 from Haines (2015). The table also lists some additional ecosystems called either something with "Silicon" or "Valley", found during the literature review, and the website for each innovation ecosystem has been added.

Table 14: Silicon Valley Inspired Names of Entrepreneurial Ecosystems in the World

No.	Name	City	Country	Website – more info
1	**Chilecon Valley**	Santiago	Chile	https://www.seedstars.com/2017/08/08/road-trip-into-chilecon-valley-discover-the-tech-ecosystem-landscape-of-chile/
2	**Dubai Silicon Oasis**	Dubai	United Arab Emirates	https://www.dsoa.ae/en/
3	**Medical Valley**	Nurnberg	Germany	https://www.medical-valley-emn.de/
4	**Medicon Valley**	Oresund	Denmark/Sweden	http://www.mediconvalley.com/
5	**Silicon Allee**	Berlin	Germany	http://www.siliconallee.com/
6	**Silicon Alley**	New York City	USA	https://www.builtinnyc.com/2015/10/12/where-exactly-or-was-silicon-alley
7	**Silicon Beach**	Los Angeles, Venice	USA	http://www.siliconbeachla.com/
8	**Silicon Beach**	Sydney	Australia	http://www.siliconbeachaustralia.org/
9	**Silicon Cape**	Cape Town	South Africa	https://www.siliconcape.com/
10	**Silicon Coast**	Sunshine Coast	Australia	http://digitalsunshinecoast.com.au/

	Silicon Corridor	M4 Corridor	United Kingdom	https://en.wikipedia.org/wiki/M4_corridor
11	**Silicon Fen**	Cambridge	United Kingdom	https://en.wikipedia.org/wiki/Silicon_Fen
12	**Silicon Glen**	Central Belt	Scotland, UK	https://en.wikipedia.org/wiki/Silicon_Glen
13	**Silicon Gorge**	Avon Gorge Area	United Kingdom	https://en.wikipedia.org/wiki/Silicon_Gorge
14	**Silicon Roundabout**	London	United Kingdom	http://www.siliconroundabout.org.uk/
15	**Silicon Savannah**	Nairobi	Kenya	https://en.wikipedia.org/wiki/Silicon_Savannah
16	**Silicon Straits**	Southeast Asia	Vietnam - Singapore	https://www.siliconstraits.com/
17	**Silicon Wadi**	Amman	Jordan	https://jordantimes.com/opinion/editorial/jordanian-silicon-wadi
18	**Silicon Wadi**	Tel Aviv	Israel	https://en.wikipedia.org/wiki/Silicon_Wadi
19	**Tech Valley**	Albany	NY Upstate, USA	https://www.albany.com/hotspot/tech-valley/

Source: Author created with adapted info from Haines (2015)

Further, Haines (2015) developed a framework to illustrate the components that play a role in the attempt to emulate Silicon Valley all over the world. There are nine main abstract components listed in Table 15, and all the components are related to each other.

Three of the nine main components of Silicon Valley's Ecosystem: networks, culture, and people, are also listed by Feeser and Willard (1990), who stated that successful high-tech companies often are established by teams rather than only by individual entrepreneurs.

Table 15: Nine Main Components of Silicon Valley's Ecosystem

1.	Technology
2.	Regulatory environment
3.	Social environment
4.	Infrastructure/Physical environment
5.	Capital
6.	Networks

7.	Culture
8.	People
9.	Practices

Source: Author with info from Haines (2015)

Not all is perfect in the often-mentioned “tech-paradise.” Success in an innovation ecosystem is based on keeping humans happy, and if their happiness decreases, then the system can start to break down. Recently the dominant narrative has shifted to begin questioning whether Silicon Valley is a good place to work, and negative stories have started to emerge about San Francisco’s progressive culture, causing some people to move to other cities with more intellectual diversity (Roose, 2018). A few high-profile people associated with venture capital firms have decided to move, and as people tend to conform to trendsetters, this may set the stage for change. In the last three months of 2017, Silicon Valley had more outward migration than any other city in the country, according to Redfin real-estate data (Roose, 2018).

2.9 Examples of Innovation Index Types or Innovation Studies

This section reviews dominant innovation indices, and the ones selected to be included in the IECO-model will be described in the methodology section in Chapter 3. In order to minimize repetition, the description of the GII 20XX and the GEI 2017 and the details about the WOTC are in Chapter 3.

2.9.1 Global Entrepreneurship Monitor

It is widely acknowledged that entrepreneurship and small businesses drive economies. Roughly half of all formal jobs worldwide in 2016 were created by Small and Medium Enterprises (SMEs) according to data from the World Bank (GEM, 2018a). The Global Entrepreneurship Monitor is a collaboration between Babson College (USA) and London Business School (UK) and is the world’s leading

study of entrepreneurship according to their website (GEM, 2018b). GEM has the following metrics: 18 years of data; 200,000+ interviews a year; 100+ economies, 500+ specialists in entrepreneurship research; 300+ academic and research institutions; and 200+ funding institutions. In each economy GEM analyses two elements:

1. The local entrepreneurial behavior and attitudes of individuals.
2. The national context and its impact on entrepreneurship.

Moreover, all research done in a country is carefully evaluated by local researchers with a deep understanding of the local entrepreneurial environment.

2.9.2 EU Innovation Scoreboard

Since the year 2000, the EU has maintained an Innovation Scoreboard, the EIS, that annually ranks EU countries in terms of innovation abilities. It has four main groups: framework conditions, investments, innovation activities, and impacts, which further is split into ten sub-groups (Hollanders & Es-Sadki, 2017). The EIS ranks all 28 EU countries on 27 indicators and evaluates the countries' innovation abilities. The final result is an innovation score. In 2017 the ranking indicated Sweden was number one, Denmark number two, and Finland number three (EU EIS, 2017).

2.9.3 OECD Eurostat Entrepreneurship Indicators Programme (EIP)

Started in 2006, OECD initiated the Eurostat Entrepreneurship Indicators Programme (EIP), which presents a simplified framework for understanding entrepreneurship. Entrepreneurship outcomes are separated from factors impacting entrepreneurship, which are also distinguished from how entrepreneurship influences the surrounding context. The Programme yields entrepreneurship indicators for each country studied.

A set of indicators of entrepreneurial performance is proposed for understanding and comparing the amount and type of entrepreneurship taking place in different countries. Here 57 indicators all were evaluated into an overall grade based on relevance, accuracy, and availability

2.9.4 Global Innovation 1000 by Strategy&

The yearly Global Innovation 1000 study developed by Strategy& (2018a), a part of PwC Global, is designed as a user-friendly interactive tool that focuses on R&D expenditure and intensity, and revenue, in 1000 companies across the world. The Global Innovation 1000 study shows which companies in which part of the world are innovating and ranks the 1000 most R&D intense companies in the world.

Additionally, Strategy& has developed an Innovation Accelerator tool to evaluate companies' readiness to innovate. Their methodology begins with surveys and progresses to more detailed tools (Strategy &, 2018b). The tool was launched in September 2014 and has gained attention from a broad spectrum of industries.

2.9.5 The Global Startup Ecosystem Ranking

A consulting company called the Startup Genome has created an aggregated index which identifies the 20 most innovative ecosystems. Ecosystems are evaluated over seven pillars that consist of Startup Output Index, Funding Index, Performance Index, Talent Index, Support Index, Mindset Index, and finally Trendsetter Index. The data are gathered through a survey of 10,000 founders across more than 100 cities and 50 countries. This survey is created by Startup Genome and the Global Entrepreneurship Network, along with 40-member cities who support this research financially (Startup Genome, 2017). The top results from their ranking of startup ecosystems were: 1. Silicon Valley, 2. New York, 3. London, 4. Beijing, and 5. Boston.

These five very different rankings of IEs or EEs illustrate the diversity in the current body of knowledge. It may be unclear how to directly compare the rankings and indices, but their diversity provides a fuller picture of the subject matter.

2.10 Introduction to the Entrepreneurial Ecosystem

The ecosystems concept is vital, as it highlights the dynamic and complex nature of entrepreneurial activity. Within the ecosystem, many factors support the development of an EE, though every ecosystem is unique, as is every entrepreneur

To better understand entrepreneurs, we can identify definitions of entrepreneurs and their activity. According to OECD (2010) the definitions are the following:

- **Entrepreneurs:** those persons (business owners) who seek to generate value, through the creation or expansion of economic activity, by identifying and exploiting new products, processes or markets.
- **Entrepreneurial activity**: the enterprising human action in pursuit of the generation of value, through the creation or expansion of economic activity, by identifying and exploiting new products, processes or markets.
- **Entrepreneurship** is the phenomenon associated with entrepreneurial activity.

To ensure that the current research view is not too narrow regarding the definitions above, Brennan and McGowan (2006) are introduced here, and they suggest two more academic definitions for entrepreneurs and entrepreneurship in their paper by (Sharma & Chrisman, 1999, p. 18):

- **Entrepreneurs**: individual or groups of individuals, acting independently or as a part of a corporate system, who create new organizations, or instigate renewal or innovation within an existing organization.
- **Entrepreneurship:** encompasses acts of organization creation, renewal, or innovation that occur within or outside an existing organization.

The difference between the five definitions listed above is fundamental, and it again shows the importance of the research lens in determining the research outcome.

This work uses the OECD definitions above, as briefly mentioned in chapter 2.1, as they focus more on the value-creating aspect for economic impact, which is the focus of this dissertation.

An EE can be defined in several ways, starting from the idea of a biological ecosystem having the functional goal of maintaining an equilibrium-sustaining state. From the global economic perspective, this equilibrium state may never exist; local economics are dynamic, and the global scale compounds this. Therefore, many factors are needed for creating synergies that feed on each other and result in value-creating exchanges. The main goal of this innovation analysis is improving the understanding of what drives innovation, which then leads to value creation through higher GDP and economic impact.

Audretsch and Link (2017) point out that the EE consists of multiple enterprises, organizations, institutions, and individuals, who all act to elevate their own economic performance as well as that of their contacts. They further describe that four areas have emerged for the study of the interactions between those parties, and for investigating the EE, and they are: university entrepreneurship, university technology transfer, the complementary nature of university-based research, and finally university research partners.

Stam (2015) lists the pillars making up a thriving EE, which were first introduced by the World Economic Forum in their Global Competitiveness Report from 2013: accessible markets; cultural support; education & training; funding & finance; government & regulatory framework; human

capital/workforce, major universities as catalysts; and support systems/mentors. Stam (2015) continues with Feld's (2012) list of the nine required attributes for a thriving ecosystem: capital; companies; engagement; government; intermediaries; leadership; network density; support services; and talent. Finally, Stam (2015) presents Isenberg's (2010) list of 9 fundamental principles for building an innovation ecosystem:

1. Stop emulating Silicon Valley
2. Shape the ecosystem around local conditions
3. Engage the private sector from the start
4. Favor the high potentials
5. Get a big win on the board
6. Tackle cultural change head-on
7. Stress the roots of new ventures
8. Don't over-engineer clusters; help them grow organically
9. Reform legal, bureaucratic, and regulatory frameworks

Daniel Isenberg (2011b) in Forbes described the IE and suggested that it has four defining characteristics:

1. Six domains representing 100 elements, grouped for simplification: culture; finance; human capital; markets; policy; and supports.
2. Each entrepreneurship ecosystem is unique.
3. Specifying generic root causes for the entrepreneurship ecosystem has limited practical value.
4. Entrepreneurship becomes (relatively) self-sustaining. (Success does breed success).

When asked whether ecosystems are created or organically occur, Isenberg (2011b) replied that "it is usually a result of intelligent evolution: a combination of the invisible hand, and deliberate local hands." (p. n. a.)

The Aspen Network of Development Entrepreneurs in 2013 evaluated nine different organizations, who have developed tools for evaluating the IE. The organizations are listed below, and a comparison of the diagnostic tools is in Table 16, and the abbreviations in parenthesis are used in the table:

1. Babson College – Babson Entrepreneurship Ecosystem Project (Babson)
2. Council of Competitiveness – Asset Mapping Roadmap (CoC)
3. George Mason University – Global Entrepreneurship and Development Index (GEDI)
4. Hwang, V. H. – Innovation Rainforest Blueprint (Rainforest)
5. Koltai and Company – Six + Six (6+6)
6. GSM Association – Information and Communication Technology Entrepreneurship (GSMA)
7. Organisation Economic Co-operation and Development – Entrepreneurship Measurement Framework (OECD)
8. World Bank – Doing Business (D. B.)
9. World Economic Forum – Entrepreneurship Ecosystem (WEF)

These groups' evaluation of the IE vary widely and can be classified based on the geographic unit of analysis, their level of detail, and their sectoral or domain focus. Some evaluations asses national levels, such as the OECD's Entrepreneurship Measurement Framework, the World Bank's Doing Business ranking, and George Mason University's Global Entrepreneurship and Development Index, and can be used to make cross-country comparisons. The global focus represented in these three tools is especially relevant for this dissertation. In table 16 a "YES" indicates that the index looks into those specific domains in more or less detail.

Table 16: A Review of Entrepreneurial Ecosystem Diagnostic Tools

Domain	**Babson**	**CoC**	**GEDI**	**Rainforest**	**6+6**	**GSMA**	**OECD**	**D. B.**	**WEF**
Policy	YES	YES	YES		YES	YES	YES	YES	YES
Finance	YES	YES	YES	YES		YES	YES		YES
Infrastructure	YES	YES				YES	YES	YES	YES

Markets	YES		YES			YES	YES		
Human Capital	YES	YES	YES	YES	YES	YES	YES		YES
Support/Services/ Connections	YES	YES	YES		YES	YES	YES		YES
Culture	YES	YES	YES	YES	YES	YES	YES		YES
R&D/Innovation	YES	YES	YES	YES		YES	YES		
Quality of Life		YES							
Macroeconomic Conditions							YES		

Source: Author with info from Aspen Network Development Entrepreneurs (2013)

2.11 The Innovation Ecosystem term

This review confirms "that new technologies are seldom if ever developed by a single firm alone in the vacuum of an institutional environment" (Van de Ven, 1993, p. 214). Van de Ven was describing what he called the innovation system, which later was reworded to the innovation ecosystem. Instead, new technologies must be regarded as part of a broader context which is the surrounding system, or infrastructure for entrepreneurship (Van de Ven, 1993).

To date, the central component of innovation studies has been to focus on the ongoing interaction between entities within the IE. Scholars from management have extensively studied the supply side, organizational structures, and industrial economics. Marketing and consumer psychology scholars are focusing on the demand side. To fully understand an IE requires a multi-disciplinary effort, which is challenging. Smorodinskaya, Russell, Katukov and Still (2017) looked into a variety of ecosystems to gain more insight. Smorodinskaya et al. (2017, p. 5247) started their survey with realizing that to gain a complete picture of an innovation-conducive environment one needs to consider both economic literature (system incentives to spur idea generation) and business literature (factors that generate motivation to innovate)." The result of their literature review of existing literature reviews is seen below in Table 17.

Table 17: Smorodinskaya et Al. (2017) Literature Review on the Variety of Ecosystems, 2005-2016

No.	Review	Review source	Review result
1. **2.**	(Peltoniemi, 2005) [11] (Peltoniemi, 2006) [12]	Literature review and conceptual analysis of **business ecosystems** as an organization population model	Dynamics of conscious choice and limited knowledge of an individual organization and from the interconnectedness and feedback loops of an organization's population; differences in cluster and value networks
3.	(Manikas & Hansen, 2013) [13]	**90 papers** relevant to **software ecosystem(s)**	The software industry is moving towards software **ecosystems** with platforms like Google Android and Apple iOS
4.	(Pilinkiene & Maciulis, 2014) [14]	A literature review of ecosystem analogies; **industrial ecosystem, innovation ecosystem, business ecosystem, digital business ecosystem, entrepreneurship ecosystem**	**Ecosystem** analogies have various scopes and objectives having an impact on the micro-level, associated with actions of internal actors; **(eco)system** can be a significant determinant of sustainable economic development
5.	(Gawer, 2014) [15]	Review of management research on technological platforms: industrial economics and engineering design	Platforms operate along an organizational continuum, including firms, supply chains, and **industry ecosystems**
6.	(Gawer & Dusumano, 2014) [16]	Platform-based ecosystem innovation. Review of research on internal and external **platforms**	A critical issue for managers is to learn to manage the evolution of their industry platforms and accompanying **ecosystems** and make interrelated technological and business decisions
7.	(Thomas, Autio, & Gann, 2014) [17]	**183** publications of **platforms** in a management context	Four streams of platform research identified: organization capability, product family, market intermediary, and technology system
8.	(Kortelainen & Jarvi, 2014) [18]	**72** empirical articles on **ecosystems** in the business context	Research on ecosystems is still a long way from the stage of theory testing (i.e., using multivariate statistical methods) or of replication studies across **ecosystems**
9.	(Valkokari, 2015) [19]	Review of types of business, innovation and knowledge	In order to survive and thrive in an **ecosystem**, a variety of forms of interaction are required; the

		ecosystems and the relationships between them	interaction between various types of **ecosystems** is an unexplored area
10.	(Suominen, Seppanen, & Dedehayir, 2016) [20]	**4681 publications** to look at innovations systems literature, **427 ecosystem** research articles	The literature on national, regional and technological innovation systems, as well as literature on corporate competitiveness and the **ecosystem** approach, has both shared and divergent intellectual roots
11.	(Aarikka-Stenroos, Peltola, Rikkiev, & Saari, 2016) [21]	Systematic content analysis of **157 articles** of **innovation and business ecosystems**	Multidisciplinary perspectives exist on **ecosystem** phenomenon; research gaps exist, including a gap in policy-making; the **business ecosystem stream is dominant**

Source: Author with info from Smorodinskaya et al. (2017)

Smorodinskaya et al. (2017) conclude that the ecosystem idea is often applied without clear definitions. They conclude that, "In the age of non-linear innovation and digital technologies, innovation can be better nurtured within a special, innovation-conducive environment. Such an environment may be seen as an ecosystem meant for co-creation of value through collaboration" (p. 5247).

The research review by Aarikka-Stenroos et al. (2016) found 157 papers involving descriptions of ecosystems. For the current dissertation, this list was narrowed to include only papers with the word ecosystem included in the paper title, which reduced the list to 59 papers, and then reduced to the number 53 of different types of ecosystems, see Appendix J. Table 18 lists in alphabetical order instances of the word ecosystem, and the author added additional ecosystem names seen during the literature review. The number rose to a total of 58 different names found for an ecosystem, see Table 18:

Table 18: Ecosystem Types Found In the Literature Review Listed Alphabetically

Types of Ecosystems
1. Apple's Health Kit Ecosystem
2. Artificial Ecosystem
3. Big Internet Business Ecosystems

4. Business Ecosystem
5. Business Innovation Ecosystem
6. City-based Innovation Ecosystems
7. Corporate Innovation Ecosystems
8. Converging Mobile Ecosystem
9. Cybercrime Ecosystem
10. Digital Ecosystem
11. Ecosystem Approach
12. Ecosystem Innovation
13. Ecosystem Model
14. Ecosystem Niches
15. Ecosystem Support
16. Ecosystem of System Communities
17. Enterprise Software Business Ecosystem
18. Entrepreneurial Ecosystem
19. European SME Ecosystems
20. Evolving Ecosystem
21. High-Tech SMEs Centered Ecosystems
22. Hybrid Ecosystems
23. Hyper-Local Innovation Ecosystems
24. Industrial Ecosystem
25. Industry Ecosystem
26. Innovation Ecosystem
27. Innovation Ecosystems
28. Internet of Things Ecosystem
29. Knowledge Ecosystem
30. Knowledge-Based Ecosystem
31. LEGO Producer-User Ecosystem
32. Mashup Ecosystem
33. Mobile Ecosystems
34. Mobile Handset Ecosystems

35. National Innovation Ecosystems
36. Natural Ecosystems
37. Open Ecosystem
38. Open Innovation Ecosystem
39. PC Ecosystem
40. Platform Ecosystem
41. Platform Innovation Ecosystem
42. Platform-Based Business Ecosystem
43. Policy-Driven Ecosystem
44. Regional Innovation Ecosystem
45. Regional Technological Innovation Ecosystem
46. Science Ecosystem
47. Service Ecosystem
48. Semiconductor Manufacturing Ecosystem
49. Space Technology Ecosystem
50. Startup Ecosystem
51. Supply Network Ecosystem
52. Sustainable Ecosystems
53. Sustainable Innovation Ecosystems
54. Sustainable Entrepreneurial Ecosystems
55. Technology Ecosystem
56. Trend-driven Ecosystem
57. University Ecosystem
58. University-Based Ecosystem

Source: Author adapted with info from Aarikka-Stenroos et al. (2016)

Clarysse et al. (2014) studied in depth how ecosystems create value and compared knowledge and business ecosystems. Their comparison identified three essential factors that demonstrate the difference between knowledge and business ecosystems, which are presented in Table 19 below:

Table 19: Difference Between Knowledge and Business Ecosystem

Factor	Knowledge Ecosystem	Business Ecosystem
Focus on activity	Knowledge generation	Customer value
Connectivity of players	Geographically clustered	Value network
Key player	University or Private Research Organization	Large Company

Source: Author with info from Clarysse et al. (2014)

Clarysse et al. (2014) conclude “it is competition between ecosystems, not between individual companies that largely fuels the next round of innovations. Innovation in business ecosystems goes beyond the focus on technological activity alone, whereas a focus on technological activity is characteristic of knowledge ecosystems” (p. 1166). In relation to IEs, in Clarysse et al. (2014) it is pointed out by (Wright, 2014) “that business ecosystems introduce the customer (demand) side which is mainly absent in IEs” (p. 1166).

2.12 Definition of the Innovation Ecosystem

The “IE is an increasingly popular but all too often ambiguously utilized concept across academia, policy, and business” (Ritala & Almpanopoulou, 2017, p. 39). They continue that the “IE is one of such concepts. Reflecting ever-increasing connectivity of innovation activities, it joins the long list of other terms describing the networked and systemic nature of innovation” (Ritala & Almpanopoulou, 2017, p. 39). An IE presents the promising advantage of allowing the collaborating firms to create value which no single firm alone could offer (Adner, 2006).

Below in Table 20, many of the innovation ecosystem definitions that have been found during the literature review are listed alphabetically by the author’s last name.

Table 20: Various Definitions of the Innovation Ecosystem Found in the Literature Review

No.	Definitions	Authors
1	An innovation ecosystem is a "collaborative arrangement through which firms combine their individual offerings into a coherent, customer-facing solution."	(Adner, 2006, p. 2)
2	An innovation ecosystem is an interdependent system of multiple partners.	(Clarysse et al., 2014)
3	An innovation ecosystem is a type of inter-organizational network where multiple partners such as product or service suppliers, providers, and distributors are committed to jointly creating and delivering innovations.	(Hengstler, 2016)
4	In essence, an innovation ecosystem is an assembly of multiple partners (e.g., suppliers, distributors, outsourcers, product or service producers, technology providers, or other organizations) that are committed to jointly developing and distributing innovations.	(Iansiti and Levien, 2004)
5	An innovation ecosystem is a loosely interconnected network of companies and other entities that coevolve capabilities around a shared set of technologies, knowledge, or skills and work cooperatively and competitively to develop new products and services.	(Nambisan and Baron, 2013)

Oxford Analytica Daily Brief (2014) points out that IEs have three defining characteristics. These are:

- inter-dependencies between participating organizations;
- a shared set of goals and objectives; and
- a shared set of knowledge and skills.

Therefore, as seen repeatedly, many factors are needed for creating the synergies that feed on each other and result in a value-creating exchange.

IEs are called geographic clusters of high productivity and business diversity based on technological innovations. “In IEs, which consist of numerous actors in different layers, actors’ decisions may cause counter-responses from other actors. This behavior is multiplied in complex interdependencies across the ecosystem” (Ritala & Almpanopoulou, 2017, p. 39). The best example of this is Silicon Valley in California, where everything an entrepreneur will need for starting a company is in the immediate surroundings, such as intellectual capital, talent pool, financial capital, resource providers, support organizations for assistance in the various stages, advocates, champions, media, and news outlets. Entrepreneurial support organizations and business incubators are essential entities in an IE.

In their 2016 book *A Silicon Valley Model – Management for Entrepreneurship*, (Steiber and Alange, 2016) investigate what makes Silicon Valley so outstanding. The book compares the traditional management model and the Silicon Valley model, and the differences in the style are very apparent. The points of contrast are listed in Table 21 below.

Table 21: Comparison of Traditional and Silicon Valley Management Model

Elements	Traditional Management Model	Silicon Valley Model
Strategic intent of top leaders	Cost and profitability	Innovation and growth
Main focus of top leadership	Internal	External
People	Valued for operational competencies	Valued for entrepreneurship as a core competence
Culture	Emphasizes efficiency, low risk, control, and quality	Emphasizes uniqueness, risk taking, adaptability, speed and fast learning
Leaders	Managers. Set direction and priorities. Instruct what should be done and, in many cases, how it should be done. Follow up, check and control.	Coaches and facilitators. Together with the teams, set direction and priorities but leave the HOW to the team members. Facilitate and coach the team in reaching goals.

Organization	Bureaucratic, highly structured, hierarchical. Use of larger work units. Vertically distributed decision power. Mostly focused on internal innovation.	Organic, semi-structured, flat. Use of small teams. Selective decentralization. Temporarily, decision power can be centralized to the top. Focused on both internal and external innovations.
Coordination mechanisms	Through standardization of work processes, job descriptions, and skills.	Through compelling vision, shared values, simple rules, and key priorities.
Automated information processes	Lower degree. Cost of communication is lower.	Higher degree. Cost of communication is high.

Source: Author with info from Steiber and Alange (2016)

The book investigates further how Silicon Valley's management practices compare to those called "*Six Basic Principles for a Changing World*" (Steiber & Alange, 2016, p. 20), which is a list of principles distilled from a vast body of management research on what makes a firm competitive for the long term in rapidly changing environments. According to Steiber & Alange (2016), Silicon Valley does exhibit those six basic principles.

Silicon Valley is always referred to as the perfect ecosystem, and therefore the Six Basic Principles for a Changing World can help in determining the attributes of a good IE, and they are listed below:

1. Dynamic capabilities
2. A continually changing organization
3. A people-centric approach
4. An ambidextrous organization
5. An open organization that networks with its surroundings
6. A system approach

Reviewing the six principles and comparing them with the attributes of Silicon Valley, it is seen that all six basic principles are represented in Silicon Valley.

Petersen (2011) states that the perspective of the National Science Foundation is IEs are primarily part of a university. The characteristics of a quality IE that NSF points out are the following:

- University research is vital, often driven by industrial needs.
- The faculty is involved along the innovation continuum, working with industry at all stages.
- A focus on translational research smoothes the handoff of technology from universities to industry—resulting in rapid, efficient innovation.

According to Spruijt (2015) owner of the consulting company Innovative Dutch, the IE is one of the most under-researched topics. Through his Dutch consulting firm, he has created one of the most complex infographics of the Innovation Ecosystem, this dissertation author has so far seen. It is named “Schematic Overview of Innovation Ecosystems” (Innovative Dutch, 2016), and it is in Appendix K, Figure 48. It illustrates that the IE is a complex system, and an extremely convoluted entity with many interested parties, flows, and ongoing relations. Figure 48 is difficult to display in the dissertation format, due to it being visual complex and is therefore presented in the Appendix K. It was not meant to be studied in detail, it is merely a visual example of how complex and visually convoluted an IE easily can become.

2.13 Societal perspective of the entities in an innovation ecosystem

Rabelo and Bernus (2015) created a foundational masterpiece for gaining the understanding of what an innovation ecosystem entails in relation to the society in their paper “A Holistic Model of Building Innovation Ecosystems.” This paper cited OECD(2010) and Carayannis (2012) who emphasize “that fostering innovation has become a mandated task on the agenda of most governments, universities, companies, professionals and the civil society as a means to facilitate the coping

mechanisms of society in light of a number of economic, social and ecological issues." (p. 2250). Rabelo and Bernus (2015) agree that combined forces have pushed society to put more emphasis on innovation, and mention a set of issues important to society, which initially Mercier-Laurent (2011) and Jackson (2011) pointed out, see the adapted list:

- Dealing with tougher competition in today's globalized market
- Boosting the economy and fostering new opportunities arising as a result of technological advances
- Improving efficiency in the development of new products and industrial equipment
- Improving production and distribution processes
- Dealing with the increasing scarcity of natural resources and global warming
- Addressing unemployment of young people
- Improving how to handle social inclusion.

The origin of innovation capabilities might be based upon a country's need to compensate for a lack of natural resources. In addition to inspiring innovation, a lack of natural resources possibly also inspired wars in order to claim resource-rich land, when stealing the resources was not an option. The Vikings can be used as an example, while they invaded and conquered the countries with resources they needed, thereby fighting to "legally" have access to those resources.

Another example of a lack of natural resources inspiring creativity and innovation is seen in Denmark. The Danish culture is founded in the Christian Protestant belief that hard work is the will of God, and nothing comes to people without first having worked hard to gain it. This philosophy has served resource-poor countries well, as they have worked themselves out of poverty that would have resulted, if they had based their income only on the few natural resources in their country. Innovation has then become a result of necessity. This leads to the discussion of what cultural values and traditions in a country impact an entrepreneur.

Innovation is considered an important global solution for creating wealth and prosperity by both governments and businesses. According to the Council of Competitiveness (2005, p. 36), economists estimate that nearly 50% of U.S. GDP growth over the past 50 years is attributed to the productivity that innovation generates. For the past two centuries, the U.S.has been the world leader in developing innovative products and services, but that is not the case any longer. Many other countries are now considered just as or more innovative than the United States, and in this dissertation, this fact will be seen in detail in the next chapters.

2.14 Examples of Innovation Ecosystems

The IE can be seen from many different angles and lenses. Angle no. 1 is the platform view, or a corporation's view, in which an industry creates the basis for all the surrounding entities in the ecosystem; angle no. 2 is the local innovation ecosystem for a geographical area, program or a university.

2.14.1 Silicon Valley

Silicon Valley is a perfect example of a geographical area where the IE is thriving, and according to Engel (2014), like all economic hubs, Silicon Valley is home to many leading global enterprises. Silicon Valley is the leading example of a high-technology entrepreneurial environment (Saxenian, 1994). Tech companies are flocking to this area, for several reasons, primarily due to the significant funding opportunities. Research about groups also helps explain this: one reason to form and join groups is to access the diverse resources of multiple partner organization to achieve complex objectives like innovation (Davis, 2016). Alone an individual would in most instances have accomplished less, or had less creative inputs than if that individual had been part of a research, study or even social group. This point is further being supported by Watts and Gilbert (2014, p. 9) "each innovation builds incrementally

on a long history of prior innovations", and communication and inspiration from others are vital in such a creative process.

According to DiGiorgio & Harris (2013), an interesting fact is that even with a well-functioning ecosystem (the world's best according to many researchers) like Silicon Valley, only 10% of the companies that start the process actually gain funding. It can take up to 6-7 years before the company is mature enough to have real success in the market. This vital metric is often overlooked. Even in this "perfect" IE, it is not possible for a company to skip the maturing process. However, this IE does shorten this maturing phase and helps the company avoid the Valley of Death, which is the time, where there is no income for the company but still costs such as to product development, labor and much more.

2.14.2 Massachusetts Institute of Technology, MIT

Massachusetts Institute of Technology, MIT, also has a strong IE. The IE is decentralized, and there are frequent meetings at several campus locations that entice and energize the students, the faculty, and the community to be aware of the impact of innovations. The Boston entrepreneurial community is like a humming beehive; at every corner of the city, due to the approximately 100 universities in close proximity, something related to entrepreneurship or innovation happens nightly, often with the aim of helping entrepreneurs to get formally started with their idea or concept.

2.14.3 University of Central Florida, UCF

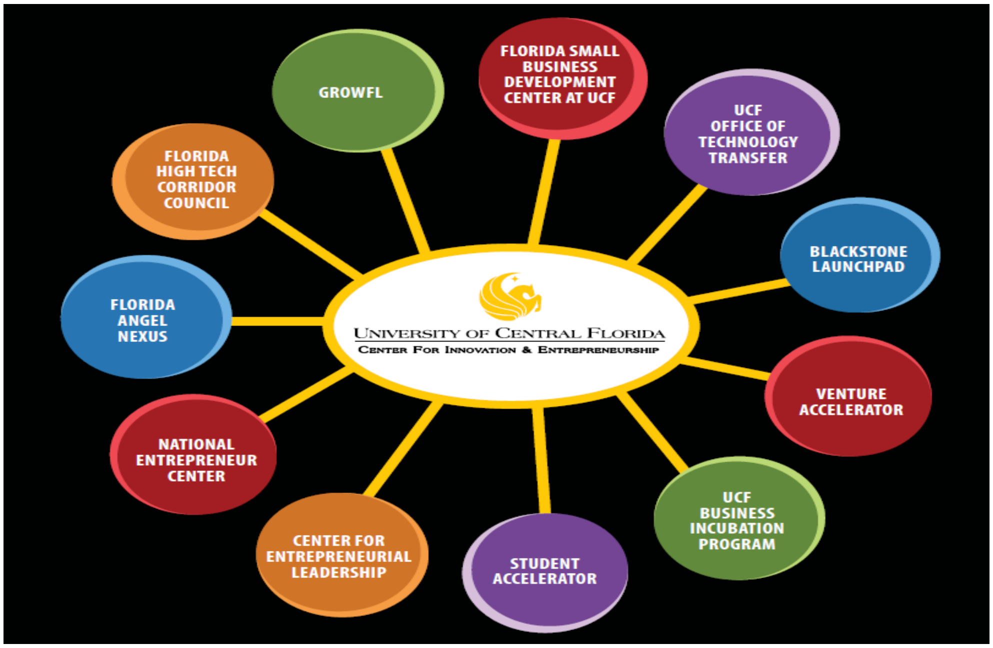
Universities are playing an increasing role in their communities and countries as a catalyst for venture creation. They are the seedbeds for the knowledgeable talent and research which later can be commercialized and taken public if deemed ready. Universities are also an essential factor in creating economic impact, and therefore have an obligation to the public to prioritize transferring knowledge and research into social applications.

Knowledge transfer from universities to the broader public is a critical process, and it is one that universities work to improve.

Universities support interest groups focused on spreading the entrepreneurial spirit, and these groups' membership range from students and faculty to global actors disseminating information about entrepreneurial research. The goal is to foster the entrepreneurial spirit at all levels so that ideas can be nurtured and brought to the market.

In the Greater Orlando region, the University of Central Florida (UCF) has taken an active role, often filling gaps in the local entrepreneurial environment, to induce venture creation and influence the IE. UCF is a partner in the regional economic development agenda in a number of ways that range from academic to very practitioner-based activities. The University offers undergraduate and graduate tracks and several certifications in entrepreneurship, and recently added many new entrepreneurial centers on campus, which primarily focus on encouraging and vetting entrepreneurial efforts accomplished by students.

UCF has through the last 18 years continuously worked on improving the process of moving ideas from university labs to the market and also helping ideas from the community grow and flourish. UCF has created or partnered with a suite of Entrepreneurship Support Entities (ESE) from the community to provide entrepreneurial assistance in all of a company's many development stages. There is an ongoing process of continually optimizing and improving the entrepreneurial efforts at UCF, and changes occur rapidly. The UCF community at large, including the university's president, has seen the impact of the efforts, realizes the vast potential, and understands UCF's engagement with entrepreneurship matters tremendously for the broader community. The Center for Innovation and Entrepreneurship, CIE, was created to be the hub of this support system. CIE is a centralized connection point for all entrepreneurial activities connected to UCF. The CIE structure is shown in Figure 7.



Source: UCF CEI (2014)

Figure 7: UCF's entrepreneurial ecosystem in 2014

This organizational construction has been working for several years now. In creating the CIE, UCF aligned and divided entrepreneurial support efforts over many independent entities under one umbrella. This has been fruitful, while aligning the entrepreneurial activities at UCF and strengthening the branding effort by having only one entity to refer to. The community can better follow the many exciting developments at the UCF CIE, where the information is given at a high-level perspective. Entrepreneurial engagement becomes more of a one-stop shopping experience, where the entrepreneur starts here and then finds out where to go for more information.

2.14.4 Example of a Corporate Innovation Ecosystem

Figure 8 depicts a very illustrative image of the corporate IE which was created by Innovation Leader (2017), a Boston management consulting firm focused on innovation. The way the IE is illustrated here, the core business is the source of profit and power, and when things are going well, there usually

is little interest in innovation. New innovation initiatives tend to sit at the edge of the business without the same resources or attention as the core of the business.

The internal innovation team tries to create their own startup ecosystem in an effort to get in contact with the creative environment surrounding the company. The "lean-startup" model is a proponent for more customer engagement, and even if it does not lead to new inventions, it at least points to stronger relations between customers and the company, which is always a great thing (Innovation Leader, 2018). Figure 8 conveys the intricacies that real life brings to the IE with all the many levels of engagement and the various stakeholders, while using a pleasant and accessible graphical format.

Source: Innovation Leader (2018)

Figure 8: Example of a corporate innovation ecosystem

2.15 Vital Components of the Innovation Ecosystem

There is some confusion in regards to what the difference between the EE and the IE is, because there are some considerable overlaps. The EE has a bit more focus on the individual entrepreneur and everything is revolving around the individual entrepreneur to optimize their assistance, but again the difference is very fluid.

Leon and Martinez (2016) posit that “IEs are becoming important poles of knowledge generation and diffusion” (p.1). Their paper focuses mainly on the university-generated IE, but for the sake of this dissertation, their ideas can easily be generalized beyond the university environment. They state that the current techniques for measuring performance of microstructures within an IE are insufficient if we want to measure the system as a whole rather than an aggregation of previous structures. Finally, “a set of qualitative IE dimensions is proposed, which are translated into metrics that make up a model for calculating the relevance of an ecosystem” (Leon & Martinez, 2016, p. 1). The eight dimensions are listed below:

1. Industrial Empowerment
2. Technology Specialization
3. Users’ involvement
4. Long-term commitments
5. Geographic Scope
6. Public Support
7. Openness
8. Sectorial specialization

Leon & Martinez (2016) list three factors to analyze to ensure relevance for the innovation ecosystem:

1. Attractiveness – ability to convince private and public entities to belong to this specific IE
2. Concentration – of member entities to ensure the critical mass of activity is reached

3. Proximity – to engage in all relevant IE related activities

Additionally, two other variables are taken into account to evaluate the IE: the national/regional interest in innovation; and the level of support offered to the members of the IE by public authorities (both direct and indirect measures) (Leon & Martinez, 2016, p. 7).

2.15.1 Accelerators – Entrepreneurial Support Organizations/Programs

Accelerators are the newest type of support organization. They are fast-paced, intensive programs where selected companies with very promising business ideas get help to start their companies within three months or so.

Accelerators stimulate a specific environment and mentality, and Haines (2015) created a list of 17 cultural attributes the accelerators promote: accepting failure, accepting imperfection, collaboration, confidence, egalitarianism, empathy, experimentation, extraversion, flat hierarchy, honesty, networking, openness, paying-it-forward, resourcefulness, taking risks, unruliness, weirdness/creativity. A successful entrepreneur would probably have these attributes.

In 2017 the U.S. accelerator program, Y Combinator, was ranked the best accelerator in the U.S. According to Forbes (2017), Y Combinator receives more than 5,000 applications for each round of classes. The interest is enormous because companies know that joining the program predicts surviving and thriving. The connections gained from joining such a program are valuable. Good connections to angels, venture capitalists, good lawyers, marketing companies, and more are needed for the company to succeed. Forbes (2017) mentions that the average accelerator program takes 6% equity in every company in their classes. Y Combinator does not disclose what they take in equity, but many companies are willing to make this deal. In the Y Combinator's innovation ecosystem, all service providers, resources, coaches, and mentors are vetted and trusted, and if a company becomes a part of this exclusive club, they are valued as very promising. It becomes a self-fulfilling prophecy, and a stamp of

approval, for the companies when having been a part of the Y Combinator. The chosen companies are seen as being part of the "elite," and as companies that should be kept an eye on. They are expected to deliver rapid growth results, and some even become a Gazelle company, with exponential growth.

2.15.2 Business Incubation or Business Incubators

The Telefonica Report created by Salido, Sabas, and Freixas (2013) describes very nicely what business incubators, accelerators, and other entrepreneurial support organizations do for new companies as part of the IE:

> Accelerators, incubators and so-called 'company builders' are innovative investment vehicles and business service providers that have made a novel contribution to advancing entrepreneurship around the globe, helping an entire generation of young companies, and particularly high-tech startups, to grow, prosper and thrive. These startup programmes have become many young companies' principal source of knowledge and support; they are in a position not just to help the needy, but to encourage the worthy" (p. 3).

Salido, Sabas, and Freixas (2013) conclude the Telefonica Report by focusing on how much startups contribute to society. They emphasize five areas in which startups contribute to the general economy besides employment, which normally receives all the focus. The areas are foreign investments, taxes, tech transfer, third-party services, and talent acquisition (Salido et al., 2013).

2.16 Creating innovation models with simulation

Scholl (2001) reminds us that all science is creating models of "the world" or of the "perceived/constructed world" depending upon the scholar's or discipline's starting point.

Various scientists have modeled the economy as a dynamic system, including Nelson and Wilson in 1982. First, the basic idea underlying the Nelson and Wilson models is that a "verbal account of

economic evolution seems to translate naturally into a description of a Markov process – though one in a rather complicated state space." (Sloth, Jensen, Madsen, & Joergensen, 1996, p. 1).

Simulation modeling has according to Grigoryev (2015) six key advantages:

1. Simulation models allow you to analyze systems and find solutions where methods such as analytic calculations and linear programming fail.
2. Once you have chosen an abstraction level, it is easier to develop a simulation model than an analytical model. It typically requires less thought, and the development process is scalable, incremental, and modular.
3. A simulation model's structure naturally reflects the system's structure.
4. In a simulation model's structure, values can be measured and entities tracked within the level of abstraction, and measurements and statistical analysis can be added at any time.
5. The ability to play and animate the system behavior in time is one of simulation's great advantages. Animations are useful for demonstrations, verification, and debugging.
6. Simulation models are far more convincing than Excel spreadsheets. If simulation is used to support a proposal, it will bring a major advantage over those who only use numbers.

Watts and Gilbert (2014a) say an advantage to innovation simulations "is that we can conceive of and examine alternative explanations, and we are freed from linear models" (p. 244). Watts and Gilbert (2014a) continue that we are released from assuming there must be one single point of origin for an innovation.

Due to system dynamics (SD)'s ability to model complicated systems with many variables, it becomes the best tool to visualize the innovation ecosystem.

Sterman (2010) mentions ten reasons why dynamic complexity arises in systems, and it is because the systems are:

- Adaptive
- Characterized by trade-offs
- Constantly changing
- Counterintuitive
- Governed by feedback
- History-dependent
- Nonlinear
- Policy resistant
- Self-organizing

Rilla & Oksanen (2016) point out that “Ecosystems are today’s concept of innovation networks that facilitate collaboration and make innovative companies increasingly affected by the interaction of factors outside the company” (p. 1). It is essential to understand how IEs develop, given that they evolve dynamically over time from a pioneering/expansion stage to a stage of authority/leadership before maturing to a renewal stage in which the aim is to prevent ecosystem death (Moore, 1993).

When modeling bigger models, it is important to separate detail complexity from dynamic complexity, according to Peter Senge (1990) in his book *TheFifth Discipline: The Art and Practice of The Learning Organization*. Senge (1990) continues that the real leverage in most management situations lies in understanding dynamic complexity, not detailed complexity. Dynamic complexity is when an action has one set of consequences locally, and a very different set of consequences in another part of the system, possibly at a much later time period.

2.17 Modeling with system dynamics

Watts and Gilbert (2014b) conclude that "computer simulations models have been proposed as a tool for understanding innovation, including models of organizational learning, technological evolution, knowledge dynamics and the emergence of innovation networks" (p. 189).

System dynamics modeling was invented by Jay Forrester in 1950 when he was a professor at MIT. He wanted to be able to model long-term, strategic, dynamic systems. With his science and engineering background, and using the laws of physics and electric circuits, he created this new method to look into economic and social systems.

According to Barlas (1996), the type of modeling that will be done in the following is in the category of white-box models, as it is design-oriented and causal-descriptive and is a set of statements on how real systems actually operate in some aspect. Generating an "accurate" output behavior is not sufficient for model validity. According to Barlas (1996) a white-box model, being a "theory" about the real system, must not only reproduce/predict its behavior, but also explain how the behavior is generated, and possibly suggest ways of changing the existing behavior.

Barlas (1996) suggests six steps for a typical system dynamics study:

1. Problem identification
2. Model conceptualization (construction of a conceptual model)
3. Model formulation (construction of a formal model)
4. Model analysis and validation
5. Policy analysis and design
6. Implementation

Scholl (2001) concludes that SD models are feedback-based modeling systemic problems at an aggregated over time. The model is the result of the modelers abstraction level and the model can be used to explain those ideas present in the minds of the modelers.

Table 22 presents a comparison of existing research methods versus a system dynamics method of analyzing technological innovation done by Kim and Choi (2009). Table 22 demonstrates the advantages of using SD for testing new innovation scenarios:

Table 22: Comparison of Statistical Versus System Dynamics Approach

Focus areas	Statistical Approach	System Dynamics Approach
Ways of Inference	Previous empirical data	Logical causal relationships among variables
Analysis Subject	Static & partial behavior	Dynamic & holistic behavior
Analysis Focus	Correlation Relationships	Feedback Relationships
Analysis Purpose & Method	Numerical Accuracy & Regression/Econometric Analysis	Structural Accuracy Causal Loop Diagram, System dynamics
Prediction	Short-term Prediction	Long-term Prediction
The Experiment of Various Policies	Difficult	Easy

Source: Author adapted from Kim & Choi (2009)

Hyperinnovation (Harris, 2002) describes that a more interdependent world means a more complex world. The book suggests that the better way to comprehend how this new era functions is through the science of complexity. As complexity science is concerned with how a large amount of data, or number of agents behave as a whole, it thereby gives an extraordinary insight into the business world and the dynamics of innovation. Harris (2002) reiterates known factors underlying innovation:

1. All innovation is inherently chaotic, and therefore uncertain.
2. New tasks often grow at exponential rates.
3. The spontaneous and unexpected are the norm for innovation.

4. Large groups of interacting autonomous agents produce a whole that is greater than the sum of the parts.
5. Simple rules breed complex behavior and profound emergent structures.
6. A bottom-up organization is more flexible and responsive.
7. Feedback enables learning and adaptation, and in turn, self-organization.

Grigoryev (2015) points out that system dynamics is a methodology to study dynamic systems and suggests the following:

- Model the system as a causally closed structure that defines its own behavior.
- Discover the system's feedback loops (circular causality) whether the flows are balancing or reinforcing. Feedback loops are the heart of system dynamics.
- Identify stocks (accumulations) and flows that affect the system.

It is therefore very appropriate to use SD to study the IE which consists of many relationships. In this research, the parameters in the model are given country-specific values that are found in carefully chosen data-sources representing economic development and growth in a country, and surveys focusing on the cultural aspects of human life.

2.18 Existing SD innovation models

In the literature review, SD models exist for simulating parts of innovation in society or a system. Kim & Choi (2009) created an SD simulation for dynamic technological innovation, focusing on manufacturing processes, and the resulting model is a large, complex system flow diagram. Milling & Maier (2011) investigated innovation diffusion with SD modeling, including feedback structures driving innovation processes. To create a picture of innovation, many entities are always involved. Many others have made SD models for some part of the area of innovation, but there has never been a focus on the user experience. The model results have always driven the model design.

In this research, the resulting IECO-model might not a very close representation of reality. The model's advantage is that it emulates the multitude of inputs that in reality influence an IE. Input from many entities acts synergistically to create something bigger than the single entities could have done by themselves. The IECO-model represents a step in a new direction for designing innovation models

This review examined SD innovation models to investigate whether anyone previously had the idea to study innovation on a conceptual level as it is done here. The goal of this research is to create a model for experimentation with various variables and data values while maintaining user-friendliness. This work aims to create a user experience in which only a moderately simple introduction to the IECO-model and its functionalities is needed in order to use the simulation model.

The most time-consuming part of using the developed IECO-model is finding reliable data sources and entering them into the model. Removing and adding nodes is relatively simple, which makes it an excellent tool for experimentation. A next version of the model can implement different methods for inserting data into the model.

2.19 Chapter summary

After having reviewed the body of knowledge in several research areas and having gained a greater understanding of the essential entities in the IE, the modeling phase could begin.

Some of the results from the review were the following:

- Identified the index, the GII 20XX, that was the primary inspiration for the nodes to be included in the IE
- Identified 104 relationships between innovation and other activities/entities to review further, and stopped at this level to avoid too many nodes and clutter in the model
- Identified the preferred data source collections to use for the parameters

- Concluded after studying the current body of knowledge that an IE designed for experimentation was not available to the public
- Realized some entities were more important to an IE than others, and that they were foundational pillars
- Clarified that the best example of a perfect innovation ecosystem is so far still Silicon Valley, but many new areas/cities are starting to understand what the “magic” in Silicon Valley entails, and are becoming successful after nurturing those found traits
- Reinforced that an entrepreneur’s personal qualities and the cultural values they have as a part of their heritage are essential for success
- Confirmed that no single definition is widely accepted for an IE
- Confirmed that no single definition is widely accepted for innovation
- Discovered that the IE research area is vast, and there is still more to explore

CHAPTER 3: RESEARCH METHODOLOGY

3.1 Introduction

In the present chapter, all the steps in IE model development will be described in detail from initial idea to finished model.

3.2 Research objective

The primary objective of this dissertation is to model the IE. The secondary objective is to create a dynamic innovation index, which is the final output of the model and will rank the investigated countries' innovation and entrepreneurship level. The tertiary objective is to improve the understanding of the IE in general.

3.3 Research Overview

The present research has an explorative nature and aims to contribute to the theories about innovation and innovation ecosystems and therefore also indirectly technological change. The purpose is to develop a new approach to modeling the innovation ecosystem considering its complexities and cross-country cultural and entrepreneurial variation.

The modeling approach is one of system dynamics, which allows for conceptual modeling while studying indirect effects. It also enables easy model experimentation using design modifications such as changes in node positions, flows, and variable and parameter variation.

The relationship between innovation and all actions that have an impact on the level of developed innovation was searched for in a literature review. Figure 9 shows the research overview and illustrates that five primary parallel research paths were reviewed to design a novel IE model.

A wide variety of relevant scholarly entrepreneurial and innovation related papers, innovation indices, official governmental reports, consulting reports from renowned research and data providers, such as the

Figure 9: Research overview

World International Patenting Office (WIPO), OECD, UNESCO, UN, and World Bank were reviewed here. The starting point for the search for factors affecting innovation were the seven pillars and many indicators in the Global Innovation Index (GII), which appear in Figure 11. More details about the GII 20XX are in chapter 3.5.1. The primary purpose of this literature review was finding articles/papers which could support a relationship between the pillars or indicators in the GII and innovation. Additionally, for the past eight years, the author of this paper worked in entrepreneurship-related positions assisting and mentoring entrepreneurs. This first-hand experience provides a good understanding of the essentials of entrepreneurship and confirms of many of the scholarly papers describing the characteristics and skill sets of entrepreneurs.

This literature search revealed 104 relationships between innovation and factors influencing it. Each relationship is a potential model node. The list of the 104 found relationships can be studied in Appendix D. The 104 relationships were then evaluated, and some were found too similar to each other and had to be eliminated. Relationships for which it was not possible to find reliable data sources were also taken out of the batch. The final relationship batch was minimized to 91 relationship nodes. These relationship nodes were used for the variables/nodes in the actual IE model development.

The current innovation ecosystem model is comprised of system dynamic and dynamic and static variables, and the outcome is the innovation index (DII). The final model based on 91 relationships or nodes is called the IECO-model. It has 43 parameters and calculates the index for 32 chosen countries of widely-distributed GDPs, in order to relate innovation to the country's wealth.

Three sources provided the data used to run the current model: the Global Innovation Index (GII) from the years 2011-2017, the Global Entrepreneurship Index (GEI) 2017, and the survey results from the acclaimed book "*A World of Three Cultures – Honor, Achievement and Joy"* (WOTC). The WOTC book is built around the "World Values Survey" as well as several other socio-economic surveys. It is a collection of social science-focused surveys conducted in 100 countries from 1981 to the present.

The choice to use this particular combination of hard data, composite indicators from international agencies, and compiled survey results focusing on the cultural impact on entrepreneurs' actions, is derived from an extensive literature search. This particular combination of data is useful for understanding the innovation ecosystem as it relates to entrepreneurial characteristics, specifically entrepreneurs' abilities and culturally inherited advantages/disadvantages.

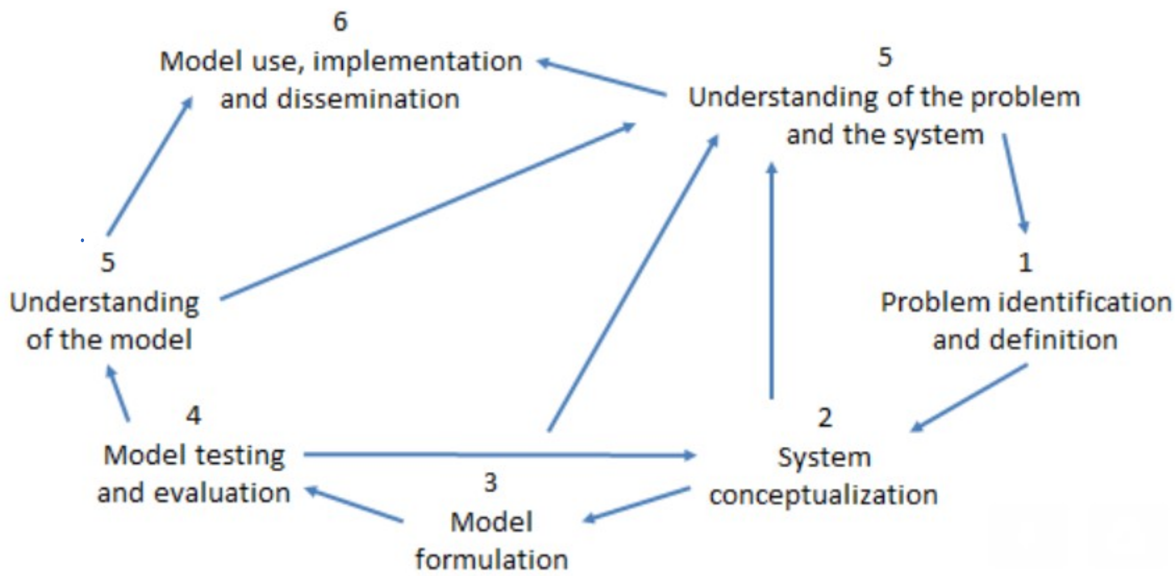
The resulting Dynamic Innovation Index (DII) characterizes countries' innovation and entrepreneurship. The DII is a novel perspective on innovation in global economies because it has a larger focus on relationships that are related to an entrepreneur's abilities, skillsets, cultural heritages, and actions in a country; the index also focuses on the country's current knowledge level and economic abilities. In the DII, 19 of the 43 entered parameter datasets for each country are related to the entrepreneurs' personal qualities.

3.4 Methodology

This research is explorative and will follow the path that is set out for a system dynamic model building process. Barlas (1996) suggests six steps for a typical system dynamics study:

1. Problem identification
2. Model conceptualization (construction of a conceptual model)
3. Model formulation (construction of a formal model)
4. Model analysis and validation
5. Policy analysis and design
6. Implementation

Here, Barlas' six steps are modified, as illustrated in Figure 10 below, where the SD modeling approach is adapted from Martinez & Richardson (2001) who took offset in Barlas' original six steps.



Source: Author adapted from Martinez & Richardson (2001)

Figure 10: Overview of the SD modeling approach

The research approach for the current model-building process is as follows:

1. **Problem identification and Definition**

- Review the current body of knowledge of definitions for innovation and innovation ecosystems
- Review the existing literature on innovation and what influences it. Research topics such as; economic growth, entrepreneurial success factors, cultural heritage, indices, rankings, and innovation ecosystem literature, in the effort to understand the mechanisms, components, and elements of such a complex network
- Review the current literature on simulation of innovation and innovation ecosystems
- Review the existing body of knowledge on system dynamics modeling on innovation
- Scrape the internet and databases for scholarly relationships among innovation and factors, or activities influential on innovation, starting with the indicators in the Global Innovation Index

2. **System conceptualization (construction of a conceptual model)**

- Develop a model of innovation processes within an innovation ecosystem inspired by system dynamics modeling techniques with the focus on creating a model suitable for experimentation
- Search for the relationship between innovation and actions (104 relationships were found)

- Study the relationships in regards to whether data for each of them would be accessible (In 13 of the relationships, the quality of the data possible to find was low, and in some situations, it was not possible to find any collected data from vetted resources. The final number of relationships was then reduced to 91)

3. Model formulation (construction of a formal model)

- Use the 91 relationships found in the literature review to design the nodes and flows in the model
- Find the nodes that do not have any incoming flow, which is equal to a dynamic equation = 0
- Create for all the 43 nodes that do not have any incoming flow a parameter
- Find appropriate data sources for the variable parameters by referring to the previous literature
- Normalize those data sources not yet normalized, and enter data into the model for each of the 32 chosen countries
- Create the stock variables. The Global Innovation Index is an index that has existed since 2007, but since 2011 only a few indicators have been replaced or improved. 18 parameters of the 43 were retrieved from the Global Innovation Index data collection
- Evaluate the data sources to find that only three parameters from the 18 GII parameters had reliable data that had been collected uniformly in the 7-year collection period, and turn those parameters into three stock variables for the model
- Create a dynamic innovation index with a novel perspective, where the entrepreneur's heritage and culture will be more prevalent compared to currently published innovation or related indices

4. Model testing and evaluation

- Compare the developed dynamic innovation index (DII) with existing innovation indices

5. Understanding of the problem and the system, and the model

- The IECO-model allows for experimentation with the model design, and variation of the size of the variables and parameters. It is a very user-friendly model
- The DII gives results that are in the range of other innovation indices, which supports the validity of the IECO-model. Further validation is not currently possible, as this model is the first of its kind

6. Model use, implementation, and dissemination

- The use, implementation, and dissemination of the IECO-model will be determined in the future

3.5 Data sources for the model formulation

The following section contains a short description of the data sources used in the model construction and the indices that are used for comparing and evaluating the final results.

3.5.1 The chosen data sources to enter into the model

Three data sources stood out in the literature review. First was the Global Innovation Index 2011-2017, and second the Global Entrepreneurship Index 2017, and finally the World Values Survey along with other survey data sources compiled in the book *A World of Three Cultures – Honor, Achievement, and Joy*. These were selected because their data were available, they were from highly respected researchers, they had longitudinal data, and they had data from many countries, including those that are the focus of this paper. In addition, the sources included reliable explanations of their data. This information was very valuable later in the process while choosing which sources to retain from the parameter values. More details about these three data source collections are discussed below.

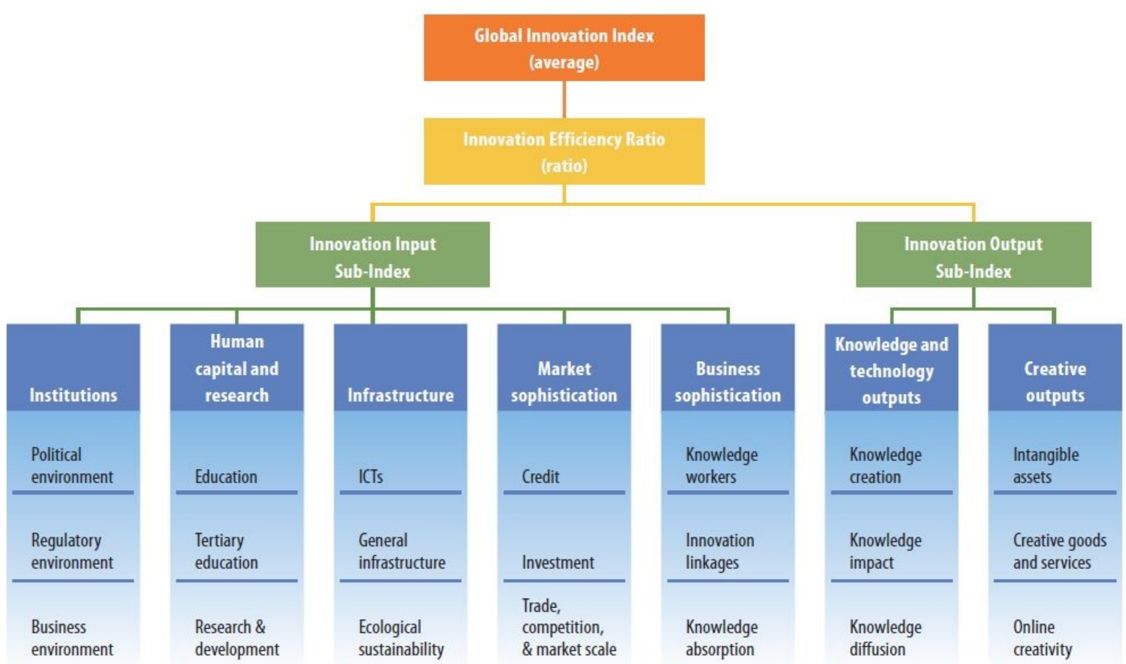
3.5.2 The Global Innovation Index 20XX

The Global Innovation Index (20XX) – GII (20XX), is considered one of the best indices to evaluate the level of innovative forces in a country. The number of index indicators and the number of countries ranked have varied a bit since 2007. In the latest index GII (2017), 127 countries are evaluated and ranked, and 81 indicators are chosen to describe the innovation level. Table 23 below shows how the index has evolved over the years.

Table 23: Collection of All the GII 20XX

Global Innovation Index						
Years	**Countries**	**Input Pillars**	**Output Pillars**	**Indicators**	**Data Included**	**Indicators**
2007	107	5	3	84	NO	84 used first time
2008-2009	130	5	3	90	NO	6 additional
2009-2010	132	5	2	60	NO	30 fewer
2011	125	5	2	80	YES	20 additonal
2012	141	5	2	84	YES	4 additional
2013	142	5	2	84	YES	Same
2014	143	5	2	81	YES	3 fewer
2015	141	5	2	79	YES	2 fewer
2016	128	5	2	82	YES	3 additional
2017	127	5	2	81	YES	1 removed

Since the GII (20XX) was first created in 2007, the conceptual framework relies on two sub-indices, the Innovation Input Sub-Index and the Innovation Output Sub-Index, each built around seven pillars. The GII (2017) is the tenth year this index was published, and the content in the pillars has changed over the years.



Source: GII (2017, p. 11)

Figure 11: Framework of the Global Innovation Index 2017

Figure 11 shows the current GII framework, which has five input pillars capturing elements of the national economy that enable innovative activities: (1) Institutions, (2) Human capital and research, (3) Infrastructure, (4) Market sophistication, and (5) Business sophistication. Two output pillars capture evidence of innovation outputs: (6) Knowledge and technology outputs and (7) Creative outputs.

Each pillar is divided into sub-pillars, and each sub-pillar is composed of individual indicators varying through the years between 60-90 in total, as seen in Table 23. Sub-pillar scores are calculated as the weighted average of individual indicators; pillar scores are calculated as the weighted average of sub-pillar scores.

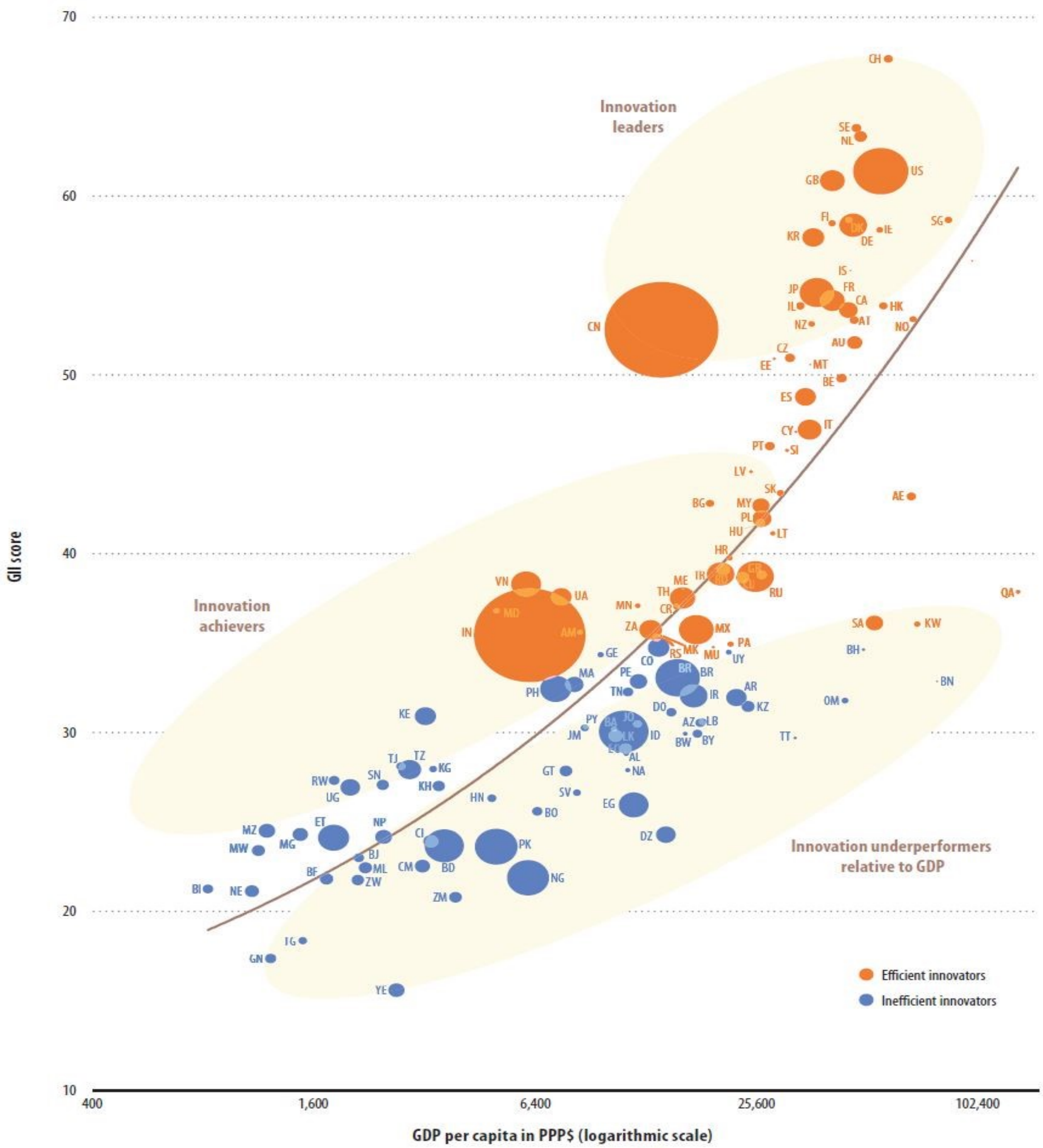
Four metrics are then calculated according to GII (2017):

- The Innovation Input Sub-Index is the simple average of the first five pillar scores.
- The Innovation Output Sub-Index is the simple average of the last two pillar scores.
- The overall GII is the simple average of the Input and Output Sub-Indices.
- The Innovation Efficiency Ratio is the ratio of the Output Sub-Index over the Input Sub-Index.

In the GII (2017) the 81 indicators are found using the most recent value possible to acquire. The data sources vary; a total of 57 variables are hard data, 19 are composite indicators from international agencies, and 5 are survey questions from the World Economic Forum's Executive Opinion Survey (EOS).

Figure 12 relates GDP per capita to GII score, and the size of the bubble refers to the number of people in that country. Figure 12 illustrates a grading of the innovation level. Countries with high GII (2017) scores are called Innovation Leaders; the ones with mid-level scores are called Innovation Achievers, and the lowest scores are the Innovation Underperformers. Figure 12 assisted in choosing the countries to include in the model, as a spread of GDP and innovation level was optimal to test the model's capabilities.

The data sources chosen from the GII (20XX) indicators to be variable parameters can be seen in Figure 16, and the 18 used GII indicators for the parameter development have been highlighted for easy recognition. Further details about all 43 parameters are given in Appendix E.



Source: GII (2017, p. 30)

Figure 12: GDP per capita in PPP$

3.5.3 The GEI (2017)

GEI (2017) is a compound index reflecting the multidimensional nature of entrepreneurship and consists of three sub-indices, 14 pillars (each pillar consists of 2 sub-pillars), and 31 variables that consist of (14*2 + the three sub-indices that through addition is equal to the GEI index itself). 137 countries are this year included in this index. The GEI (2017) is composed of sub-systems (pillars) that are aggregated into systems (sub-indices) that can be optimized for system performance at the ecosystem level.

The GEI (2017) highlights that fertilizing the development of entrepreneurship impacts society broadly by stating, " Improving the conditions for entrepreneurship by 10% could add $22 trillion to global GDP because institutions that support entrepreneurs also positively impact the economy as a whole." (p. 9). In the GEI (2017) report the following considerations are made:

> There is a growing recognition in the entrepreneurship literature that entrepreneurship theory focused only on the entrepreneur may be too narrow. The concept of systems of entrepreneurship is based on three important premises that provide an appropriate model for analyzing EEs. **First**, entrepreneurship is fundamentally an action undertaken and driven by agents on the basis of incentives**. Second**, the individual action is affected by an institutional framework condition. **Third**, entrepreneurship ecosystems are complex, multifaceted structures in which many elements interact to produce systems performance, thus, the index method needs to allow the constituent elements to interact (p. 4).

All these considerations above fits with the design ideas for the new IE model, and in the IECO-model, all 14 GEI pillars are used. The data sheets can be seen in Appendix G, and the 43 parameters are listed in Appendix E.

The authors of the GEI index, Ács, Szerb, Autio, and Lloyd have defined entrepreneurship on a country-level in order to design the GEI. Entrepreneurship is:

"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." (GEI, 2017, p. 77).

In the following, the terminology of the GEI authors is used, and the OECD definition of entrepreneurship is also taken into account.

The GEI index consists of the Super index itself, the final ranking for each country. It is a four-level index structure consisting of (starting from the lowest level): Variables, Pillars, Sub-indices, and the Super-index. The GEI (2017) version of the components of each level is illustrated in Table 24 below. In the IECO-model only the Pillar values are used.

All three sub-indices: Attitudes, Abilities, and Aspiration contain several pillars, which can be interpreted as the quasi-interdependent building blocks of this entrepreneurship index. In Table 24 each pillar consists of two variables, one pertaining to the individual entrepreneur (written in cursive) and one pertaining to the institutional level (with light blue shading). The institutional variables are written in red font, in order to highlight a data collection change from previous GEI versions.

Entrepreneurship Monitor (GEM) data is used. For the institutional data, a variety of indices and data are used. These are from various well-known institutions such as the World Economic Forum and the World Bank.

Table 24: GEI Framework With Sub-Indices, Pillars, and Variables

	Sub-indexes	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*INFRASTUCTURE)
		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*
			COMPETETIVNESS (MARKET DOMINANCE*REGULATION)
	ASPIRATION SUB-INDEX	PRODUCT INNOVATION	*NEW PRODUCT*
			TECH TRANSFER
		PROCESS INNOVATION	*NEW TECHLOLOGY*
			SCIENCE (GERD*(AVERAGEQUALITY OF SCIENTIFICAL INSTITUTIONS +AVAILABILITY OF SCIENTISTS AND ENGENEERS))
		HIGH GROWTH	*GAZELLE*
			FINANCE AND STRATEGY (VENTURE CAPITAL*BUSINESS SOPHISTICATION)
		INTERNATIONALIZATION	*EXPORT*
			ECONOMIC COMPLEXITY
		RISK CAPITAL	*INFORMAL INVESTMENT*
			DEPTH OF CAPITAL MARKET

Source: GEI (2017)

In the GEI (2017) publication, individual data from 2014-2015 or previous years' Global

3.5.4 A World of Three Cultures and the World Values Survey

A World of Three Cultures (WOTC) is a book that looks into understanding countries different cultures, and back it all up with a collection of survey results from several established survey collections among others the World Values Survey (WVS). In the WOTC it is pointed out that researchers have not been able to agree on the definition of economic development, nor on which countries are considered most highly developed. The author then posits that a country's development is the result of the combined effect of both material and cultural impacts, and these factors combine to influence society and bring about technological and institutional innovations (Basañez, 2016). If this postulate is correct,

then Silicon Valley can certainly not be copied without having adaptations for each individual country fitting the cultural heritage, and the local current development trends.

The WVS was initiated in 1981. Its main purpose is to help scientists and policymakers understand changes in the beliefs, values, and motivations of people throughout the world. The WVS seeks to use the most rigorous, high-quality research designs in each country, and consists of nationally representative surveys conducted in almost 100 countries which contain almost 90 percent of the world's population, using a common questionnaire. The WVS is the largest non-commercially funded time series survey ever executed. It is cross-national and is investigating human beliefs and is currently including interviews with almost 400,000 respondents. Importantly, the WVS is the only academic study covering the full range of GDPs, in all of the world's major cultural zones, and therefore the results from these surveys are of tremendous value.

The current wave of the survey is the WVS-7 questionnaire, and it is a research tool consisting of 290 questions measuring cultural values, attitudes and beliefs towards gender, family, and religion, attitudes and experience of poverty, education, health, and security, social tolerance and trust, attitudes towards multilateral institutions, cultural differences, and similarities between regions and societies. Also, the WVS-7 questionnaire has been expanded and now includes new topics such as the issues of justice, moral principles, corruption, accountability and risk, migration, national security and global governance.

Survey fieldwork for WVS-7 will be conducted worldwide in 2017-2018 and successfully commenced in January 2017. Subsequent waves are planned every five years.

WVS-wave 7 questionnaire is structured along 14 thematic sub-sections, including demography, as follows:

- social values, attitudes & stereotypes (45 items);
- societal well-being (11 items);

- social capital, trust and organizational membership (49 items);
- economic values (6 items);
- corruption (9 items);
- migration (10 items);
- post-materialist index (6 items);
- science & technology (6 items);
- religious values (12 items);
- security (21 items);
- ethical values & norms (23 items);
- political interest and political participation (36 items);
- political culture and political regimes (25 items);
- demography (31 items).

Data from WOTC is used in 11 parameters in the final IECO-model, and WOTC data can be studied in Appendix F and Appendix E, where all 43 parameters are listed and described.

3.6 System dynamics as the chosen method used for modeling

Next, the data should be entered into the chosen modeling method, which is system dynamics. This modeling method is well suited for studying complex and dynamic processes. Anylogic is the modeling platform used, as it results in a final model which is user-friendly and graphically pleasing.

As in the rest of science, reproducibility is central in simulation-based research (Rahmandad and Sterman, 2012). To ensure reproducibility, all details regarding the model development are written in the following. The chosen data sources are mentioned below.

3.6.1 Datasets used to design the IECO-model

A research review was done to discover what activities created innovation and to develop the IECO-model studying global innovation relationships.The search concluded with 104 relations, which are shown in Appendix D. These were reduced to 91 relations that were included in the model. The 91 final

nodes can be seen in Figure 13, and in more detail in Table 25. In order to be used as a node, they had to be related to reliable data about global innovation that was easily retrievable. The data had to be publicly available, verifiable, and independent third-party data; be comparable across nations; be available for the 32 chosen countries; and preferably exist for several years in order to create the stock variables.

3.6.2 The 91 variables/nodes used in the model and explained in detail

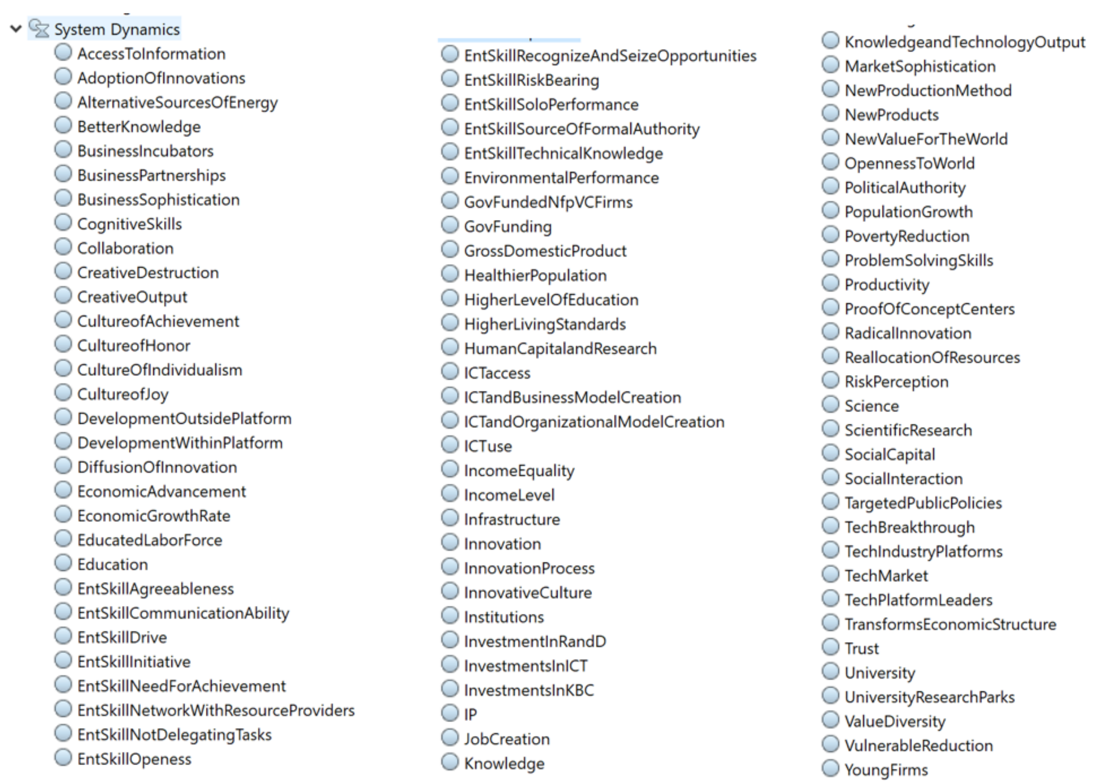


Figure 13: Nodes used in the IECO-model

Figure 13 shows all nodes used in the IECO-model. They are based upon the scholarly relationship between innovation and other factors. In Table 25 below, all the details regarding each variable/node are listed alphabetically based upon the name, as taken from Appendix D. Table 25 aims to make a brief and simple introduction to all relationships found which lead to model variables/nodes.

An introduction to each of the five columns in Table 25 is given below:

Column 1: Variable/node number and a function number is delegated

Column 2: Name of the variable/node used in the model

Column 3: Description of the relationship between innovation and the factor

Column 4: The actual reference to the scholarly paper/report is mentioned

Column 5: Here the actual equation is listed, which the IECO-model uses to calculate the node value, and the parameter number is added, when the equation uses parameters in the calculation. The parameters are added to show the connection between variables/nodes and parameters.

There are three stock variables in the IECO-model, and in Table 25, they are shaded with dark green for easy recognition, and refer to the color coding used in this dissertation and seen in Figure 17, and especially used in the list of the 43 parameters in Appendix E. The stock variables are the variables numbered 47, 72 and 80.

Table 25: Details for All the Nodes/Relations Used in the IECO-Model

Node no.	Name	Description	Reference	Equation for node
1 = X_1	Access To Information	Access to Information leads to more educated population	UNESCO (2017)	AccessToInformation = Education = **Innovation**
2 = X_2	AdoptionOfInnovation	Fundamental to the creation, diffusion, and adoption of innovations are investments in R&D.	Barlevy (2007)	AdoptionofInnovation = InvestmentInRandD = p(InvestmentInRandD) = **P 26**
3 = X_3	Alternative	Alternative Sources of Energy and innovation	OECD (2015)	AlternativeSourcesofEnergy **= Innovation**

	Sourcesof Energy	can help to decouple growth from natural capital depletion. Innovation is a key to enable green growth.		
4 = X_4	Better Knowledge	Better Knowledge leads to the better-educated population.	UNESCO (2017)	Better Knowledge = Education = **Innovation**
5 = X_5	Business Incubators	Business Incubators supports the innovation process	Hackett and Dilts (2004)	Business Incubators = p(BusinessIncubators) = **P 1**
6 = X_6	Business Partnerships	Business Partnerships. Changing strategies—even in the largest corporations—means that many firms now pursue innovations through partnerships rather than primarily through their own laboratories.	Block (2008, p. 19)	Business Partnerships = p(BusinessPartnerships) = **P 2**
7 = X_7	Business Sophistication	Business Sophistication. The results of this study imply the importance of business sophistication and infrastructure to improve innovation capacities.	Sohn et al. (2016)	Business Sophistication = Institutions * Human Capital and Research * Infrastructure = $(\text{Infrastructure})^3$ **=** **p(Infrastructure)^3 = (P 24)^3**
8 = X_8	CognitiveSkills	Cognitive Skills can be improved from education.	UNESCO (2017)	Cognitive Skills = Education = **Innovation**

9 = X_9	Collaboration	Collaboration. Now, most innovation occurs among networks of collaborators that cross the public-private divide.	Block (2008, p. 19)	Collaboration = Business Incubators * Business Partnerships * Proof Of Concept Centers = **P 1 * P 2 * P 33**
10 = X_{10}	Creative Destruction	Creative destruction that results from innovation, as new firms enter the market, sometimes growing quickly and thus increasing their market share, replacing other firms with low productivity	Andrews & Criscuolo (2013).	CreativeDestruction = **Innovation**
11 = X_{11}	Creative Output	Creative Output is here considered human capital, and there is found a strong and positive relationship between human capital and innovation.	Dakhli & De Clercq (2004)	CreativeOutput = TechIndustryPlatforms * HumanCapitalandResearch * BusinessSophistication * KnowledgeandTechnologyOutput * MarketSophistication
12 = X_{12}	CultureOf Achievement	Culture of Achievement leads to emphasizing economic advancement	Basañez (2016)	CultureOfAchievement = p(CultureOfAchievement) = **P 3**
13 = X_{13}	CultureOf Honor	Culture of Honor favor loyalty, obedience, and discipline, which all are traits needed for keeping a job.	Basañez(2016)	CultureOfHonor = p(CultureOfHonor) = **P 4**
14 = X_{14}	CultureOf Individualism	Culture of Individualism. Interestingly, the authors find that innovation (as measured		CultureOfIndividualism = p(CultureOfIndividualism) = **P 5**

		by R&D expenditure) is more significant in societies where individualism is higher.	Ezell & Marxgut (2015)	
15 = X_{15}	CultureOfJoy	The culture of Joy is where there is focus on social life and interaction, and that can lead to many ideas are shared, that later leads to innovation	Basañez (2016)	CultureOfJoy = p(CultureOfJoy) = **P 6**
16 = X_{16}	Development Outside Platform	Development Outside Platform can lead to big innovations while it is often young and agile companies	OECD (2015)	DevelopmentOutsidePlatform = TechPlatformLeaders
17 = X_{17}	Development Within Platform	Development Within Platform can help with development within the	OECD (2015)	DevelopmentWithinPlatform = TechPlatformLeaders
18 = X_{18}	DiffusionOf Innovation	Due to increased investment in R & D, there is more diffusion of Innovation	Barlevy (2007)	DiffusionofInnovation = InvestmentInRandD
19 = X_{19}	Economic Advancement	Economic Advancement is a result of a culture of Achievement	Basañez (2016)	EconomicAdvancement = CultureofAchievement
20 = X_{20}	Economic GrowthRate	Economic Growth Rate. These attitudes appear to matter as there is a strong positive correlation between the extent to which a nation's citizens think that more emphasis on	Ezell & Marxgut (2015)	EconomicGrowthRate = **Innovation**

		technology is good and their overall per capita GDP growth rate over the last decade		
21 = X_{21}	Educated LaborForce	Educated Labor Force. Advances in educational technology have ultimately led to a better-educated labor force.	WIPO (2015)	EducatedLaborForce = **Innovation**
22 = X_{22}	Education	Education	Steel et al. (2012)	Education = **Innovation**
23 = X_{23}	Entrepreneurial Skill: Agreeableness	Entrepreneurial Skill: Agreeableness	Steel et al. (2012)	EntrepreneurialSkill:Agreeableness =p(EntrepreneurialSkill:Agreeableness) = **P 7**
24 = X_{24}	Entrepreneurial Skill: CommunicationAbility	Entrepreneurial Skill: Communication Ability	Timmons (1999)	EntrepreneurialSkill:CommunicationAbility = p(EntrepreneurialSkill:CommunicationAbility) = **P 8**
25 = X_{25}	Entrepreneurial Skill: Drive	Entrepreneurial Skill: Drive	Timmons (1999)	EntrepreneurialSkill:Drive = p(EntrepreneurialSkill:Drive) = **P 9**
26 = X_{26}	Entrepreneurial Skill: Initiative	Entrepreneurial Skill: Initiative	Timmons (1999)	EntrepreneurialSkill:Initiative = p(EntrepreneurialSkill:Initiative) = **P 10**
27 = X_{27}	Entrepreneurial Skill: Need For Achievement	Entrepreneurial Skill, characteristics Need for Achievement	Timmons (1999)	EntrepreneurialSkill:NeedForAchievement = p(EntrepreneurialSkill:NeedForAchievement) = **P 11**
28 = X_{28}	Entrepreneurial Skill: NetworkWith Resource Providers	Entrepreneurial Skill, characteristics. Network with Resource Providers	Timmons (1999)	EntrepreneurialSkill:NetworkWithResourceProviders = p(EntrepreneurialSkill:NetworkWithResourceProviders) = **P 12**

29 = X_{29}	Entrepreneurial Skill: Not Delegating Tasks	Entrepreneurial Skill: Not Delegating Tasks	McGrath et al. (1992)	EntrepreneurialSkill:NotDelegatingTasks = p(EntrepreneurialSkill:NotDelegatingTasks) = **P 13**
30 = X_{30}	Entrepreneurial Skill: Openness	Entrepreneurial Skill: Openness	Steel et al. (2012)	EntrepreneurialSkill:Openness = p(EntrepreneurialSkill:Openness) = **P 14**
31 = X_{31}	Entrepreneurial Skill: Recognize And Seize Opportunities	Entrepreneurial Skill: Recognize and Seize Opportunities	Timmons (1999)	Entrepreneurial Skill:RecognizeAndSeize Opportunities = p(Entrepreneurial Skill:RecognizeAndSeize Opportunities) = **P 15**
32 = X_{32}	Entrepreneurial Skill: Risk Bearing	Entrepreneurial Skill: Risk Bearing	Timmons (1999)	EntrepreneurialSkill:RiskBearing = p(EntrepreneurialSkill:RiskBearing) = **P 16**
33 = X_{33}	Entrepreneurial Skill: Solo Performance	Entrepreneurial Skill: Solo Performance	McGrath et al. (1992)	EntrepreneurialSkill:SoloPerformance = p(EntrepreneurialSkill:SoloPerformance) = **P 17**
34 = X_{34}	Entrepreneurial Skill: Source Of Formal Authority	Entrepreneurial Skill: Source Of Formal Authority	Timmons (1999)	EntrepreneurialSkill:SourceOfFormalAuthority = p(EntrepreneurialSkill:SourceOfFormalAuthority) = **P 18**
35= X_{35}	Entrepreneurial Skill: Technical Knowledge	Entrepreneurial Skill: Technical Knowledge	Timmons (1999)	EntrepreneurialSkill:TechnicalKnowledge = p(EntrepreneurialSkill:TechnicalKnowledge) = **P 19**
36 = X_{36}	Environmental Performance	Environmental Performance	OECD Strategy (2015)	EnvironmentalPerformance = **Innovation**
37 = X_{37}	Government FundedNotFor ProfitVCFirms	Government Funded Not For Profit VC Firms are very important for	Block (2008)	GovernmentFundedNotForProfit VCFirms =

		creating more innovation in the USA		p(GovernmentFundedNotForProfitVCFirms) = **P 20**
38 = X_{38}	Government Funding	Government Funding. This finding helps demonstrate that Federal programs that might spend as little as $50 million or $150 million per year could still be making a significant difference for overall rates of innovation.	Block (2008, p. 19)	GovernmentFunding = p(GovernmentFunding) = **P 21**
39 = X_{39}	Gross Domestic Product	Gross Domestic Product is increasing, when innovation-driven growth is seen	WIPO (2015)	GrossDomesticProduct = ICTaccess * ICTuse * Productivity * InvestmentsInICT * TechBreakthrough * Innovation * InvestmentsInKBC
40 = X_{40}	Healthier Population	Healthier Population, technology has contributed to a healthy and economically more productive workforce.	WIPO (2015)	HealthierPopulation = **Innovation**
41 = X_{41}	Higher Level of Education	Higher Level of Education	WIPO (2015)	HigherLevelofEducation = **Innovation**
42 = X_{42}	Higher Living Standards	Higher Living Standards is a result of economic growth	WIPO (2015)	HigherLivingStandards = **Innovation**
43 = X_{43}	HumanCapital and Research	Human Capital and Research. The authors proposed that a country's	Dakhli & De Clercq (2004)	HumanCapitalandResearch = Infrastructure

		overall human capital is related to business expertise and skills relevant to innovation, such as the number of professionally active people engaged in R&D-related activities.		
44 = X_{44}	ICT Access	ICT Access	EU EIS 2017 Methodology (2017, p. 5)	ICTaccess = p(ICTaccess) = **P 22**
45 = X_{45}	ICT and Business ModelCreation	ICT and Business Model Creation	EU EIS 2017 Methodology (2017)	ICTandBusinessModelCreation = ICTaccess * ICTuse
46 = X_{46}	ICTAndOrganizationalModelCreation	ICT and Organizational Model Creation	EU EIS 2017 Methodology (2017)	ICTAndOrganizationalModelCreation = ICTaccess * ICTuse
47 = X_{47}	ICT use	ICT use leads to a productivity explosion	Brynjolfsson and Saunders (2009)	ICTuse = p(ICTuse) = d(ICTuse)/dt = posChange – negChange = **P 23**
48= X_{48}	Income Equality	Income Equality	OECD Strategy (2015)	IncomeEquality = **Innovation**
49 = X_{49}	Income Level	Income Level. Growth at the frontier and lack from other countries have created a difference in absolute income levels across the world.	WIPO (2015)	IncomeLevel = **Innovation**
50 = X_{50}	Infrastructure	In industrialized nations, there are infrastructures and focused policies to aid in support of	Jaffe and Lerner (2001)	Infrastructure = p(Infrastructure) = **P 24**

		innovation, such as a national laboratory system.		
51 = X_{51}	**Innovation**	Innovation is the creation of new value to the world (Ezell & Marxgut, 2015) Innovation leads to a better-educated labor force (WIPO, 2015)	Timmons (1999) Ezell & Marxgut (2015)	**Innovation** = EntSkillNeedForAchievement * EntSkillRiskBearing * EntSkillNotDelegatingTasks * EntSkillSoloPerformance * EntSkillDrive * EntSkillTechnicalKnowledge * ScientificResearch * EntSkillRecognizeAndSeizeOpportunities * InvestmentInRandD * Knowledge * InnovativeCulture * EntSkillSourceOfFormalAuthority * EntSkillNetworkWithResource-Providers * EntSkillInitiative * Trust * EntSkillCommunicationAbility * TechIndustryPlatforms * InnovationProcess * IP * OpennessToWorld * DevelopmentOutsidePlatform * DevelopmentWithinPlatform * TechMarket * PoliticalAuthority * SocialInteraction * EconomicAdvancement *

				InvestmentsInKBC * EntSkillOpeness * EntSkillAgreeableness * BusinessPartnerships * ValueDiversity * MarketSophistication * HumanCapitalandResearch * KnowledgeandTechnologyOutput * Collaboration * CultureOfIndividualism * GovFundedNfpVCFirms * GovFunding * NewProductionMethod * University
52 = X_{52}	InnovationProcess	Innovation Process leads to productivity increase in firms	WIPO (2015)	InnovationProcess = ProofOfConceptCenters * UniversityResearchParks * TargetedPublicPolicies * BusinessIncubators * Infrastructure
53 = X_{53}	InnovativeCulture	Innovative Culture. A thriving national innovation culture leverages the existing strengths of a country's research and IE.	Ezell & Marxgut (2015)	InnovativeCulture = p(InnovativeCulture) = **P 25**
54 = X_{54}	Institutions	Some institutions support the innovation process. These include incubators (Hackett and		Institutions = Infrastructure = p(Infrastructure) = **P 24**

		Dilts, 2004), university research parks (Link and Scott, 2007), and proof of concept centers (Gulbranson and Audretsch, 2008).	Link & Antonelli (2013)	
55 = X_{55}	InvestmentInRandD	Investments In R&D leads to more adoption, creation and diffusion of innovation.	Barlevy(2007)	Investment In R&D = p(Investment In R&D) = **P 26**
56 = X_{56}	InvestmentsInICT	Investments In ICT	OECD (2015)	InvestmentsInICT= p(Investments In ICT) = **P 27**
57 = X_{57}	InvestmentsInKBC	Investments In KBC. Available data underscore the importance of investments in intangible assets as a share of total business investments	WIPO (2015)	InvestmentsInKBC = p(Investments In KBC) = **P 28**
58= X_{58}	IP	IP incentivizes Innovation	WIPO (2015)	IP = p(IP) = **P 29**
59 = X_{59}	JobCreation	Innovation is defined by the output; Job Creation	Steel et al. (2012, p. 5)	JobCreation **= Innovation**
60 = X_{60}	Knowledge	Knowledge and technology outputs indicate a higher level of human capital and research, which leads to higher level of innovation.	UNESCO (2015)	Knowledge = p(Knowledge) = **P 30**
61 = X_{61}	KnowledgeAndTechnologyOutput	Knowledge and Technology Output	Sohn et al. (2016)	KnowledgeAndTechnology Output = BusinessSophistication

				* MarketSophistication * HumanCapitalandResearch
62 = X_{62}	MarketSophistication	Market Sophistication	Sohn et al. (2016)	MarketSophistication = Institutions
63 = X_{63}	NewProductionMethod	New Production Method	Schumpeter (1934)	NewProductionMethod = p(NewProductionMethod) = **P 31**
64 = X_{64}	NewProducts	Innovation is producing new Products	Schumpeter (1934)	New Products = **Innovation**
65 = X_{65}	NewValueForTheWorld	New Value for the World	Ezell and Marxgut (2015)	New Value for the World = **Innovation**
66 = X_{66}	Openness-ToWorld	Openness to World	OECD Strategy (2015)	Openness to World = p(Openness to World) = **P 32**
67 = X_{67}	Political-Authority	The culture of honor favors Political Authority	Basañez (2016)	PoliticalAuthority = CultureOfHonor
68 = X_{68}	Population-Growth	Population Growth	WIPO (2015)	PopulationGrowth = **Innovation**
69 = X_{69}	Poverty-Reduction	Poverty Reduction is a result from better educated population	UNESCO (2017)	Poverty Reduction= Education = **Innovation**
70 = X_{70}	Problem-SolvingSkills	Problem Solving Skills are a result from more Education	UNESCO (2017)	Problem Solving Skills= Education = **Innovation**
71= X_{71}	Productivity	Innovation leads to Productivity increase in firms	WIPO (2015)	Productivity = ICTuse * ReallocationOfResources * Innovation * OpennessToWorld
72 = X_{72}	ProofOfConceptCenters	Proof of Concept Centers supports the innovation process	Gulbrandson and Audretsch (2008)	ProofofConceptCenters = p(ProofOfConceptCenters) d(ProofOfConceptCenters)/dt = posLevel – negLevel = **P 33**
73 = X_{73}	RadicalInnovation	Radical Innovation is more commercialized by young firms	OECD Strategy (2015)	RadicalInnovation = TechIndustryPlatforms * YoungFirms

74 = X_{74}	ReallocationOf Resources	Reallocation of Resource can drive aggregated growth	OECD (2015)	ReallocationOfResources = p(ReallocationOfResources) = **P 34**
75 = X_{75}	RiskPerception	Risk Perception is a part of the entrepreneurial skill sets, and here is viewed as risk-bearing. Mill (1848) meant it was the major difference between an entrepreneur and a manager, the willingness to take on risk, and that leads to more innovation.	Timmons (1999)	RiskPerception = Education = **Innovation**
76 = X_{76}	Science	Science Innovation and the process of bringing innovation about are built on scientific research.	(Fleming and Sorenson, 2004).	Science = **Innovation** *University
77 = X_{77}	ScientificResea rch	Scientific Research	Fleming & Sorenson (2004)	ScientificResearch = P(ScientificResearch) = **P 35**
78 = X_{78}	SocialCapital	Social Capital can be changed with education	UNESCO (2017)	SocialCapital = Education = **Innovation**
79 = X_{79}	SocialInteracti on	Social Interaction is seen in cultures of Joy	Basañez (2016)	SocialInteraction = CultureOfJoy = **P 6**
80 = X_{80}	TargetedPublic Policies	Targeted Public Policies support the innovation policies	Mohnen & Roller (2005) Jaffe, Newell, and Stavins (2005)	TargetedPublicPolicies = p(TargetedPublicPolicies) = d(TargetedPublicPolicies)/dt = posFlow – negFlow = **P 36**
81= X_{81}	TechBreakthro ugh	Tech Breakthrough	Schumpeter (1934)	TechBreakthrough = DiffusionOfInnovation

82 = X_{82}	TechIndustry Platforms	Tech Industry Platforms are associated with a strong positive impact on innovation	OECD (2015)	TechIndustry Platforms = p(TechIndustry Platforms) = **P 37**
83 = X_{83}	TechMarket	IP enables the Tech Market	WIPO (2015)	TechMarket = IP
84 = X_{84}	TechPlatformL eaders	Tech Platform Leaders discourage innovations that do not help the platform.	OECD (2015)	TechPlatformLeaders = p(TechPlatformLeaders) = **P 38**
85 = X_{85}	Transforms EconomicStruc ture	Transforms Economic Structure	WIPO (2015)	TransformsEconomicStructure = **Innovation**
86 = X_{86}	Trust	They found partial support for the positive effect of trust and associational activity on innovation	Dakhli & De Clercq (2004)	Trust = p(Trust) = **P 39**
87 = X_{87}	University	University Support for Science and Innovation Universities serve as an important dimension of the innovation process. Universities are often the source of innovation as reflected through the patenting behavior of faculty	Link & Antonelli, 2013	University = p(University) = **P 40**
88 = X_{88}	University-ResearchParks	University Research Parks support the innovation process	Link and Scott (2007)	UniversityResearchParks = p(UniversityResearchParks) = **P 41**
89 = X_{89}	ValueDiversity	Value Diversity. We find that countries that are		ValueDiversity = p(ValueDiversity) = **P 42**

		ethnically homogenous but diverse in values orientation are the best innovators.	Ramasamy & Yeung (2016)	
90 = X_{90}	Vulnerable Reduction	Vulnerable Reduction. More education makes people less vulnerable.	OECD (2015)	VulnerableReduction = Education = **Innovation**
91 = X_{91}	YoungFirms	Young firms possess a comparative advantage and are commercializing more radical innovations.	OECD (2015)	Young Firms = p(YoungFirms) = **P 43**

3.7 Creating the model parameters

The final 91 relationships were used to create the nodes in the model. After creating the model, there were 43 nodes that did not have any other relation than to the node "**Innovation**," and none of these 43 nodes had any input, so the dynamic variable = 0 in that case. These relations/nodes have parameters related to them, where values could be inserted or adjusted to observe the resulting development of the model. Figure 14 lists the parameters created for those 43 nodes. Appendix E lists details about the 43 parameters.

In the model development, dynamic variables were used where it was possible to find reliable longitudinal data. Dynamic variables are special in that their value is recalculated each time the model is run, and the parameter is assessed through a function. Only three parameters had data that were reliable over a 7-year period: P47, P72, and P80. They were converted to dynamic variables, and details about them can be seen in chapter 3.8.3.

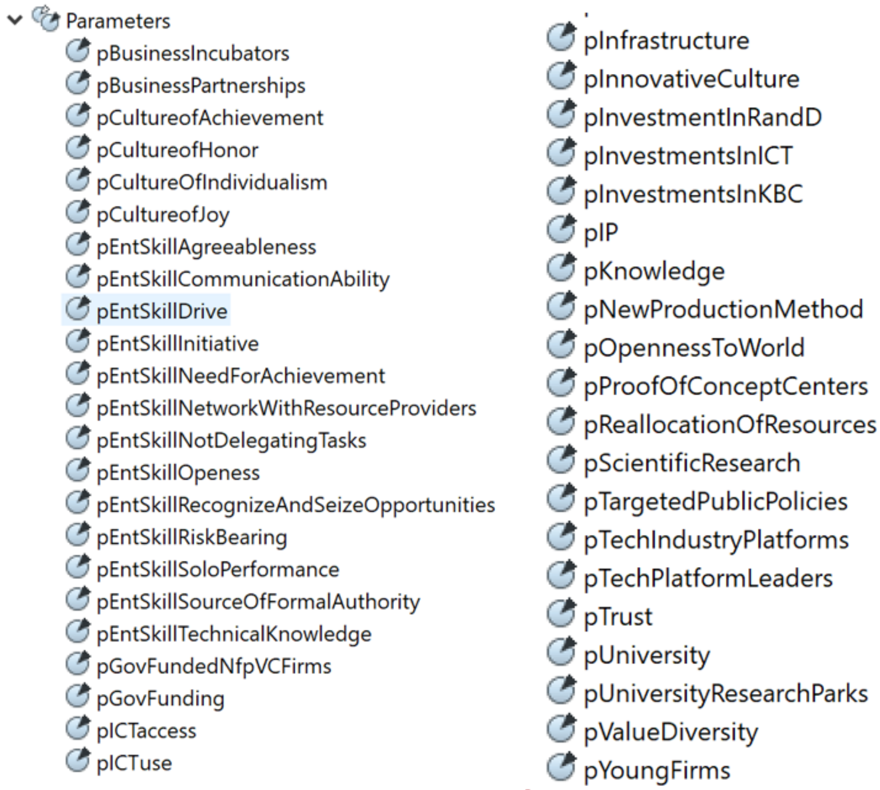


Figure 14: The 43 parameters

Figure 15 lists the 32 countries which were examined in the IECO-model. They were chosen to represent a broad spectrum of GDP values to better evaluate the model's capabilities.

Figure 15: The 32 countries included in the model

3.7.1 Data sources for the 43 parameters

Data for the 43 parameters were then found in the following way from the three main data sources; the GII 20XX, the GEI 2017, and *A World of Three Cultures*:

1. **Global Innovation Index 2017:** **18 parameters,** see Figure 16
   - Parameters are chosen from following pillars:
     - Institutions – **2:** (P36 and P41)
     - Human Capital & Research – **3:** (P26, P38, and P40)
     - Infrastructure – **4:** (P22, P23, P24, and P27)
     - Market Sophistication – **1:** (P21)
     - Business Sophistication – **2:** (P19 and P33)
     - Knowledge & Tech. outputs – **4:** (P13, P25, P19, and P30)
     - Creative output – **2:** (P8 and P28)
2. **A World of Three Cultures (World Values Survey, survey results):** **11 parameters,** see Appendix F
3. **Global Entrepreneurship Index 2017:** **14 parameters**, see Appendix G

19 of the 43 parameters focused on the skills or traits of an entrepreneur. Further details about each parameter are in Table 26, and the color legend description is contained in Figure 17, to help with faster identification of the data source. More detailed description of the data sources for the parameters is in Appendix E.

Figure 16 shows an example of GII (2017) results for the USA, with the indicators chosen to be data sources for the 18 variable parameters highlighted for easy recognition.

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I: Country/Economy Profiles

United States of America

Key indicators

Population (millions)	324.1
GDP (US$ billions)	18,561.9
GDP per capita, PPP$	55,805.2
Income group	High income
Region	Northern America

	Score 0–100 or value (hard data)	Rank
Global Innovation Index (out of 127)	**61.4**	**4**
Innovation Output Sub-Index	53.9	5
Innovation Input Sub-Index	68.9	5
Innovation Efficiency Ratio	0.8	21
Global Innovation Index 2016 (out of 128)	61.4	4

			Score	Rank	
	1	**Institutions**	**86.2**	**17**	
	1.1	Political environment	80.3	21	
	1.1.1	Political stability & safety*	80.8	31	
	1.1.2	Government effectiveness*	79.7	20	
	1.2	Regulatory environment	90.4	13	
P36	1.2.1	Regulatory quality*	75.3	19	
	1.2.2	Rule of law*	86.3	18	
	1.2.3	Cost of redundancy dismissal, salary weeks	8.0	1	●
	1.3	Business environment	88.1	10	
P41	1.3.1	Ease of starting a business*	91.2	44	
	1.3.2	Ease of resolving insolvency*	89.2	5	
	1.3.3	Ease of paying taxes*	83.9	32	
	2	**Human capital & research**	**57.2**	**13**	
P40	2.1	Education	54.7	41	
	2.1.1	Expenditure on education, % GDP	4.9	54	
	2.1.2	Gov't expenditure/pupil, secondary, % GDP/cap	22.7	41	
	2.1.3	School life expectancy, years	16.5	20	
	2.1.4	PISA scales in reading, maths, & science	487.6	29	
	2.1.5	Pupil-teacher ratio, secondary®	14.8	63	○
	2.2	Tertiary education	38.1	54	
	2.2.1	Tertiary enrolment, % gross	85.8	9	
	2.2.2	Graduates in science & engineering, %	14.9	85	○
	2.2.3	Tertiary inbound mobility, %	4.6	40	
	2.3	Research & development (R&D)	78.8	4	
	2.3.1	Researchers, FTE/mn pop.®	4,232.0	20	
P26	2.3.2	Gross expenditure on R&D, % GDP	2.8	10	
P38	2.3.3	Global R&D companies, avg. expend. top 3, mn $US	100.0	1	●
	2.3.4	QS university ranking, average score top 3*	99.0	1	●
	3	**Infrastructure**	**61.0**	**21**	
P27	3.1	Information & communication technologies (ICTs)	85.2	11	
P22	3.1.1	ICT access*	82.7	19	
P23	3.1.2	ICT use*	75.7	17	
	3.1.3	Government's online service*	92.8	9	
	3.1.4	E-participation*	89.8	12	
P24	3.2	General infrastructure	52.8	16	
	3.2.1	Electricity output, kWh/cap	13,342.4	8	
	3.2.2	Logistics performance*	89.2	10	
	3.2.3	Gross capital formation, % GDP	19.8	82	○
	3.3	Ecological sustainability	45.0	61	
	3.3.1	GDP/unit of energy use	7.6	76	○
	3.3.2	Environmental performance*	84.7	26	
	3.3.3	ISO 14001 environmental certificates/bn PPP$ GDP	0.3	91	○
	4	**Market sophistication**	**83.4**	**1**	●
	4.1	Credit	85.5	1	●
	4.1.1	Ease of getting credit*	95.0	2	●
	4.1.2	Domestic credit to private sector, % GDP	188.8	3	●
	4.1.3	Microfinance gross loans, % GDP	n/a	n/a	
P21	4.2	Investment	72.2	3	●
	4.2.1	Ease of protecting minority investors*	64.7	40	
	4.2.2	Market capitalization, % GDP	139.0	5	
	4.2.3	Venture capital deals/bn PPP$ GDP	0.4	1	●
	4.3	Trade, competition, & market scale	92.7	1	●
	4.3.1	Applied tariff rate, weighted mean, %	1.6	50	
	4.3.2	Intensity of local competition†	83.0	5	
	4.3.3	Domestic market scale, bn PPP$	18,561.9	2	●
	5	**Business sophistication**	**56.4**	**8**	
	5.1	Knowledge workers	67.4	11	
P19	5.1.1	Knowledge-intensive employment, %®	38.0	28	
	5.1.2	Firms offering formal training, % firms	n/a	n/a	
	5.1.3	GERD performed by business, % of GDP	2.0	7	
	5.1.4	GERD financed by business, %	64.2	8	
	5.1.5	Females employed w/advanced degrees, % total	n/a	n/a	
	5.2	Innovation linkages	46.6	15	
	5.2.1	University/industry research collaboration†	76.2	4	
P33	5.2.2	State of cluster development†	76.0	1	●
	5.2.3	GERD financed by abroad, %	4.7	66	○
	5.2.4	JV–strategic alliance deals/bn PPP$ GDP	0.1	17	
	5.2.5	Patent families 2+ offices/bn PPP$ GDP	5.0	13	
	5.3	Knowledge absorption	55.2	6	
	5.3.1	Intellectual property payments, % total trade	1.6	19	
	5.3.2	High-tech imports less re-imports, % total trade	17.7	11	
	5.3.3	ICT services imports, % total trade	1.3	52	
	5.3.4	FDI net inflows, % GDP	1.7	90	○
	5.3.5	Research talent, % in business enterprise®	71.0	4	
	6	**Knowledge & technology outputs**	**54.4**	**7**	
P30	6.1	Knowledge creation	63.4	7	
P29	6.1.1	Patents by origin/bn PPP$ GDP	16.0	6	
	6.1.2	PCT patent applications/bn PPP$ GDP	3.0	14	
	6.1.3	Utility models by origin/bn PPP$ GDP	n/a	n/a	
	6.1.4	Scientific & technical articles/bn PPP$ GDP	19.8	38	
	6.1.5	Citable documents H index	100.0	1	●
P25	6.2	Knowledge impact	52.5	7	
	6.2.1	Growth rate of PPP$ GDP/worker, %	0.7	67	○
	6.2.2	New businesses/th pop. 15–64	n/a	n/a	
	6.2.3	Computer software spending, % GDP	1.1	1	●
	6.2.4	ISO 9001 quality certificates/bn PPP$ GDP	1.8	94	○
	6.2.5	High- & medium-high-tech manufactures, %®	0.4	13	
P13	6.3	Knowledge diffusion	47.3	12	
	6.3.1	Intellectual property receipts, % total trade	5.1	1	●
	6.3.2	High-tech exports less re-exports, % total trade	7.1	26	
	6.3.3	ICT services exports, % total trade	1.5	68	
	6.3.4	FDI net outflows, % GDP	2.1	29	
	7	**Creative outputs**	**53.5**	**10**	
P28	7.1	Intangible assets	50.1	38	
	7.1.1	Trademarks by origin/bn PPP$ GDP	21.5	81	○
	7.1.2	Industrial designs by origin/bn PPP$ GDP	1.3	54	
	7.1.3	ICTs & business model creation†	79.2	12	
	7.1.4	ICTs & organizational model creation†	82.3	1	●
	7.2	Creative goods & services	48.2	5	
	7.2.1	Cultural & creative services exports, % of total trade®	2.0	1	●
	7.2.2	National feature films/mn pop. 15–69	3.5	53	
	7.2.3	Global ent. & media market/th pop. 15–69	97.1	3	●
	7.2.4	Printing & publishing manufactures, %®	1.9	24	
	7.2.5	Creative goods exports, % total trade	1.7	31	
P8	7.3	Online creativity	65.4	7	
	7.3.1	Generic top-level domains (TLDs)/th pop. 15–69	100.0	1	●
	7.3.2	Country-code TLDs/th pop. 15–69	2.9	58	
	7.3.3	Wikipedia edits/mn pop. 15–69	6.1	41	
	7.3.4	Video uploads on YouTube/pop. 15–69	100.0	1	●

NOTES: ● indicates a strength; ○ a weakness; * an index; † a survey question.
® indicates that the country's data are older than the base year; see Appendix II for details, including the year of the data, at http://globalinnovationindex.org.
Square brackets indicate that the data minimum coverage (DMC) requirements were not met at the sub-pillar or pillar level; see page 181 of this appendix for details.

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Figure 16: Example of GII country results - USA with numbered parameters

The input in Table 26 gives the following information: Parameter number, parameter name, data source, the name of the specific variable, and the year the data is collected. Finally, it shows whether a high value is a value equal to 1 or close to 0.

Table 26: Overview Descriptions of the 43 Parameters for the IECO-Model

No.	Name	Data?	Year
Parameter 1	Business Incubators	GEI - Opportunity Startups	2017 (H = 1)
Parameter 2	Business Partnerships	GEI - Internationalization	2017 (H = 1)
Parameter 3	Culture of Achievement	WOTC p. 127	2010 (H=1)
Parameter 4	Culture of Honor	WOTC p. 121	2010 (H=1)
Parameter 5	Culture of Individualism	WOTC p. 49	2001 (H=1)
Parameter 6	Culture of Joy	WOTC p. 128	2010 (H=1)
Parameter 7	Ent. Skill (ES): Agreeableness	WOTC p. 152	2000 (H=0)
Parameter 8	ES: Communication Ability	GII - 7.3 - Online Creativity	2017 (H=1)
Parameter 9	ES: Drive	WOTC p. 150 Competition (is good)	2010 (H=1)
Parameter 10	ES: Initiative	GEI - Startup Skill	2017 (H=1)
Parameter 11	ES: Need For Achievement	GEI- Cultural Support	2017 (H=1)
Parameter 12	ES: Network With Resource Providers	GEI - Networking	2017 (H=1)
Parameter 13	ES: Not Delegating Tasks	GII - 6.3 - Knowledge Diffusion	2017 (H=1)
Parameter 14	ES: Openness	WOTC p. 47	2001 (H=1)
Parameter 15	ES: Recognize and Seize Opportunity	GEI - Opportunity Perception	2017 (H=1)
Parameter 16	ES.: Risk Bearing	GEI - Risk Acceptance	2017 (H=1)
Parameter 17	ES: Solo Performance	WOTC p. 334-336. Subj. Dev. Index (SDI)	Latest survey (H=1)
Parameter 18	ES: Source Of Formal Authority	WOTC p. 46	2001 (H=1)
Parameter 19	ES: Technical Knowledge	GII - 5.1.1 - Knowl. Intens. empl.	2017 (H=1)
Parameter 20	Gov Fund. Not for profit VC Firms	GEI - Risk Capital	2017 (H=1)
Parameter 21	Gov Funding	GII - 4.2 - Investment	2017 (H=1)
Parameter 22	ICT Access	GII - 3.1.1 - ICT access	2017 (H=1)
Parameter 23 - Stock	ICT Use	GII - 3.1.2	2011 - 2017 (H=1)
Parameter 24	Infrastructure	GII- 3.2 -General Infrastructure	2017 (H=1)
Parameter 25	Innovative Culture	GII- 6.2 -Knowledge Impact	2017 (H=1)
Parameter 26	Investments In R and D	GII - 2.3.2 - Gross exp. on R&D	2017 (H=1)
Parameter 27	Investments In ICT	GII - 3.1 - ICTs	2017 (H=1)
Parameter 28	Investments In Knowledge BC	GII - 7.1 - Intangible assets	2017 (H=1)
Parameter 29	Intellectual Property	GII - 6.1.1 - Patent by origin	2017 (H=1)
Parameter 30	Knowledge	GII - 6.1 - Knowledge Creation	2017 (H=1)
Parameter 31	New Production Method	GEI- Product Innovation	2017 (H=1)
Parameter 32	Openness To World	WOTC p. 144	2000 (H=1)
Parameter 33 - Stock	Proof Of Concept Centers	GII 5.2.2 - State of cluster dev.	2011 - 2017 (H=1)
Parameter 34	Reallocation Of Resources	GEI - Competition	2017 (H=1)
Parameter 35	Scientific Research	GEI - Process Innovation	2017 (H=1)
Parameter 36 - Stock	Targeted Public Policies	GII - 1.2.1 - Regulatory Quality	2011 - 2017 (H=1)
Parameter 37	Tech Industry Platforms	GEI - Technology Absorption	2017 (H=1)
Parameter 38	Tech Platform Leaders	GII - 2.3.3 -Global R&D Companies	2017 (H=1)
Parameter 39	Trust	WOTC p. 138	2000 (H=1)
Parameter 40	University	GII - 2.1 - Education	2017 (H=1)
Parameter 41	University Research Parks	GII - 1.3.1 -Ease of starting business	2017 (H=1)
Parameter 42	Value Diversity	GEI - Human Capital	2017 (H=1)
Parameter 43	Young Firms	GEI - High Growth	2017 (H=1)

The color legends in Figure 17 may facilitate recognition of the data source (GII, GEI, or WOTC, or stock data sources):

Color legends	Data info
	Data found in the GII 2017 - Global Innovation Index 2017
	Data found in the book “World of Three Cultures” by Basañez
	Data found in the GEI 2017 - Global Entrepreneurship Index 2017
	Stock variables collected from 2011 - 2017

Figure 17: Color legends for the 43 parameters

3.8 Final IECO-model design and the DII Final

Figure 18 shows the resulting IECO-model with its 91 variables/nodes, 43 parameters, and three stock variables. The green flows/links differentiate all variables related to the entrepreneurial skill set. In Appendix A this model view has been magnified and is made into 4 quadrant pictures, to help with reading the nodes.

System dynamics facilitates the use of equations in the model development. Here the function type chosen was multiplication. Multiplication was chosen to be able to look at innovation in a new way, where all flows and nodes are important as seen when investigating the brain. Here the IE is conceptually compared with the neural network, which also is far from fully explored, and new research are added every day to the body of knowledge of the IE.

As mentioned above the calculations in each node equation are multiplicative, which differs from most of the other indices, as they use addition in their index calculation formula. As a result of using multiplication, the IECO-model final result the DII Final is found by using the geometric mean, whereas other indices use the arithmetic mean.

Multiplication was used to capture each factor's combined impact with equal weights while calculating the absolute score per country. This model design has the premise that all the countries investigated have to have values between 0.001 - 1 for all the 38 parameters used to calculate the value in the "Innovation" node, which is equal to the resulting DII value. Additionally, all 43 parameters have to have a data value for each country investigated, a lack of entry in one of the parameters, or a value equal to zero will prevent the model from being able to run. Valid data may be less likely to exist for developing countries than for developed countries, so the current process required that data for all 43 parameters must be available for a country to be included, can limit the countries that can be entered into the model.

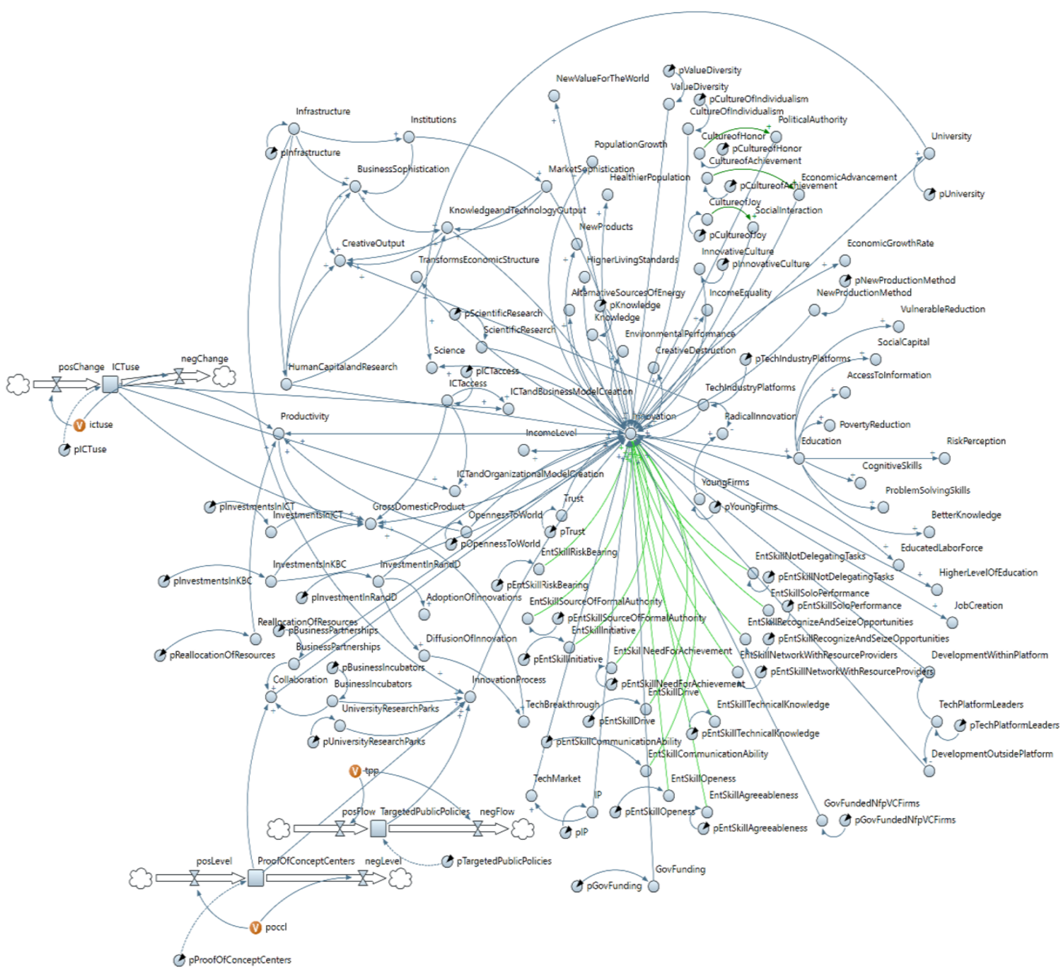


Figure 18: The IECO-model with parameters

3.8.1 The IECO-models' Earth View

The IECO-model has two layers of functionality. Figure 19 shows one layer called the "Earth view," where all the countries included in the sample/batch are listed. Here the final innovation index will be calculated, and the calculations are ongoing when the model is in "run mode." The calculations appear by each country, and are displayed when clicking on the red agent on the country.

From the "Earth view," the user can go to the "Country view" by clicking the red agent button on a particular country. Then, the "Country view" seen in Figure 20 will appear.

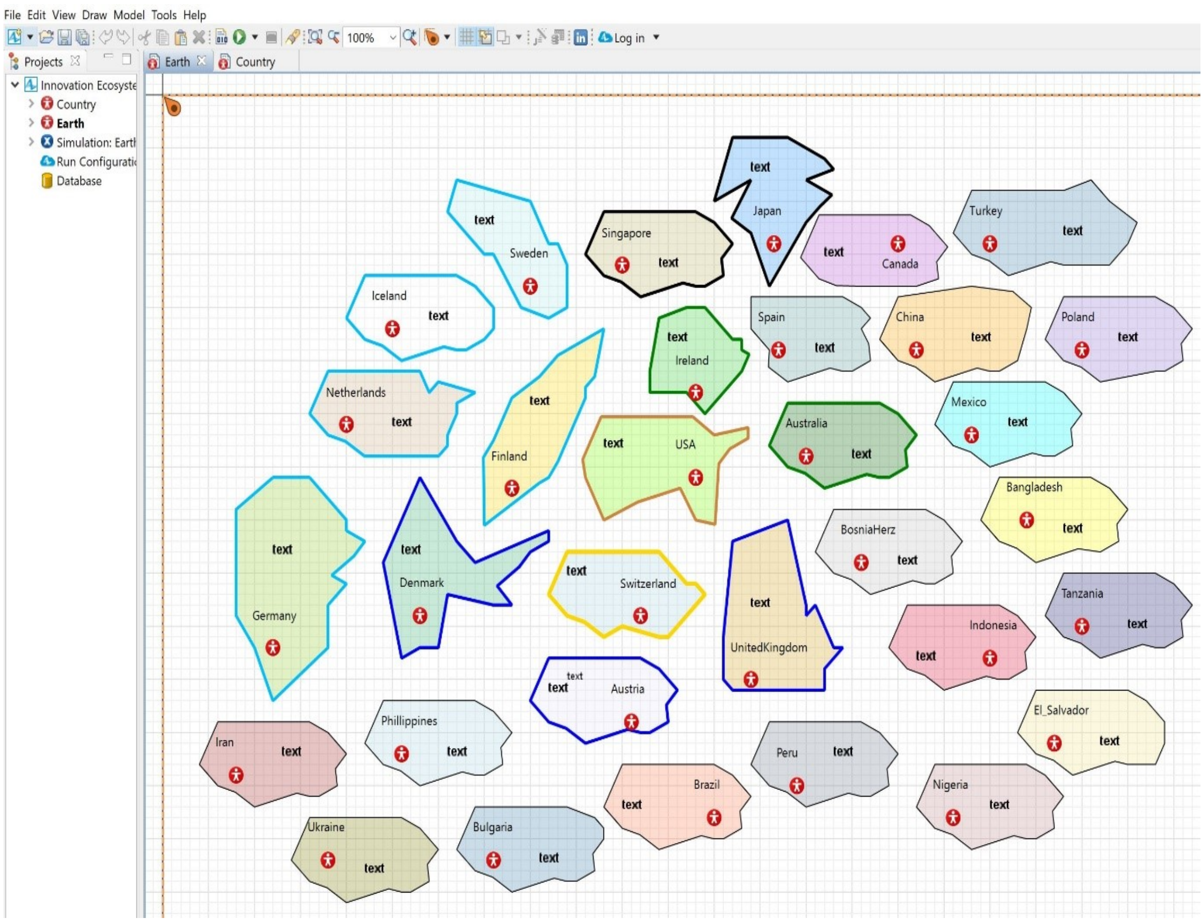


Figure 19: IECO-model's Earth view

3.8.2 The IECO-models' Country View

Below in Figure 20 the model's "Country View" is shown. Moreover, the three stock diagrams are also shown for the chosen country. When the model runs this view displays the changing dynamic parameters, so the user can observe development over time at each node.

Figure 20: IECO-model's Country view

Three stock variables are created in the model, and the details about each one are given in the following chapter section.

3.8.3 Stocks created for the IECO-model

Only three parameters were converted to stocks, as this requires longitudinal data from reliable sources which have been collected in the same manner over the whole observed period.

Creation of the ICTuse stock:

The graphical representation of the netChange for ICTuse is seen in Figure 21 below:

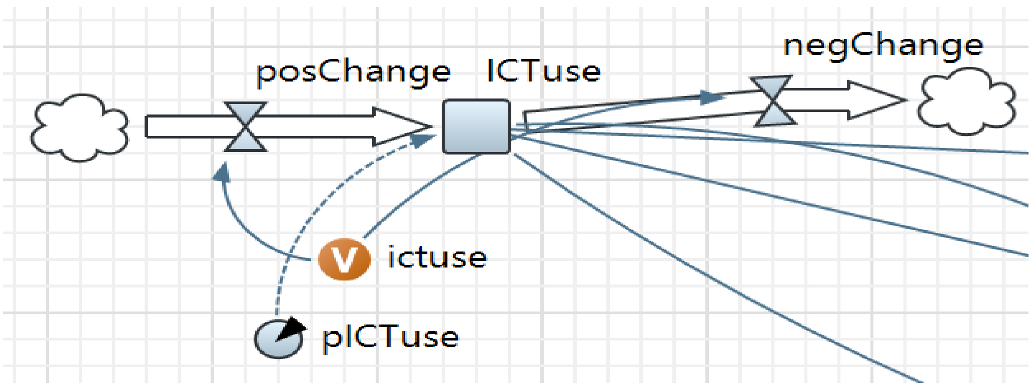


Figure 21: Stock variable for ICTuse

The equation for ICTuse at time *t* using 1-year increments can be expressed:

d(ICTuse)/dt = posChange – negChange, where

posChange = (earth.sheet4.getCellNumericValue("Sheet1", ictuse+5, 22)<0)?0:earth.sheet4.getCellNumericValue("Sheet1", ictuse+5, 22), and

negChange = (earth.sheet4.getCellNumericValue("Sheet1", ictuse+5, 22)>0)?0:-earth.sheet4.getCellNumericValue("Sheet1", ictuse+5, 22)

Data for this stock is retrieved from sheet 4 in the model and shown in Table 27:

Table 27: Data for ICTuse Node From GII 3.1.2, Called “sheet 4” in the IECO-Model

	Name									
Parameter 23:	3.1.2	GII - ICT Use								
ICT Use	Country	2011	2012	2013	2014	2015	2016	2017	Slope	R(squared)
	Australia	0.553	0.657	0.541	0.746	0.929	0.758	0.770	0.044	0.495
	Austria	0.494	0.599	0.634	0.597	0.748	0.647	0.667	0.026	0.526
	Bangladesh	0.001	0.001	0.001	0.024	0.027	0.060	0.106	0.016	0.815
	Bosnia & Herz	0.143	0.266	0.001	0.319	0.283	0.373	0.421	0.048	0.512
	Brazil	0.160	0.210	0.261	0.341	0.598	0.516	0.560	0.077	0.862
	Bulgaria	0.233	0.317	0.132	0.420	0.236	0.521	0.584	0.056	0.533
	Canada	0.430	0.486	0.394	0.638	0.913	0.684	0.685	0.060	0.509
	China	0.108	0.173	0.398	0.270	0.606	0.383	0.458	0.060	0.570
	Denmark	0.576	0.684	0.703	0.815	0.661	0.883	0.891	0.046	0.700
	El Salvador	0.047	0.082	0.001	0.125	0.535	0.241	0.187	0.045	0.301
	Finland	0.525	0.710	0.861	0.805	0.771	0.820	0.818	0.036	0.472
	Germany	0.475	0.569	0.646	0.605	0.669	0.698	0.749	0.039	0.888
	Iceland	0.484	0.688	0.601	0.750	0.614	0.800	0.844	0.047	0.651
	Indonesia	0.039	0.069	0.001	0.164	0.362	0.179	0.219	0.040	0.489
	Iran	0.106	0.047	0.176	0.114	0.370	0.219	0.274	0.037	0.526
	Ireland	0.427	0.516	0.396	0.608	0.677	0.685	0.738	0.055	0.800
	Japan	0.633	0.708	0.741	0.751	0.944	0.798	0.814	0.033	0.539
	Mexico	0.116	0.186	0.096	0.223	0.661	0.337	0.424	0.064	0.475
	Netherlands	0.566	0.638	0.463	0.732	0.929	0.768	0.777	0.049	0.465
	Nigeria	0.061	0.104	0.046	0.172	0.307	0.181	0.228	0.033	0.569
	Peru	0.096	0.155	0.030	0.163	0.629	0.211	0.294	0.047	0.263
	Philippines	0.050	0.148	0.021	0.146	0.480	0.354	0.293	0.057	0.539
	Poland	0.285	0.383	0.171	0.484	0.543	0.562	0.535	0.053	0.583
	Singapore	0.581	0.602	0.474	0.725	0.992	0.761	0.754	0.048	0.392
	Spain	0.430	0.534	0.301	0.552	0.944	0.662	0.693	0.060	0.399
	Sweden	0.639	0.754	0.767	0.825	0.700	0.831	0.836	0.024	0.494
	Switzerland	0.540	0.637	0.652	0.654	0.503	0.800	0.867	0.041	0.470
	Tanzania	0.005	0.043	0.095	0.049	0.299	0.027	0.003	0.006	0.015
	Turkey	0.157	0.246	0.189	0.263	0.559	0.377	0.418	0.051	0.585
	Ukraine	0.060	0.135	0.192	0.176	0.267	0.216	0.257	0.030	0.787
	UK - Britain	0.523	0.643	0.401	0.719	0.897	0.841	0.809	0.063	0.563
	USA	0.464	0.589	0.629	0.676	0.944	0.786	0.757	0.057	0.628

Creation of the Targeted Public Policies stock:

The graphical representation of the netFlow for TargetedPublicPolicies as in Figure 22:

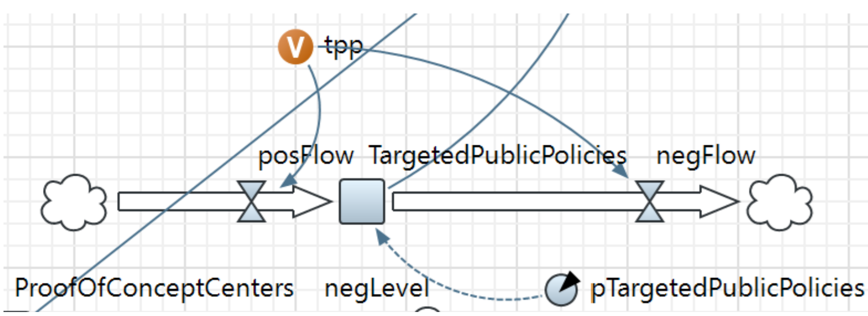


Figure 22: Stock variable for TargetedPublicPolicies

The equation for TargetedPublicPolicies at time *t* using 1-year increments can be expressed:

d(TargetedPublicPolicies)/dt = posFlow – negFlow

posFlow = (earth.sheet3.getCellNumericValue("Sheet1", ictuse+5, 22)<0)?0:earth.sheet3.getCellNumericValue("Sheet1", ictuse+5, 22), and

negFlow = (earth.sheet3.getCellNumericValue("Sheet1", ictuse+5, 22)>0)?0:-earth.sheet3.getCellNumericValue("Sheet1", ictuse+5, 22)

Data for this stock and flow is retrieved from sheet 3 in the model and shown in Table 28.

Table 28: Data for TargetedPublicPolicies Node, from GII 1.2.1, Called "sheet 3" in IECO-Model

	Name									
Parameter 36:	1.2.1	GII - Regulatory Quality								
Targeted Public Policies	Country	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**Slope**	**R(squared)**
	Australia	0.981	0.937	0.962	0.95	0.954	0.91	0.88	-0.013	0.683
	Austria	0.928	0.904	0.864	0.883	0.871	0.816	0.787	-0.021	0.873
	Bangladesh	0.233	0.298	0.283	0.236	0.231	0.214	0.183	-0.013	0.527
	Bosnia & Herz	0.514	0.4922	0.484	0.471	0.456	0.425	0.375	-0.021	0.914
	Brazil	0.552	0.565	0.539	0.511	0.495	0.429	0.366	-0.031	0.871
	Bulgaria	0.714	0.671	0.641	0.63	0.616	0.589	0.562	-0.023	0.969
	Canada	0.961	0.945	0.935	0.929	0.934	0.901	0.857	-0.014	0.812
	China	0.461	0.458	**0.439**	0.42	0.3964	0.381	0.352	-0.019	0.976
	Denmark	0.99	1	1	0.956	0.967	0.872	0.864	-0.024	0.779
	El Salvador	0.633	0.611	0.622	0.571	0.559	0.532	0.472	-0.025	0.907
	Finland	0.976	0.997	0.958	0.963	0.973	0.919	0.888	-0.014	0.700
	Germany	0.9238	0.917	0.89	0.888	0.891	0.867	0.847	-0.012	0.912
	Iceland	0.79	0.748	0.759	0.765	0.768	0.747	0.745	-0.005	0.383
	Indonesia	0.428	0.422	0.41	0.416	0.425	0.422	0.367	-0.006	0.378
	Iran	0.033	0.1	0.056	0.115	0.079	0.085	0.093	0.006	0.232
	Ireland	0.952	0.936	0.925	0.894	0.898	0.882	0.885	-0.012	0.901
	Japan	0.809	0.766	0.73	0.78	0.771	0.729	0.722	-0.011	0.495
	Mexico	0.609	0.587	0.586	0.611	0.6	0.553	0.523	-0.011	0.556
	Netherlands	0.971	0.972	0.977	0.945	0.948	0.887	0.873	-0.018	0.809
	Nigeria	0.2571	0.319	0.316	0.299	0.29	0.244	0.206	-0.012	0.370
	Peru	0.638	0.632	0.626	0.615	0.598	0.576	0.547	-0.015	0.921
	Philippines	0.523	0.45	0.426	0.473	0.459	0.443	0.411	-0.011	0.454
	Poland	0.795	0.764	0.746	0.738	0.605	0.709	0.676	-0.022	0.554
	Singapore	1	0.974	0.972	1	1	1	1	0.003	0.219
	Spain	0.847	0.8198	0.78	0.734	0.725	0.639	0.622	-0.039	0.972
	Sweden	0.966	0.953	0.974	0.981	0.981	0.894	0.883	-0.013	0.448
	Switzerland	0.947	0.936	0.923	0.922	0.913	0.897	0.87	-0.011	0.925
	Tanzania	0.381	0.412	0.38	0.384	0.387	0.362	0.328	-0.009	0.564
	Turkey	0.585	0.614	0.605	0.596	0.591	0.548	0.505	-0.014	0.605
	Ukraine	0.314	0.377	0.35	0.328	0.308	0.292	0.272	-0.012	0.545
	UK - Britain	0.942	0.96	0.918	0.916	0.948	0.9	0.895	-0.008	0.516
	USA	0.895	0.877	0.883	0.824	0.813	0.762	0.753	-0.026	0.936

Creation of the ProofOfConceptCenters stock:

The graphical representation of the netLevel of ProofOfCenceptCenters is in Figure 23:

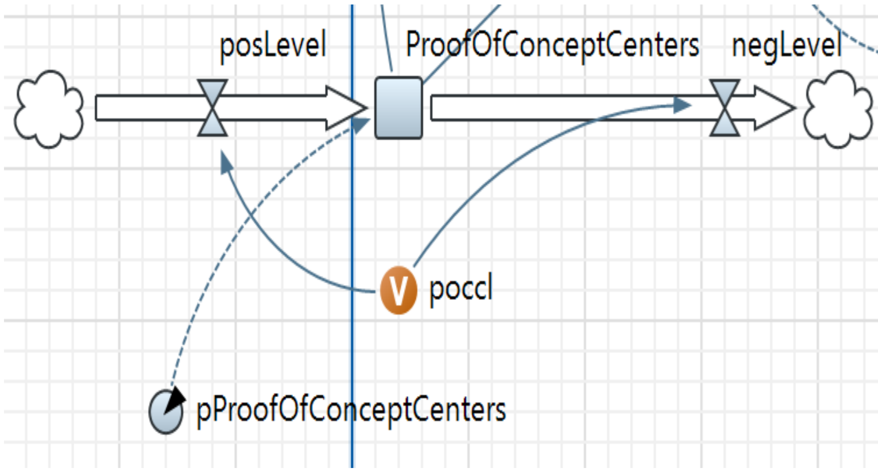


Figure 23: Stock variable for ProofOfConceptCenters

The equation for ProofOfConceptCenters at time *t* using 1-year increments can be expressed:

d(ProofOfConceptCenters)/dt = posLevel – negLevel

posLevel = (earth.sheet2.getCellNumericValue("Sheet1", ictuse+5, 22)<0)?0:earth.sheet2.getCellNumericValue("Sheet1", ictuse+5, 22), and

negLevel = (earth.sheet2.getCellNumericValue("Sheet1", ictuse+5, 22)>0)?0:-earth.sheet2.getCellNumericValue("Sheet1", ictuse+5, 22)

Data for this stock and flow is retrieved from sheet 2 in the model and shown in Table 29.

Table 29: Data for ProofOfConceptCenters Node, from GII 5.2.2, Called “sheet 2” in IECO-Model

	Name									
Parameter 33:	5.2.2	GII - State of Cluster Development								
Proof of	Country	2011	2012	2013	2014	2015	2016	2017	Slope	R(squared)
Concept Centers	Australia	0.495	0.493	0.539	0.545	0.530	0.510	0.495	0.001	0.007
	Austria	0.594	0.583	0.623	0.641	0.658	0.654	0.638	0.011	0.676
	Bangladesh	0.421	0.442	0.442	0.481	0.474	0.459	0.440	0.004	0.201
	Bosnia & Herz	0.370	0.396	0.385	0.160	0.243	0.326	0.358	-0.011	0.079
	Brazil	0.522	0.520	0.544	0.588	0.604	0.525	0.493	-0.001	0.001
	Bulgaria	0.337	0.366	0.412	0.388	0.326	0.359	0.437	0.007	0.149
	Canada	0.599	0.587	0.635	0.640	0.628	0.632	0.619	0.005	0.309
	China	0.646	0.643	0.596	0.601	0.593	0.587	0.609	-0.008	0.525
	Denmark	0.595	0.614	0.614	0.550	0.551	0.577	0.606	-0.004	0.083
	El Salvador	0.373	0.370	0.387	0.512	0.580	0.444	0.361	0.011	0.078
	Finland	0.685	0.723	0.711	0.680	0.677	0.651	0.648	-0.010	0.638
	Germany	0.642	0.620	0.685	0.730	0.748	0.744	0.727	0.020	0.722
	Iceland	0.464	0.468	0.543	0.505	0.486	0.495	0.515	0.005	0.176
	Indonesia	0.582	0.554	0.544	0.571	0.588	0.561	0.575	0.001	0.033
	Iran	0.364	0.358	0.392	0.406	0.403	0.426	0.432	0.013	0.913
	Ireland	0.511	0.526	0.591	0.633	0.633	0.648	0.657	0.026	0.883
	Japan	0.680	0.667	0.694	0.703	0.713	0.712	0.703	0.006	0.649
	Mexico	0.436	0.481	0.524	0.546	0.534	0.532	0.537	0.015	0.645
	Netherlands	0.613	0.612	0.654	0.695	0.724	0.702	0.711	0.019	0.810
	Nigeria	0.456	0.483	0.487	0.483	0.462	0.420	0.414	-0.010	0.499
	Peru	0.377	0.419	0.428	0.403	0.377	0.365	0.373	-0.006	0.283
	Philippines	0.428	0.447	0.504	0.505	0.505	0.496	0.457	0.007	0.194
	Poland	0.320	0.326	0.385	0.401	0.414	0.430	0.448	0.022	0.938
	Singapore	0.689	0.690	0.690	0.700	0.688	0.688	0.694	0.000	0.026
	Spain	0.479	0.483	0.507	0.525	0.497	0.487	0.542	0.007	0.380
	Sweden	0.653	0.645	0.662	0.638	0.623	0.637	0.664	-0.001	0.013
	Switzerland	0.624	0.398	0.674	0.713	0.725	0.717	0.689	0.032	0.347
	Tanzania	0.409	0.398	0.405	0.420	0.402	0.409	0.448	0.005	0.385
	Turkey	0.410	0.400	0.492	0.570	0.547	0.485	0.470	0.014	0.243
	Ukraine	0.302	0.286	0.353	0.311	0.332	0.325	0.325	0.005	0.200
	UK - Britain	0.596	0.624	0.688	0.676	0.705	0.716	0.722	0.021	0.868
	USA	0.634	0.632	0.671	0.705	0.736	0.747	0.759	0.024	0.955

Now the IECO-model is fully developed, and all nodes and parameters are created. The model is ready for testing and comparison with other indices, and those results are in Chapter 4.

3.9 The chosen data sources for model testing and evaluation

Two innovation indices were selected for validation. One was the Economic Complexity Index from Harvard. This data set of 128 countries included only 30 of the current sample of 32 countries. The second index was the Bloomberg Innovation Index, which includes 50 countries, 22 of which are in the current sample. This research also used the Bloomberg Innovation Index to validate the top 10 innovation index scoring countries.

3.9.1 The Economic Complexity Index, ECI

According to the webpage of the Atlas of Economic Complexity, the Atlas is intended for policymakers, researchers, investors, entrepreneurs, students, and the general public to better understand the economic structure of their country and to discover paths to prosperity, all through powerful and accessible data visualizations.

Each country's Economic Complexity Index (ECI) is calculated for a given year, based on the number and the complexity of the products that a country exports with comparative advantage. From studies it is seen that countries that do well in this index, taken their income level into consideration, tend to achieve higher levels of economic growth (Hausmann et al., 2013).

122 countries were ranked in 2016, and the rankings of the 32 countries in the current sample are shown in Tables 36 and 37. These tables also compare each country's ECI ranking to their GII 2017, GEI 2017, and DII Final.

3.9.2 The Bloomberg Innovation Index, BII

Since 2012 the BII has ranked the most innovative countries in the world according to the BII's categories. In the current work, the BII 2017 is used to validate the DII 2017's top 10 most innovative countries. The BII 2017 uses the seven following categories, and their definitions, to rank the countries:

1. **R&D intensity:** R&D expenditure as % of GDP.
2. **Manufacturing added-value:** MVA as % of GDP and per capita ($PPP).
3. **Productivity:** GDP and GNI per employed person age 15+ and 3Y improvement.
4. **High-tech density:** Number of domestically domiciled high-tech companies – such as aerospace and defense, biotechnology, hardware, software, semiconductors, Internet software and services, and renewable energy companies – as % of domestic publicly listed companies and as a share of world's total public high-tech companies.

5. **Tertiary efficiency:** Total enrollment in tertiary education, regardless of age, as % of the post-secondary cohort; the minimum share of labor force with at least tertiary degrees; annual new science and engineering graduates as % of total tertiary graduates and as % of the labor force.
6. **Researcher concentration:** Professionals, including postgraduate Ph.D. students engaged in R&D per million population.
7. **Patent activity:** Resident patent filings, total patent grants and patent in force, per million population; filings per $100 billion GDP and total grants by country as a share of the world total.

These two indices, ECI 2016 and BII 2017 will ensure that the IECO-model will be compared with ranking models which have very different conceptual designs from the DII.

CHAPTER 4: RESULTS

Figure 24 shows an overview of the steps used in finding the DII Final results:

Reviewing thoroughly the literature on innovation, focusing on societal factors influencing it and its effects., entrepreneurship indices and more.

↓

Identifying **104** relationships of various types that show how societal factors underlie innovation.

↓

Reducing the relationship set to **91** by focusing on relationships from trustworthy sources and with data available. See Figure 25.

↓

Designing the model. Converting **43** nodes having only output (no input) into parameters. See Figure 26.

↓

Identifying the **38** variables/parameters used in the Innovation equation to calculate the DII. To calculate the **DII Final** the geometric mean is used.

↓

Comparing the DII Final ranking results for each of the 32 countries with other entrepreneurship or innovation

Figure 24: Steps in the creation of the DII results

Figure 25 lists the final 91 nodes used in the IECO-model.

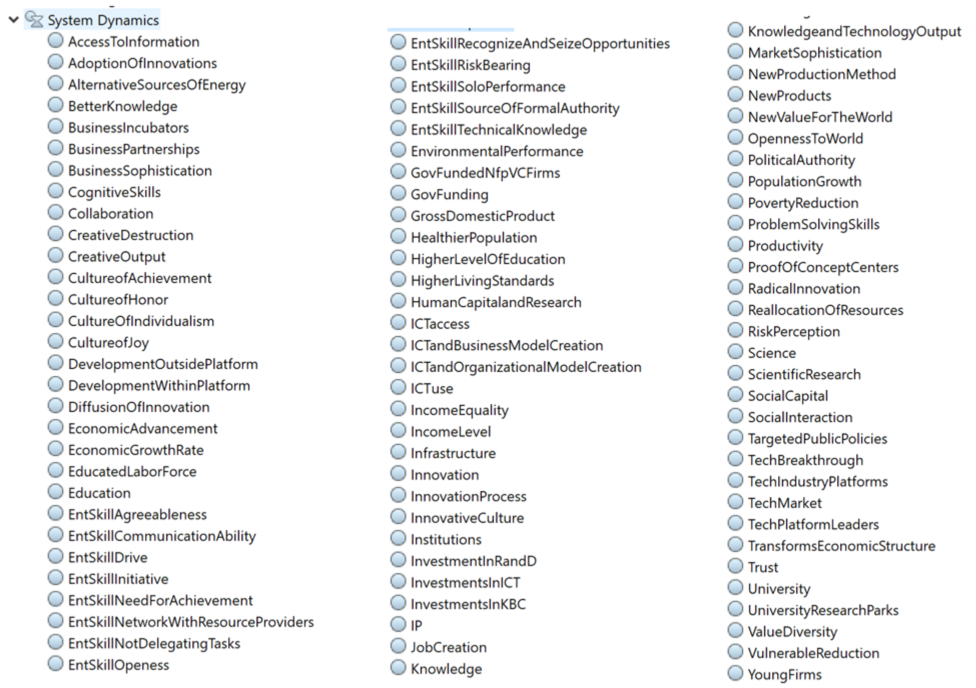


Figure 25: The 91 nodes/relations in the IECO-model

Figure 26 lists the 43 parameters created for the IECO-model.

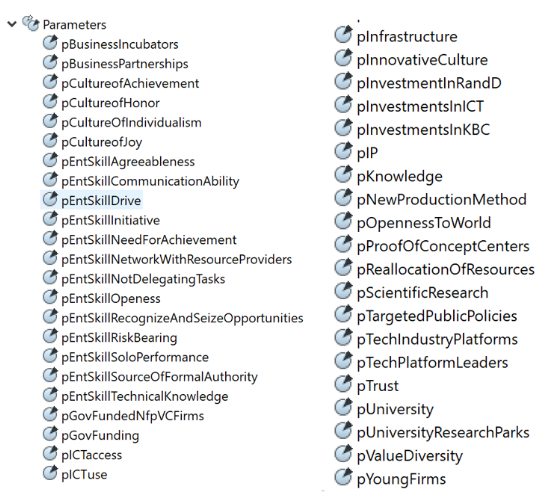


Figure 26: The 43 parameters in the IECO-model

4.1 Country Results for all 32 countries

The resulting dynamic innovation index (DII), from the IECO-model is below in Figure 27, in the model's "Earth view" in which each of the 32 countries display the final value of the DII next to the country name.

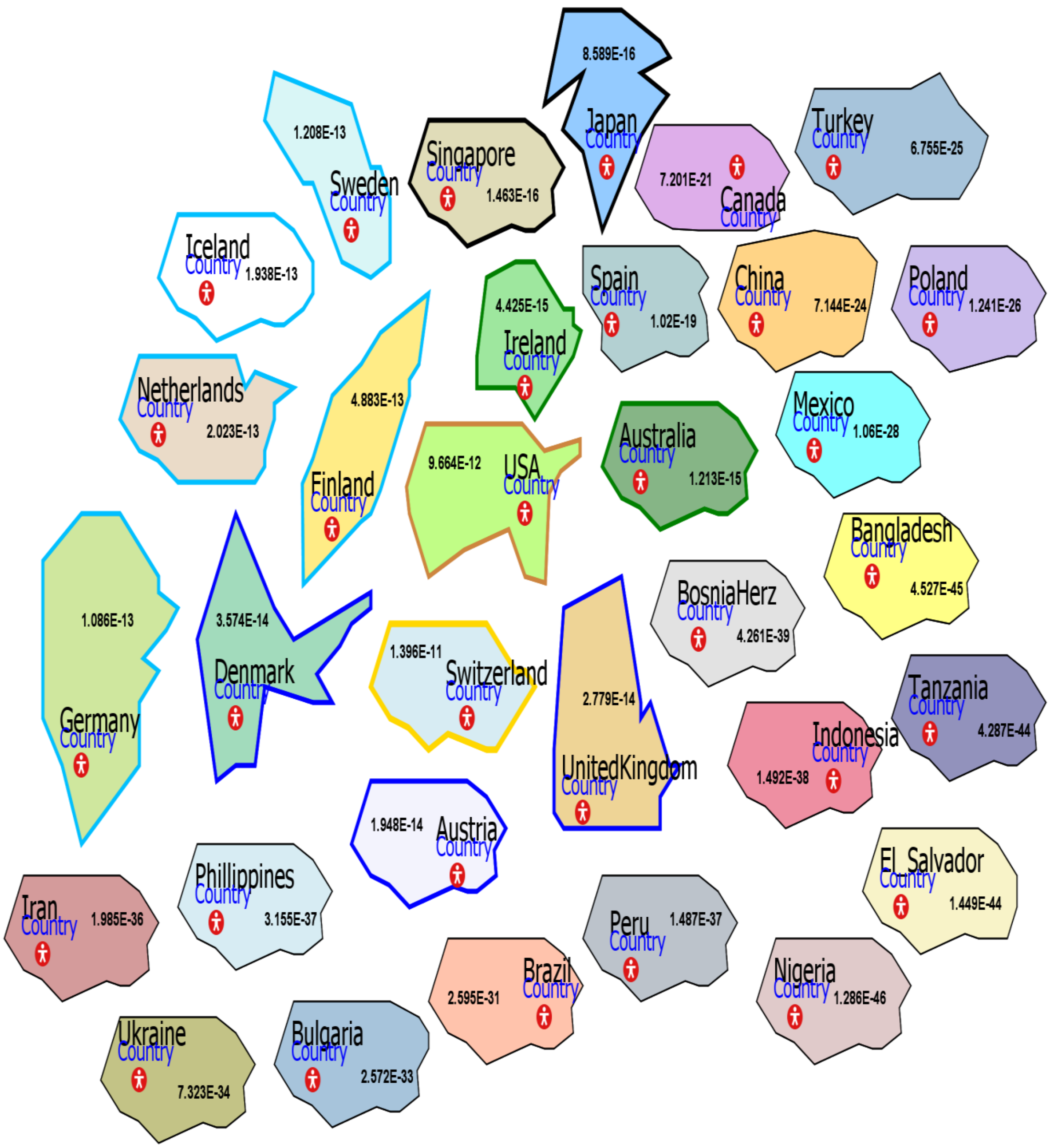


Figure 27: Ranking of countries visually from the IECO-model

In Figure 27 the color coding on the frame of the countries indicates countries with similarly-sized DIIs. Table 30 lists the countries that are in the same size range and therefore have the same color on their country's frame.

Table 30: DII Final Results Size Clustering

Same cluster – color	Countries clustering – same range of result (DII result)
	Switzerland (1)
	USA (2)
	Finland (3), Netherlands (4), Iceland (5), Sweden (6), and Germany (7)
	Denmark (8), United Kingdom (9), and Austria (10)
	Ireland (11), and Australia (12)
	Japan (13), and Singapore (14)

Table 31 shows the final ranked order of the 32 countries along with the country's GDP (World Bank 2016), and the GDP/capita (World Bank 2016). The model can also show the resulting values for each country in the "Country view," which is in Figure 28 below. Figure 29 presents Switzerland for demonstrations, and here all the calculations for each individual flow are seen, and the three stock variables' values over seven periods are illustrated in the three diagrams. A small arrow on top to the left in Figure 29 shows how the model is designed with the feature to be able to swap back and forth between the "Earth" and "Country" view, and a button named "To Earth" is created for that functionality.

The DII Final ranking result for the 32 countries is below in Table 31. For each result, the geometric mean is written in blue and referred to as DII Final. The GDP and the GDP/capita for each country are also presented, while wealthier countries tend to have more innovation. It does seem to be the case here that the countries with very high GDP/capita are ranked very high in regards to innovation.

Table 31: Results for DII (2017), DII FINAL, GDP (2016), and GDP/capita (2016)

No	Country	DII 2017 Results	$\sqrt[38]{DII\ 2017}$ = DII FINAL	GDP (2016) Mill $ World Bank (2016)	GDP/capita $ World Bank (2016)
1	Switzerland	1.396 E-11	0.518	668,851	79,887.5
2	United States	9.664 E-12	0.513	18,624,475	57,638.2
3	Finland	4.883 E-13	0.474	238,503	43,433.0
4	Netherlands	2.023 E-13	0.463	777,228	45,637.9
5	Iceland	1.938 E-13	0.462	20,047	60,529.9
6	Sweden	1.208 E-13	0.457	514,460	51,844.8
7	Germany	1.086 E-13	0.455	3,477,796	42,161.3
8	Denmark	3.574 E-14	0.442	306,900	55,578.8
9	United Kingd.	2.779 E-14	0.439	2,647,899	40,412.0
10	Austria	1.948 E-14	0.435	390,800	44,757.6
11	Ireland	4.425 E-15	0.419	304,819	64,175.4
12	Australia	1.213 E-15	0.405	1,204,616	49,755.3
13	Japan	8.589 E-16	0.401	4,940,159	38,972.3
14	Singapore	1.463 E-16	0.383	296,976	52,962.5
15	Spain	1.02 E-19	0.316	1,237,255	26,615.5
16	Canada	7.201 E-21	0.295	1,529,760	42,348.9
17	China	7.144 E-24	0.245	11,199,145	8,123.2
18	Turkey	6.755 E-25	0.231	863,712	10,862.6
19	Poland	1.241 E-26	0.208	471,364	12,414.1
20	Mexico	1.06 E-28	0.183	1,046,923	8,208.6
21	Brazil	2.595 E-31	0.156	1,796,187	8,649.9
22	Bulgaria	2.572 E-33	0.138	53,238	7,469.0
23	Ukraine	7.323 E-34	0.134	93,270	2,185.7
24	Iran	1.985 E-36	0.114	418,977	5,219.1
25	Philippines	3.155 E-37	0.109	192,207	2,951.1
26	Peru	1.487 E-37	0.107	304,905	6,049.2
27	Indonesia	1.492 E-38	0.101	932,259	3,570.3
28	Bosnia & Her.	4.261 E-39	0.097	16,910	4,808.4
29	Tanzania	4.287 E-44	0.072	26,797	877.5
30	El Salvador	1.449 E-44	0.070	47,340	4,223.6
31	Bangladesh	4.527 E-45	0.068	205,276	1,358.8
32	Nigeria	1.286 E-46	0.061	404,653	2,175.7

4.2 Calculation details and proof of "Innovation" node results

The formula in the model used to find the DII consists of 38 variable inputs that are multiplied, and are equal to the node "**Innovation**," as seen in Figure 28 with purple flows. In the center of the model, the "Innovation" node has inflow from 40 nodes. Each node consists of its own equation, which becomes a part of the "Innovation" equation due to the flow from that node to the Innovation node. To illustrate that process, in the following equations, a series of steps are taken to mathematically reduce the formula. These steps show the nodes and parameters from which the data originate. Appendix B shows a magnified Figure 28, separated into 4 quadrant figures, to enhance the readability of the nodes.

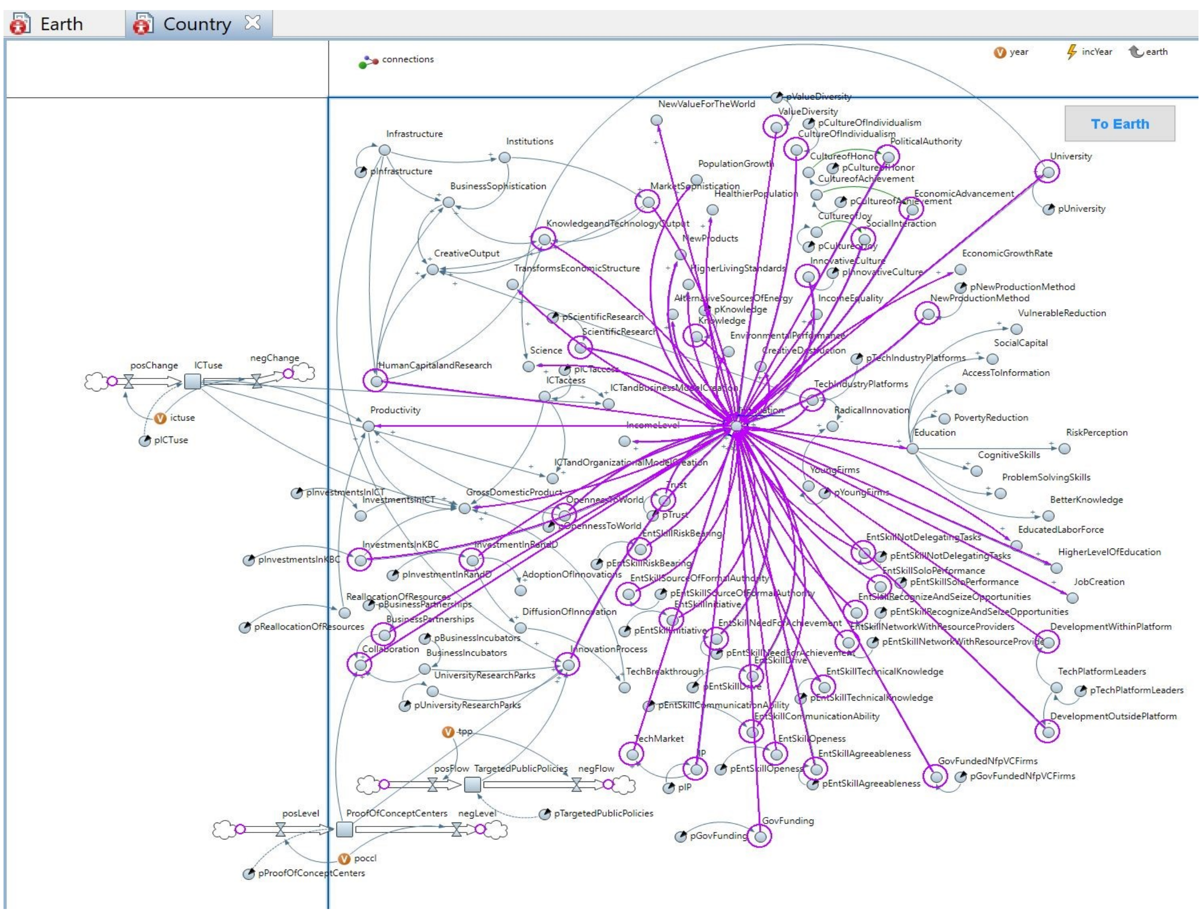


Figure 28: IECO-model with purple flows showing the to and from Innovation node

The **"Innovation"** formula is the following, referring to the node names from Table 25:

Innovation = EntSkillNeedForAchievement * EntSkillRiskBearing * EntSkillNotDelegatingTasks * EntSkillSoloPerformance * EntSkillDrive * EntSkillTechnicalKnowledge * ScientificResearch * EntSkillRecognizeAndSeizeOpportunities * InvestmentInRandD * Knowledge * InnovativeCulture * EntSkillSourceOfFormalAuthority * EntSkillNetworkWithResourceProviders * EntSkillInitiative * Trust * EntSkillCommunicationAbility * TechIndustryPlatforms * InnovationProcess * IP * OpennessToWorld * DevelopmentOutsidePlatform * DevelopmentWithinPlatform * TechMarket * PoliticalAuthority * SocialInteraction * EconomicAdvancement * InvestmentsInKBC * EntSkillOpeness * EntSkillAgreeableness * BusinessPartnerships * ValueDiversity * MarketSophistication * HumanCapitalandResearch * KnowledgeandTechnologyOutput * Collaboration * CultureOfIndividualism * GovFundedNfpVCFirms * GovFunding * NewProductionMethod * University

The Innovation formula in the algebraic version is below, referring to Table 25:

Innovation = $X_{27} * X_{32} * X_{29} * X_{33} * X_{25} * X_{35} * X_{77} * X_{31} * X_{55} * X_{60} * X_{53} * X_{34} * X_{28} * X_{26} * X_{86} * X_{24} * X_{82} * \mathbf{X_{52}} * X_{58} * X_{66} * \mathbf{X_{16} * X_{17} * X_{83} * X_{67} * X_{79} * X_{19}} * X_{57} * X_{30} * X_{23} * X_{6} * X_{89} * \mathbf{X_{62} * X_{43} * X_{61} * X_{9}} * X_{14} * X_{37} * X_{38} * X_{63} * X_{87}$

The variable values, X_{ii} that are bolded in the formula above refer to those values are not just an integer value; instead, they are equal to another function. The non-bolded variables are equal to the parameter value that can be found in the model's database for the particular country's variable value. All the parameter data sources can be seen in Appendix E, and all the 43 parameter values found and inserted in the model for each country can be seen in Appendix I.

After adding all the formulas from the bolded variables above, the final formula for **"Innovation"** in its reduced form and written in numerical listing order consists of 38 parameters being multiplied:

Innovation = $(x_5)^2 * (x_6)^2 * x_{12} * x_{13} * x_{14} * x_{15} * x_{23} * x_{24} * x_{25} * x_{26} * x_{27} * x_{28} * x_{29} * x_{30} * x_{31} * x_{32} * x_{33} * x_{34} * x_{35} * x_{37} * x_{38} * (x_{50})^8 * x_{53} * x_{55} * x_{57}\ (x_{58})^2\ x_{60} * x_{63} * x_{66} * [d(x_{72})/dt]^2 * x_{77} * d(x_{80})/dt * x_{82} * (x_{84})^2 * x_{86} * x_{87} * x_{88} * x_{89} = \prod_{1}^{38} \mathbf{Xi}$

The "Innovation" result for USA is here converted to multiplication of the 38 parameters by using Table 32 below to find each parameters' actual value and then insert it in the formula:

Innovation = $(P_1)^2 * (P_2)^2 * P_3 * P_4 * P_5 * P_6 * P_7 * P_8 * P_9 * P_{10} * P_{11} * P_{12} * P_{13} * P_{14} * P_{15} * P_{16} * P_{17} * P_{18} * P_{19} * P_{20} * P_{21} * (P_{24})^8 * P_{25} * P_{26} * P_{28} * (P_{29})^2 * P_{30} * P_{31} * P_{32} * (P_{33})^2 * P_{35} * P_{36} * P_{37} * (P_{38})^2 * P_{39} * P_{40} * P_{41} * P_{42} = \prod_{1}^{38} \mathbf{Pi}$

As an example, the **"Innovation"** result for USA is calculated with the parameter values inserted here:

Innovation (USA) = $(0.766)^2 * (1)^2 * 0.71 * 0.29 * 0.776 * 0.54 * 0.68 * 0.654 * 0.845 * 1 * 0.877 * 0.529 * 0.473 * 0.582 * 0.84 * 0.844 * 0.451 * 0.93 * 0.38 * 1 * 0.722 * (0.528)^8 * 0.525 * 0.028 * 0.501 * (0.16)^2\ 0.634 * 0.909 * 0.537 * 0.932 * [0.801]^2 * 0.713 * 0.812 * (1)^2 * 0.79 * 0.547 * 0.912 * 1 =$ $\mathbf{9.645 * 10^{-1}}$ (result comes from using Excel's Product formula).

Table 32: The 43 parameters numbered and their data value for USA

USA - Country

Name: USA

☑ Show name ☐ Ignore

◉ Single agent ○ Population of agents

Parameter	No.	Value
pCultureofJoy:	P6 =	0.54
pCultureofAchievement:	P3 =	0.71
pInfrastructure:	P24 =	0.528
pICTuse:	P23 =	
pInvestmentsInKBC:	P28 =	0.501
pReallocationOfResources:	P34 =	0.712
pCultureofHonor:	P4 =	0.29
pNewProductionMethod:	P31 =	0.909
pTechPlatformLeaders:	P38 =	1
pGovFundedNfpVCFirms:	P20 =	1
pEntSkillAgreeableness:	P7 =	0.68
pGovFunding:	P21 =	0.722
pProofOfConceptCenters:	P33 =	
pUniversityResearchParks:	P41 =	0.912
pScientificResearch:	P35 =	0.932
pICTaccess:	P22 =	0.827
pValueDiversity:	P42 =	1
pCultureOfIndividualism:	P5 =	0.776
pYoungFirms:	P43 =	1
pEntSkillNotDelegatingTasks:	P13 =	0.473
pEntSkillSoloPerformance:	P17 =	0.451

USA - Country

Parameter	No.	Value
pEntSkillRecognizeAndSeizeOpportunities:	P15 =	0.85
pEntSkillTechnicalKnowledge:	P19 =	0.38
pEntSkillOpeness:	P14 =	0.582
pEntSkillCommunicationAbility:	P8 =	0.654
pEntSkillDrive:	P9 =	0.845
pEntSkillNeedForAchievement:	P11 =	0.877
pOpennessToWorld:	P32 =	0.537
pEntSkillRiskBearing:	P16 =	0.844
pEntSkillSourceOfFormalAuthority:	P18 =	0.93
pEntSkillInitiative:	P10 =	1
pIP:	P29 =	0.16
pInvestmentInRandD:	P26 =	0.028
pBusinessIncubators:	P1 =	0.766
pTrust:	P39 =	0.79
pKnowledge:	P30 =	0.634
pInnovativeCulture:	P25 =	0.525
pTechIndustryPlatforms:	P37 =	0.812
pEntSkillNetworkWithResourceProviders:	P12 =	0.529
pBusinessPartnerships:	P2 =	1
pTargetedPublicPolicies:	P36 =	
pInvestmentsInICT:	P27 =	0.852
pUniversity:	P40 =	0.547

For all the other 31 countries, the same calculation can be done, and the formula is the same as the one seen above. Table 31 presents the ranked DII results, the output from the "**Innovation"** equation.

All data for the 38 parameters used for calculating the DII, for all the 32 countries, are listed in Table 33. The calculations are made with the use of the Excel Product formula. There is a small difference in the outputs from Excel and Anylogic (the modeling platform in which the IECO-model was built), and it must be due to differences in rounding when multiplying 38 parameters. All data values have been checked and are the same as the ones entered in the model. The data for each country are in Appendix I.

Table 33: The Data Used to Calculate the DII Parameters for 32 Countries

b_i	Country / Var./ P_i	Austra-lia	Austria	Bangla-desh	Bosnia & Herzego	Brazil	Bulgaria	Canada	China
b_1	$(x_5)^2 = (P_1)^2$	$(0.88)^2$	$(0.821)^2$	$(0.322)^2$	$(0.14)^2$	$(0.137)^2$	$(0.276)^2$	$(0.389)^2$	$(0.261)^2$
b_2	$(x_6)^2 = (P_2)^2$	$(0.721)^2$	$(0.843)^2$	$(0.015)^2$	$(0.506)^2$	$(0.063)^2$	$(0.252)^2$	$(0.161)^2$	$(0.255)^2$
b_3	$x_{12} = P_3$	0.9	0.88	0.09	0.63	0.6	0.57	0.8	0.45
b_4	$x_{13} = P_4$	0.1	0.12	0.91	0.37	0.39	0.43	0.2	0.55
b_5	$x_{14} = P_5$	0.891	0.919	0.417	0.549	0.456	0.776	0.899	0.402
b_6	$x_{15} = P_6$	0.71	0.85	0.21	0.56	0.91	0.1	0.72	0.2
b_7	$x_{23} = P_7$	0.69	0.74	0.01	0.28	0.44	0.4	0.73	0.08
b_8	$x_{24} = P_8$	0.562	0.496	0.089	0.215	0.234	0.312	0.569	0.078
b_9	$x_{25} = P_9$	0.905	0.881	0.845	0.881	0.821	0.786	0.833	0.952
b_{10}	$x_{26} = P_{10}$	1	0.844	0.04	0.105	0.199	0.81	0.137	0.152
b_{11}	$x_{27} = P_{11}$	0.748	0.691	0.2	0.316	0.362	0.277	0.213	0.271
b_{12}	$x_{28} = P_{12}$	0.509	0.574	0.104	0.11	0.401	0.396	0.270	0.491
b_{13}	$x_{29} = P_{13}$	0.179	0.341	0.144	0.185	0.211	0.235	0.391	0.388
b_{14}	$x_{30} = P_{14}$	0.642	0.537	0.224	0.328	0.328	0.119	0.657	0.179
b_{15}	$x_{31} = P_{15}$	0.955	0.815	0.265	0.098	0.393	0.130	0.302	0.131
b_{16}	$x_{32} = P_{16}$	0.678	0.692	0.022	0.015	0.276	0.188	0.334	0.525
b_{17}	$x_{33} = P_{17}$	0.648	0.63	0.103	0.335	0.333	0.324	0.565	0.277
b_{18}	$x_{34} = P_{18}$	0.97	0.96	0.56	0.62	0.81	0.379	0.98	0.18
b_{19}	$x_{35} = P_{19}$	0.449	0.406	0.2	0.24	0.216	0.323	0.437	0.001
b_{20}	$x_{37} = P_{20}$	0.964	0.585	0.068	0.243	0.161	0.204	0.387	0.89
b_{21}	$x_{38} = P_{21}$	0.452	0.402	0.324	0.384	0.373	0.387	0.743	0.35
b_{22}	$(x_{50})^8 = (P_{24})^8$	$(0.537)^8$	$(0.515)^8$	$(0.355)^8$	$(0.255)^8$	$(0.309)^8$	$(0.354)^8$	$(0.597)^8$	$(0.675)^8$
b_{23}	$x_{53} = P_{25}$	0.44	0.378	0.292	0.272	0.188	0.495	0.362	0.643
b_{24}	$x_{55} = P_{26}$	0.022	0.031	0.001	0.002	0.012	0.01	0.016	0.021
b_{25}	$x_{57} = P_{28}$	0.503	0.549	0.301	0.265	0.38	0.594	0.508	0.711
b_{26}	$(x_{58})^2 = (P_{29})^2$	$(0.02)^2$	$(0.104)^2$	$(0.001)^2$	$(0.01)^2$	$(0.015)^2$	$(0.023)^2$	$(0.026)^2$	$(0.492)^2$

b_{27}	$x_{60} = P_{30}$	0.343	0.427	0.045	0.059	0.167	0.231	0.406	0.66
b_{28}	$x_{63} = P_{31}$	0.587	0.739	0.026	0.128	0.134	0.054	0.441	0.863
b_{29}	$x_{66} = P_{32}$	0.597	0.507	0.358	0.239	0.045	0.403	0.582	0.821
b_{30}	$[d(x_{72})/dt]^2 = (P_{33})^2$	$(0.501)^2$	$(0.671)^2$	$(0.452)^2$	$(0.29)^2$	$(0.518)^2$	$(0.387)^2$	$(0.635)^2$	$(0.59)^2$
b_{31}	$x_{77} = P_{35}$	0.765	0.710	0.146	0.254	0.163	0.464	0.648	0.665
b_{32}	$d(x_{80})/dt = P_{36}$	0.89	0.78	0.14	0.369	0.334	0.553	0.86	0.33
b_{33}	$x_{82} = P_{37}$	0.774	0.892	0.125	0.394	0.193	0.291	0.230	0.213
b_{34}	$(x_{84})^2 = (P_{38})^2$	$(0.686)^2$	$(0.517)^2$	$(0.106)^2$	$(0.001)^2$	$(0.661)^2$	$(0.001)^2$	$(0.732)^2$	$(0.891)^2$
b_{35}	$x_{86} = P_{39}$	0.81	0.88	1	0.75	0.88	0.7	0.69	0.06
b_{36}	$x_{87} = P_{40}$	0.586	0.597	0.161	0.902	0.493	0.471	0.449	0.696
b_{37}	$x_{88} = P_{41}$	0.965	0.837	0.817	0.651	0.65	0.868	0.982	0.81
b_{38}	$x_{89} = P_{42}$	0.937	0.530	0.126	0.231	0.1	0.243	0.128	0.445
$\prod_{1}^{38}$	$\prod_{5}^{89} Xi$	1.212 E-15	1.947 E-14	4.517 E-45	4.245 E-39	2.601 E-31	2.574 E-33	7.201 E-21	7.154 E-24
IECO-model – DII 2017		**1.213 E-15**	**1.948 E-14**	**4.527 E-45**	**4.261 E-39**	**2.595 E-31**	**2.572 E-33**	**7.201 E-21**	**7.144 E-24**
$\sqrt[38]{DII\ 2017}$ = **DII FINAL**		**0.405**	**0.435**	**0.068**	**0.097**	**0.156**	**0.138**	**0.295**	**0.245**

b_i	Country / Var./ P_i	Den-mark	El Sal-vador	Finland	Ger-many	Iceland	Indo-nesia	Iran	Ireland
b_1	$(x_5)^2 = (P_1)^2$	$(1)^2$	$(0.162)^2$	$(1)^2$	$(0.763)^2$	$(1)^2$	$(0.285)^2$	$(0.269)^2$	$(0.907)^2$
b_2	$(x_6)^2 = (P_2)^2$	$(0.394)^2$	$(0.099)^2$	$(0.683)^2$	$(0.779)^2$	$(0.952)^2$	$(0.045)^2$	$(0.147)^2$	$(0.827)^2$
b_3	$x_{12} = P_3$	0.98	0.15	0.94	0.92	0.93	0.3	0.18	0.69
b_4	$x_{13} = P_4$	0.02	0.85	0.06	0.08	0.07	0.7	0.82	0.27
b_5	$x_{14} = P_5$	0.98	0.471	0.958	0.948	0.95	0.494	0.365	0.885
b_6	$x_{15} = P_6$	0.31	0.38	0.74	0.65	0.68	0.51	0.36	0.75
b_7	$x_{2\ 3} = P_7$	0.79	0.19	0.71	0.81	0.88	0.05	0.06	0.63

b_8	**$x_{24} = P_8$**	0.665	0.136	0.467	0.604	0.814	0.152	0.187	0.505
b_9	**$x_{25} = P_9$**	0.726	0.786	0.702	0.786	1	0.655	0.774	0.774
b_{10}	**$x_{26} = P_{10}$**	0.634	0.240	0.943	0.569	1	0.39	0.623	0.904
b_{11}	**$x_{27} = P_{11}$**	0.923	0.303	0.905	0.832	0.64	0.296	0.148	0.743
b_{12}	**$x_{28} = P_{12}$**	0.674	0.397	0.986	0.381	1	0.53	0.43	0.391
b_{13}	**$x_{29} = P_{13}$**	0.471	0.22	0.449	0.427	0.401	0.199	0.127	0.811
b_{14}	**$x_{30} = P_{14}$**	0.672	0.836	0.358	0.299	0.701	0.313	0.373	0.627
b_{15}	**$x_{31} = P_{15}$**	1	0.269	0.914	0.761	0.948	0.24	0.086	0.664
b_{16}	**$x_{32} = P_{16}$**	0.736	0.192	0.75	0.624	0.903	0.251	0.016	0.664
b_{17}	**$x_{33} = P_{17}$**	0.833	0.133	0.683	0.671	0.682	0.22	0.168	0.397
b_{18}	**$x_{34} = P_{18}$**	0.98	0.77	1	0.96	1	0.65	0.160	0.97
b_{19}	**$x_{35} = P_{19}$**	0.451	0.121	0.46	0.442	0.478	0.098	0.177	0.406
b_{20}	**$x_{37} = P_{20}$**	1	0.188	0.591	0.758	0.604	0.166	0.317	0.63
b_{21}	**$x_{38} = P_{21}$**	0.714	0.32	0.678	0.449	0.663	0.332	0.204	0.505
b_{22}	**$(x_{50})^8 = (P_{24})^8$**	$(0.431)^8$	$(0.207)^8$	$(0.531)^8$	$(0.501)^8$	$(0.592)^8$	$(0.467)^8$	$(0.381)^8$	$(0.471)^8$
b_{23}	**$x_{53} = P_{25}$**	0.398	0.045	0.403	0.431	0.311	0.398	0.425	0.625
b_{24}	**$x_{55} = P_{26}$**	0.03	0.001	0.029	0.029	0.022	0.001	0.003	0.015
b_{25}	**$x_{57} = P_{28}$**	0.538	0.391	0.577	0.657	0.583	0.375	0.478	0.625
b_{26}	**$(x_{58})^2=(P_{29})^2$**	$(0.131)^2$	$(0.001)^2$	$(0.146)^2$	$(0.187)^2$	$(0.056)^2$	$(0.004)^2$	$(0.101)^2$	$(0.027)^2$
b_{27}	**$x_{60} = P_{30}$**	0.503	0.014	0.612	0.673	0.485	0.029	0.25	0.241
b_{28}	**$x_{63} = P_{31}$**	1	0.199	0.792	0.757	0.684	0.49	0.126	0.84
b_{29}	**$x_{66} = P_{32}$**	1	0.224	0.866	0.522	0.612	0.761	0.97	0.522
b_{30}	**$[d(x_{72})/dt]^2 = (P_{33})^2$**	$(0.569)^2$	$(0.449)^2$	$(0.613)^2$	$(0.754)^2$	$(0.502)^2$	$(0.591)^2$	$(0.452)^2$	$(0.692)^2$
b_{31}	**$x_{77} = P_{35}$**	0.727	0.035	0.867	0.841	0.869	0.198	0.187	0.756
b_{32}	**$d(x_{80})/dt = P_{36}$**	0.823	0.457	0.875	0.841	0.758	0.386	0.076	0.868
b_{33}	**$x_{82} = P_{37}$**	1	0.094	0.601	0.789	1	0.026	0.303	0.801

b_{34}	$(x_{84})^2 = (P_{38})^2$	$(0.723)^2$	$(0.001)^2$	$(0.735)^2$	$(0.971)^2$	$(0.442)^2$	$(0.001)^2$	$(0.001)^2$	$(0.811)^2$
b_{35}	$x_{86} = P_{39}$	0.9	0.84	0.88	0.77	0.96	1	0.99	0.91
b_{36}	$x_{87} = P_{40}$	0.741	0.32	0.73	0.585	0.647	0.335	0.386	0.603
b_{37}	$x_{88} = P_{41}$	0.941	0.807	0.931	0.834	0.926	0.764	0.851	0.959
b_{38}	$x_{89} = P_{42}$	1	0.244	0.457	0.452	0.495	0.187	0.392	0.926
$\prod_1^{38} Bi$	$\prod_5^{89} Xi$	3.573 E-14	1.447 E-44	4.888 E-13	1.005 E-13	1.941 E-13	1.491 E-38	1.981 E-36	4.425 E-15
IECO-model – DII 2017		**3.574 E-14**	**1.449 E-44**	**4.883 E-13**	**1.086 E-13**	**1.938 E-13**	**1.492 E-38**	**1.985 E-36**	**4.425 E-15**
$\sqrt[38]{DII\ 2017}$ = **DII FINAL**		**0.442**	**0.070**	**0.474**	**0.455**	**0.462**	**0.101**	**0.114**	**0.419**

b_i	Country / Var./ P_i	Japan	Mexico	Nether-lands	Nigeria	Peru	Philip-pines	Poland	Singa-pore
b_1	$(x_5)^2 = (P_1)^2$	$(0.592)^2$	$(0.331)^2$	$(0.965)^2$	$(0.077)^2$	$(0.374)^2$	$(0.342)^2$	$(0.425)^2$	$(1)^2$
b_2	$(x_6)^2 = (P_2)^2$	$(0.6)^2$	$(0.208)^2$	$(0.612)^2$	$(0.188)^2$	$(0.186)^2$	$(0.153)^2$	$(0.705)^2$	$(1)^2$
b_3	$x_{12} = P_3$	0.78	0.47	0.95	0.23	0.24	0.29	0.44	0.48
b_4	$x_{13} = P_4$	0.22	0.53	0.05	0.77	0.75	0.71	0.56	0.52
b_5	$x_{14} = P_5$	0.827	0.505	0.952	0.198	0.506	0.466	0.822	0.65
b_6	$x_{15} = P_6$	0.13	0.61	0.67	0.53	0.46	0.48	0.69	0.73
b_7	$x_{23} = P_7$	0.7	0.47	0.93	0.22	0.43	0.71	0.4	0.45
b_8	$x_{24} = P_8$	0.251	0.171	0.778	0.034	0.171	0.124	0.327	0.378
b_9	$x_{25} = P_9$	0.667	0.714	0.595	0.893	0.798	0.655	0.702	0.893
b_{10}	$x_{26} = P_{10}$	0.152	0.179	0.902	0.099	0.309	0.513	0.688	0.033
b_{11}	$x_{27} = P_{11}$	0.592	0.148	1	0.169	0.295	0.289	0.468	0.724
b_{12}	$x_{28} = P_{12}$	0.327	0.612	0.765	0.316	0.468	0.188	0.369	0.439
b_{13}	$x_{29} = P_{13}$	0.516	0.259	0.793	0.164	0.134	0.34	0.238	0.671
b_{14}	$x_{30} = P_{14}$	0.433	0.851	0.687	1	0.463	0.567	0.269	0.433
b_{15}	$x_{31} = P_{15}$	0.183	0.477	0.87	0.368	0.446	0.272	0.389	0.482
b_{16}	$x_{32} = P_{16}$	0.639	0.406	0.817	0.204	0.445	0.335	0.391	0.798

b_{17}	$x_{33} = P_{17}$	0.538	0.281	0.703	0.204	0.206	0.213	0.276	0.290
b_{18}	$x_{34} = P_{18}$	0.88	0.65	0.99	0.46	0.71	0.63	0.93	0.52
b_{19}	$x_{35} = P_{19}$	0.248	0.188	0.466	0.001	0.146	0.24	0.376	0.543
b_{20}	$x_{37} = P_{20}$	0.554	0.160	0.656	0.168	0.233	0.116	0.580	0.807
b_{21}	$x_{38} = P_{21}$	0.437	0.345	0.528	0.339	0.341	0.302	0.366	0.75
b_{22}	$(x_{50})^8=(P_{24})^8$	$(0.497)^8$	$(0.367)^8$	$(0.486)^8$	$(0.185)^8$	$(0.349)^8$	$(0.329)^8$	$(0.387)^8$	$(0.577)^8$
b_{23}	$x_{53} = P_{25}$	0.332	0.303	0.446	0.103	0.276	0.403	0.357	0.472
b_{24}	$x_{55} = P_{26}$	0.035	0.006	0.02	0.002	0.001	0.001	0.01	0.022
b_{25}	$x_{57} = P_{28}$	0.52	0.417	0.577	0.328	0.381	0.376	0.459	0.49
b_{26}	$(x_{58})^2=(P_{29})^2$	$(0.534)^2$	$(0.006)^2$	$(0.111)^2$	$(0.001)^2$	$(0.002)^2$	$(0.005)^2$	$(0.052)^2$	$(0.031)^2$
b_{27}	$x_{60} = P_{30}$	0.567	0.083	0.648	0.031	0.063	0.106	0.242	0.277
b_{28}	$x_{63} = P_{31}$	1.0	0.293	0.666	0.174	0.162	0.579	0.605	0.659
b_{29}	$x_{66} = P_{32}$	0.642	0.313	0.896	0.388	0.164	0.119	0.284	0.254
b_{30}	$[d(x_{72})/dt]^2 = (P_{33})^2$	$(0.724)^2$	$(0.54)^2$	$(0.749)^2$	$(0.387)^2$	$(0.334)^2$	$(0.475)^2$	$(0.475)^2$	$(0.691)^2$
b_{31}	$x_{77} = P_{35}$	1	0.220	0.787	0.164	0.122	0.197	0.375	1
b_{32}	$d(x_{80})/dt = P_{36}$	0.735	0.531	0.848	0.175	0.535	0.444	0.643	1.02
b_{33}	$x_{82} = P_{37}$	0.969	0.2	0.765	0.145	0.122	0.014	0.381	0.741
b_{34}	$(x_{84})^2 = (P_{38})^2$	$(0.932)^2$	$(0.425)^2$	$(0.83)^2$	$(0.001)^2$	$(0.001)^2$	$(0.001)^2$	$(0.001)^2$	$(0.64)^2$
b_{35}	$x_{86} = P_{39}$	0.41	0.81	0.45	0.99	0.95	0.9	0.96	0.8
b_{36}	$x_{87} = P_{40}$	0.538	0.431	0.611	0.357	0.382	0.269	0.571	0.44
b_{37}	$x_{88} = P_{41}$	0.861	0.857	0.942	0.786	0.85	0.689	0.842	0.965
b_{38}	$x_{89} = P_{42}$	1	0.154	0.38	0.424	0.33	0.45	0.512	1
$\prod_1^{38} \mathrm{Bi}$	$\prod_5^{89} \mathrm{Xi}$	8.571 E-16	1.061 E-28	2.023 E-13	1.289 E-46	1.486 E-37	3.163 E-37	1.240 E-26	1.462 E-16
IECO-model – DII 2017		**8.589 E-16**	**1.06 E-28**	**2.023 E-13**	**1.286 E-46**	**1.487 E-37**	**3.155 E-37**	**1.241 E-26**	**1.463 E-16**
$\sqrt[38]{DII\ 2017}$ = **DII FINAL**		**0.401**	**0.183**	**0.463**	**0.061**	**0.107**	**0.109**	**0.208**	**0.383**

b_i	Country Var./ P_i	Spain	Sweden	Switzer-land	Tanza-nia	Turkey	Ukraine	UK	USA
b_1	$(x_5)^2 = (P_1)^2$	$(0.544)^2$	$(0.946)^2$	$(0.918)^2$	$(0.255)^2$	$(0.337)^2$	$(0.234)^2$	$(0.892)^2$	$(0.766)^2$
b_2	$(x_6)^2 = (P_2)^2$	$(0.264)^2$	$(0.868)^2$	$(1)^2$	$(0.077)^2$	$(0.389)^2$	$(0.381)^2$	$(0.636)^2$	$(1)^2$
b_3	$x_{12} = P_3$	0.76	1	0.97	0.11	0.37	0.52	0.86	0.71
b_4	$x_{13} = P_4$	0.24	0.01	0.03	0.9	0.64	0.48	0.14	0.29
b_5	$x_{14} = P_5$	0.872	0.992	0.913	0.372	0.543	0.646	0.817	0.776
b_6	$x_{15} = P_6$	0.98	0.01	0.4	0.27	0.55	0.45	0.81	0.54
b_7	$x_{23} = P_7$	0.83	0.91	0.83	0.06	0.15	0.29	0.75	0.68
b_8	$x_{24} = P_8$	0.408	0.602	0.686	0.035	0.235	0.258	0.687	0.654
b_9	$x_{25} = P_9$	0.619	0.881	0.893	0.893	0.774	0.738	0.702	0.845
b_{10}	$x_{26} = P_{10}$	0.682	0.509	0.723	0.034	0.6	0.595	0.583	1
b_{11}	$x_{27} = P_{11}$	0.333	0.896	0.83	0.193	0.331	0.162	0.913	0.877
b_{12}	$x_{28} = P_{12}$	0.624	0.738	0.529	0.197	0.435	0.331	0.506	0.529
b_{13}	$x_{29} = P_{13}$	0.362	0.621	0.723	0.126	0.192	0.246	0.303	0.473
b_{14}	$x_{30} = P_{14}$	0.299	0.552	0.597	0.851	0.463	0.09	0.627	0.582
b_{15}	$x_{31} = P_{15}$	0.394	1	0.759	0.286	0.336	0.13	0.835	0.85
b_{16}	$x_{32} = P_{16}$	0.663	0.75	0.893	0.093	0.249	0.013	0.844	0.844
b_{17}	$x_{33} = P_{17}$	0.497	1	0.759	0.105	0.233	0.299	0.615	0.451
b_{18}	$x_{34} = P_{18}$	0.96	1	0.95	0.66	0.6	0.57	0.97	0.93
b_{19}	$x_{35} = P_{19}$	0.329	0.504	0.53	0.034	0.205	0.376	0.476	0.38
b_{20}	$x_{37} = P_{20}$	0.557	0.622	1	0.135	0.761	0.548	0.56	1
b_{21}	$x_{38} = P_{21}$	0.439	0.684	0.635	0.273	0.385	0.306	0.63	0.722
b_{22}	$(x_{50})^8 = (P_{24})^8$	$(0.445)^8$	$(0.647)^8$	$(0.517)^8$	$(0.417)^8$	$(0.346)^8$	$(0.255)^8$	$(0.436)^8$	$(0.528)^8$
b_{23}	$x_{53} = P_{25}$	0.41	0.505	0.491	0.331	0.346	0.281	0.532	0.525
b_{24}	$x_{55} = P_{26}$	0.012	0.033	0.03	0.005	0.001	0.006	0.017	0.028
b_{25}	$x_{57} = P_{28}$	0.565	0.587	0.65	0.483	0.647	0.537	0.639	0.501

b_{26}	$(x_{58})^2=(P_{29})^2$	$(0.027)^2$	$(0.124)^2$	$(0.177)^2$	$(0.001)^2$	$(0.036)^2$	$(0.067)^2$	$(0.074)^2$	$(0.16)^2$
b_{27}	$x_{60} = P_{30}$	0.316	0.749	0.858	0.042	0.288	0.455	0.56	0.634
b_{28}	$x_{63} = P_{31}$	0.317	0.806	0.971	0.102	0.716	0.259	0.646	0.909
b_{29}	$x_{66} = P_{32}$	0.537	0.96	0.612	0.119	0.239	0.403	0.448	0.537
b_{30}	$[d(x_{72})/dt]^2 = (P_{33})^2$	$(0.526)^2$	$(0.647)^2$	$(0.867)^2$	$(0.443)^2$	$(0.511)^2$	$(0.334)^2$	$(0.741)^2$	$(0.801)^2$
b_{31}	$x_{77} = P_{35}$	0.551	1	0.877	0.235	0.383	0.378	0.712	0.932
b_{32}	$d(x_{80})/dt = P_{36}$	0.574	0.876	0.845	0.38	0.489	0.23	0.884	0.713
b_{33}	$x_{82} = P_{37}$	0.75	1	0.899	0.15	0.623	0.348	0.984	0.812
b_{34}	$(x_{84})^2 = (P_{38})^2$	$(0.749)^2$	$(0.82)^2$	$(0.943)^2$	$(0.001)^2$	$(0.512)^2$	$(0.001)^2$	$(0.88)^2$	$(1)^2$
b_{35}	$x_{86} = P_{39}$	0.83	0.76	1	0.98	0.98	0.56	0.83	0.79
b_{36}	$x_{87} = P_{40}$	0.562	0.677	0.586	0.229	0.455	0.583	0.599	0.547
b_{37}	$x_{88} = P_{41}$	0.866	0.946	0.884	0.791	0.87	0.944	0.946	0.912
b_{38}	$x_{89} = P_{42}$	0.395	0.627	0.775	0.128	0.386	0.502	1	1
$\prod_{1}^{38} \mathrm{Bi}$	$\prod_{5}^{89} \mathrm{Xi}$	1.02 E-19	1.206 E-13	1.396 E-11	4.287 E-44	6.283 E-25	7.3612 E-34	2.779 E-14	9,645 E-12
IECO-model – DII 2017		**1.02 E-19**	**1.208 E-13**	**1.396 E-11**	**4.287 E-44**	**6.755 E-25**	**7.323 E-34**	**2.779 E-14**	**9,664 E-12**
$\sqrt[38]{DII\ 2017}$ = **DII FINAL**		**0.316**	**0.457**	**0.518**	**0.072**	**0.231**	**0.134**	**0.439**	**0.513**

Figure 29 shows how the values of each variable change in real time as the model runs.The three stock variables are also shown in view in Figure 29. The model sample dates are from 8/1/2011 – 7/30/2018, which represents the years with valid data retrieved from the GII 2011-2017. To see the calculations in real time in the "Country-view," the model runtime duration is set to 40 seconds. This length of time allows the user to watch the changing calculations within each variable, and this runtime can easily be adjusted in the bar above the "Country view" next to the "run" or "stop" button.

In Figure 30, Figure 29 is magnified. In Figure 31 the three stock diagrams for the three stock variables, ICTuse, ProofOfConceptCenters, and TargetedPublicPolicies, are created based upon parameters from Switzerland found in Sheets 2, 3, and 4, found in Tables 27, 28, and 29. In the stock diagrams the green line represents the values from GII (2011) – GII (2017); the blue line represents the predicted results; and the red line illustrates the stock value. Appendix C presents a larger version of this country view magnified by at least four times, which makes the calculations at each node legible.

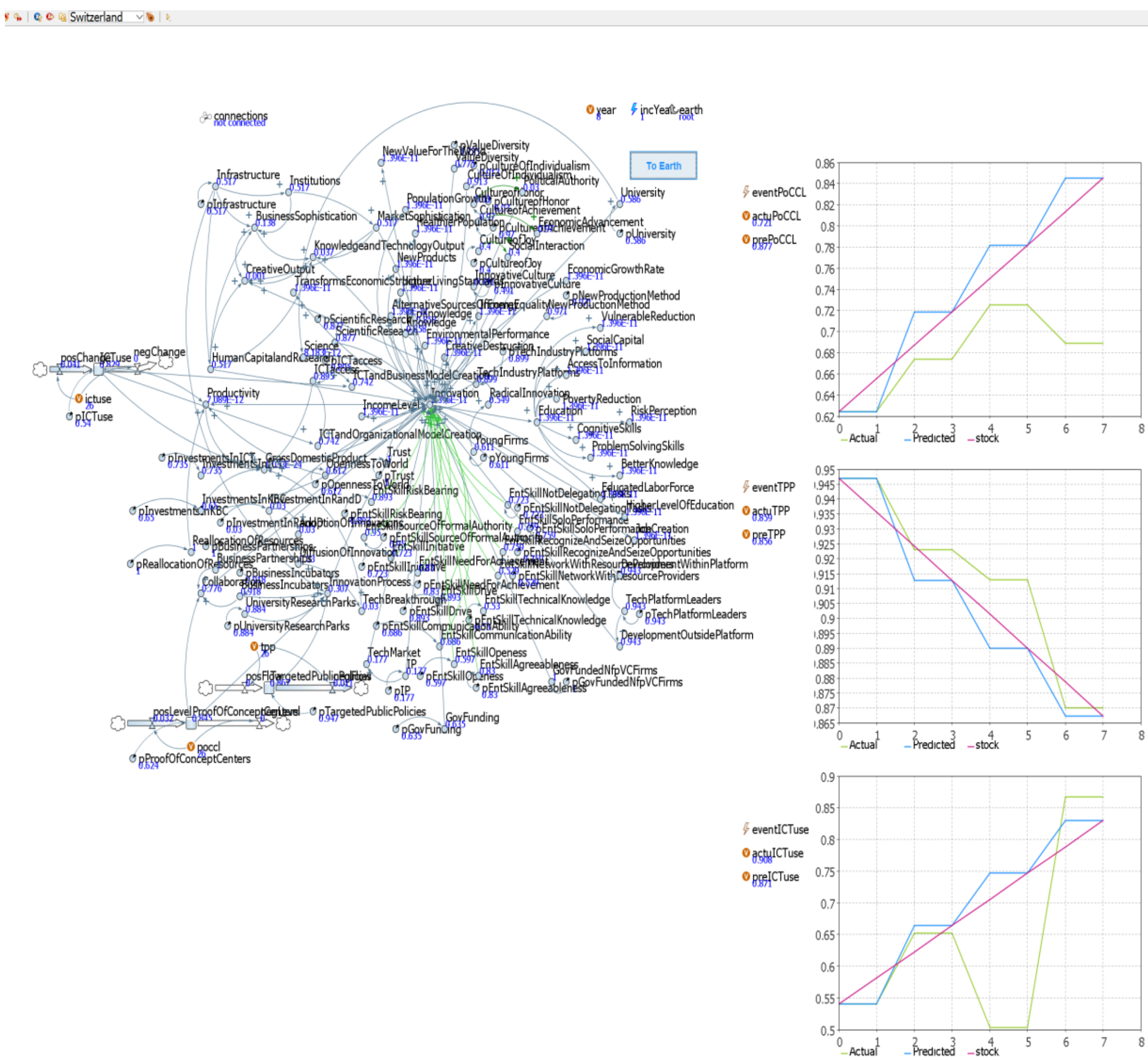


Figure 29: Model run results for Switzerland

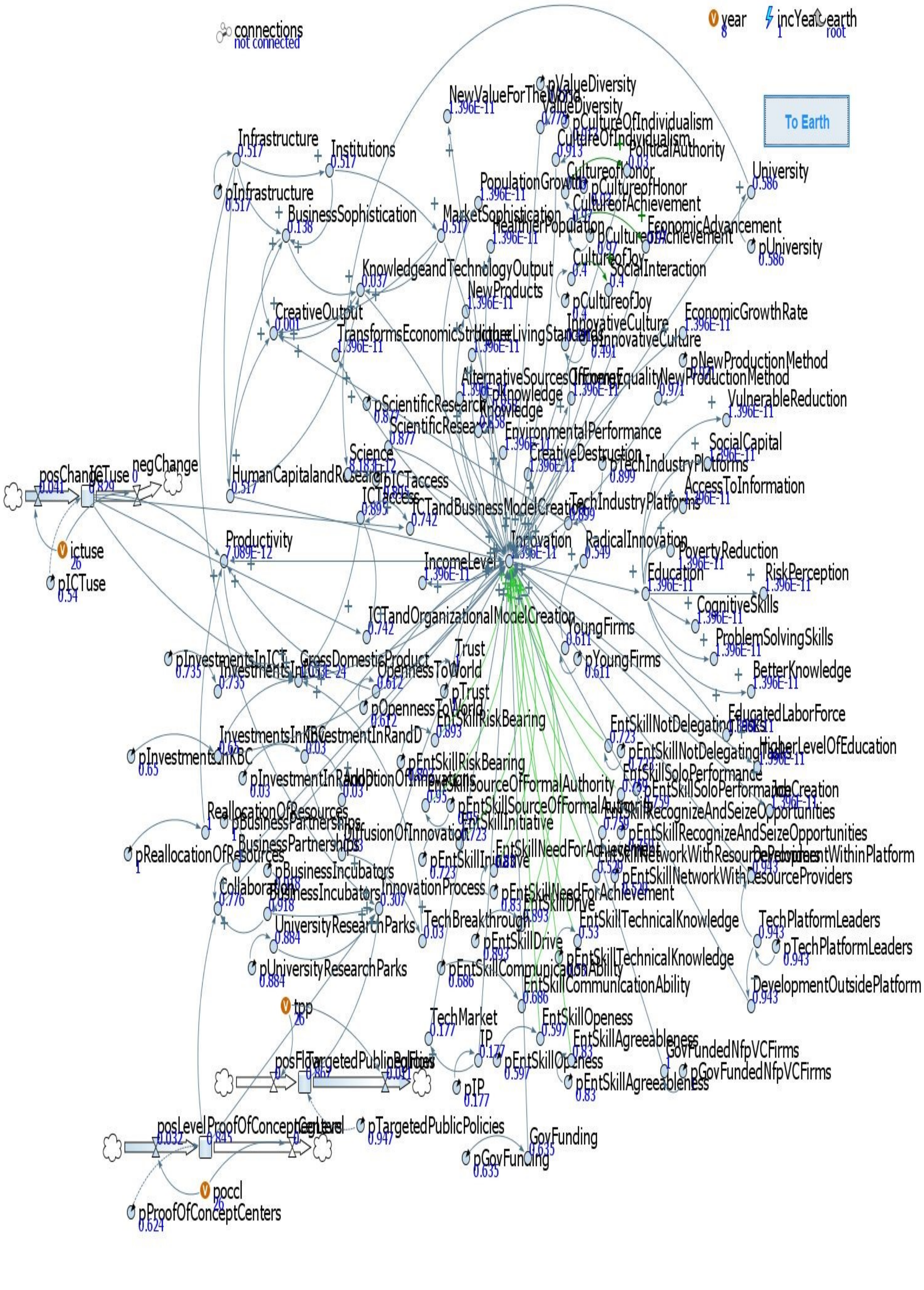


Figure 30: Country view with values at each node for Switzerland after a model run

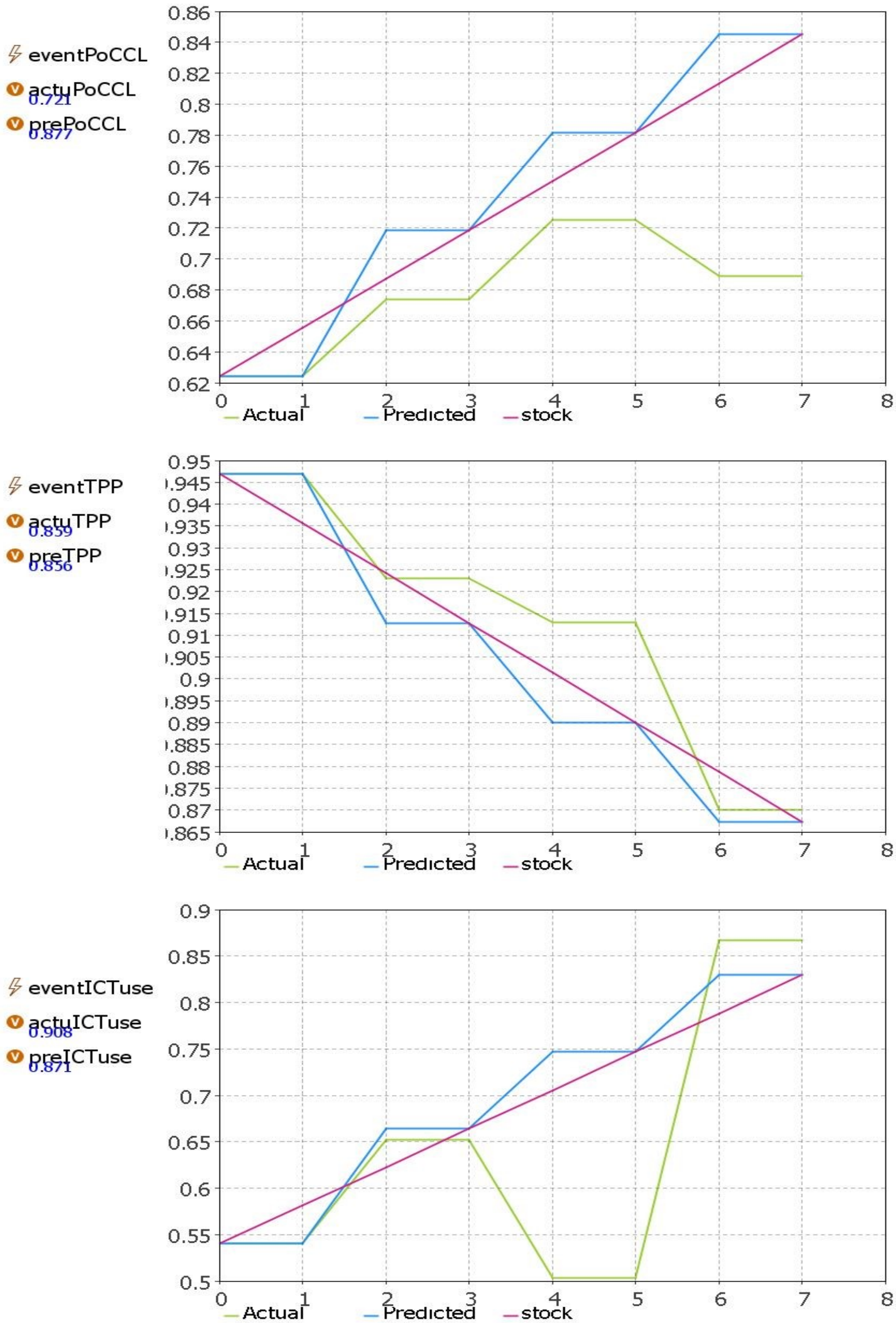


Figure 31: Values from the three stock variables for Switzerland

4.3 Comparison of country index results

No similar model exists in the literature review, and therefore validation with a similar model is not possible. The closest comparison is to compare the DII country results with other innovation indices. Thus, the current research compares the DII model to the GII, GEI and BII rankings from 2017. In comparing the DII and BII, we focus on the 10 top ranking countries, as the BII 2017 did not include many of the countries included in the DII. The results are below in Table 34.

A few countries are considered top-ten innovators in all four rankings: Denmark, Sweden, Switzerland, and the United States. Table 35 adds to the data from Table 34 by showing arrows to demonstrate changes in rankings from year to year.

Table 36 compares the 32 countries' rankings from the DII 2017to the GII (2017), GEI (2017), and ECI (2016). The ECI does not have a 2017 version yet. The ECI refers to the skill and mental capacity or knowledge level collected in a country, so the author postulates that one year's difference will not change those values significantly due to having observed the ECI(2015) had more or less same ranking as the ECI(2016). Therefore the 2016-year data from the ECI is sufficient for testing whether the four rankings are comparable.

In general, the DII has a ranking that is in the range of all the other indices or rankings, which is interesting given that the various indices have different ways of calculating their final country index.

Table 37, reproduces Table 36 and adds color coding to help with comparing the many country rankings in the four indices faster. The reader can follow the color codes horizontally, while keeping in mind that the rankings are relative, as each index originally entered and ranked different numbers of countries in their research.

Table 34: Comparison of the Top 10 Most Innovative Countries From Four Rankings

No.	DII 2017	GII 2017	GEI 2017	Bloomberg II 2017
1	Switzerland	Switzerland	USA	South Korea
2	USA	Sweden	Switzerland	Sweden
3	Finland	Netherlands	Canada	Germany
4	Netherlands	USA	Sweden	Switzerland
5	Iceland	United Kingdom	Denmark	Finland
6	Sweden	Denmark	Iceland	Singapore
7	Germany	Singapore	Australia	Japan
8	Denmark	Finland	United Kingdom	Denmark
9	United Kingdom	Germany	Ireland	USA
10	Austria	Ireland	Netherlands	Israel

Table 35: The Top 10 Most Innovative Countries From Four Rankings with Change Arrows

No.	DII 2017	GII 2017	GEI 2017	Bloomberg II 2017
1	Switzerland	Switzerland	USA	South Korea
2	USA	Sweden	Switzerland	Sweden
3	Finland	Netherlands	Canada	Germany
4	Netherlands	USA	Sweden	Switzerland
5	Iceland	United Kingdom	Denmark	Finland
6	Sweden	Denmark	Iceland	Singapore
7	Germany	Singapore	Australia	Japan
8	Denmark	Finland	United Kingdom	Denmark
9	United Kingdom	Germany	Ireland	USA
10	Austria	Ireland	Netherlands	Israel

Table 36: Ranking Comparison - DII (2017), GII (2017), GEI (2017) and ECI (2016)

		DII 2017		GEI 2017		GII 2017		ECI 2016
No.	GR	Country	GR	Country	GR	Country	GR	Country
1	**1**	**Switzerland**	**1**	**United States**	**1**	**Switzerland**	**1**	**Japan**
2	**2**	United States	**2**	Switzerland	**2**	Sweden	**2**	Switzerland
3	**3**	Finland	**3**	Canada	**3**	Netherlands	**3**	Germany
4	**4**	Netherlands	**4**	Sweden	**4**	United States	**6**	Sweden
5	**5**	Iceland	**5**	Denmark	**5**	United Kingdom	**7**	Austria
6	**6**	Sweden	**6**	Iceland	**6**	Denmark	**8**	United States
7	**7**	Germany	**7**	Australia	**7**	Singapore	**9**	United Kingdom
8	**8**	Denmark	**8**	United Kingdom	**8**	Finland	**?**	Singapore
9	**9**	United Kingdom	**9**	Ireland	**9**	Germany	**10**	Finland
10	**10**	Austria	**10**	Netherlands	**10**	Ireland	**12**	Ireland
11	**11**	Ireland	**11**	Finland	**13**	Iceland	**18**	Denmark
12	**12**	Australia	**12**	Germany	**14**	Japan	**20**	Poland
13	**13**	Japan	**14**	Austria	**18**	Canada	**21**	Netherlands
14	**14**	Singapore	**24**	Singapore	**20**	Austria	**24**	Mexico
15	**15**	Spain	**25**	Japan	**22**	China	**26**	China
16	**16**	Canada	**31**	Poland	**23**	Australia	**30**	Spain
17	**17**	China	**33**	Spain	**28**	Spain	**33**	Canada
18	**18**	Turkey	**36**	Turkey	**36**	Bulgaria	**36**	Bulgaria
19	**19**	Poland	**48**	China	**38**	Poland	**38**	Bosnia & H.
20	**20**	Mexico	**66**	Ukraine	**40**	Turkey	**39**	Ukraine
21	**21**	Brazil	**67**	Peru	**42**	Ukraine	**40**	Turkey
22	**22**	Bulgaria	**71**	Mexico	**43**	Mexico	**41**	Philippines
23	**23**	Ukraine	**76**	Philippines	**49**	Brazil	**?**	Iceland
24	**24**	Iran	**82**	Bulgaria	**58**	Peru	**50**	Brazil
25	**25**	Philippines	**85**	Iran	**69**	Philippines	**53**	El Salvador
26	**26**	Peru	**90**	Indonesia	**70**	Iran	**65**	Australia
27	**27**	Indonesia	**98**	Brazil	**72**	Bosnia & Herz.	**71**	Indonesia
28	**28**	Bosnia & Herz.	**99**	Bosnia & Herz.	**73**	Indonesia	**83**	Iran
29	**29**	Tanzania	**100**	Nigeria	**75**	Tanzania	**90**	Peru
30	**30**	El Salvador	**101**	El Salvador	**86**	El Salvador	**97**	Tanzania
31	**31**	Bangladesh	**118**	Tanzania	**87**	Bangladesh	**105**	Bangladesh
32	**32**	Nigeria	**133**	Bangladesh	**96**	Nigeria	?	Nigeria

Table 37: Ranking Comparison Color-Coded - DII (2017), GII (2017), GEI (2017) and ECI (2016)

		DII 2017		GEI 2017		GII 2017		ECI 2016
No.	GR	Country	GR	Country	GR	Country	GR	Country
1	1	Switzerland	1	United States	1	Switzerland	1	Japan
2	2	United States	2	Switzerland	2	Sweden	2	Switzerland
3	3	Finland	3	Canada	3	Netherlands	3	Germany
4	4	Netherlands	4	Sweden	4	United States	6	Sweden
5	5	Iceland	5	Denmark	5	United Kingdom	7	Austria
6	6	Sweden	6	Iceland	6	Denmark	8	United States
7	7	Germany	7	Australia	7	Singapore	9	United Kingdom
8	8	Denmark	8	United Kingdom	8	Finland	?	Singapore
9	9	United Kingdom	9	Ireland	9	Germany	10	Finland
10	10	Austria	10	Netherlands	10	Ireland	12	Ireland
11	11	Ireland	11	Finland	13	Iceland	18	Denmark
12	12	Australia	12	Germany	14	Japan	20	Poland
13	13	Japan	14	Austria	18	Canada	21	Netherlands
14	14	Singapore	24	Singapore	20	Austria	24	Mexico
15	15	Spain	25	Japan	22	China	26	China
16	16	Canada	31	Poland	23	Australia	30	Spain
17	17	China	33	Spain	28	Spain	33	Canada
18	18	Turkey	36	Turkey	36	Bulgaria	36	Bulgaria
19	19	Poland	48	China	38	Poland	38	Bosnia & H.
20	20	Mexico	66	Ukraine	40	Turkey	39	Ukraine
21	21	Brazil	67	Peru	42	Ukraine	40	Turkey
22	22	Bulgaria	71	Mexico	43	Mexico	41	Philippines
23	23	Ukraine	76	Philippines	49	Brazil	?	Iceland
24	24	Iran	82	Bulgaria	58	Peru	50	Brazil
25	25	Philippines	85	Iran	69	Philippines	53	El Salvador
26	26	Peru	90	Indonesia	70	Iran	65	Australia
27	27	Indonesia	98	Brazil	72	Bosnia & Herz.	71	Indonesia
28	28	Bosnia & Herz.	99	Bosnia & Herz.	73	Indonesia	83	Iran
29	29	Tanzania	100	Nigeria	75	Tanzania	90	Peru
30	30	El Salvador	101	El Salvador	86	El Salvador	97	Tanzania
31	31	Bangladesh	118	Tanzania	87	Bangladesh	105	Bangladesh
32	32	Nigeria	133	Bangladesh	96	Nigeria	?	Nigeria

CHAPTER 5: CONCLUSIONS

Just as Watts and Gilbert (2014a, p. 246) pronounced, the current results agree with that "Innovation comes from interaction. Interact more to be more innovative!" This perspective fits with the finding that countries which have the most openness to the world rank highly in innovation according to the DII.

The DII Final ranking of all the 32 countries can be seen in Table 31, Table 36, and finally in the color-coded version for easy comparison in Table 37. Tables 36 and 37 show that the relative rankings the DII produces correspond reasonably well to the three comparator indices, although a direct comparison is not possible because each index contains different countries. The differences in the rankings is easily accounted for, as the calculations behind the four indices differ. The comparison across indices shows that the DII produces at least "reasonable" ranking results that are not totally "off the chart" or disparate from the others. It can be concluded that the DII has ranking results that are in the range of the other existing and already established yearly innovation index contributors.

The objective of this research of creating a new model for evaluating innovation in an IE was accomplished, and the IECO-model is designed to be very adaptable, where modifications and extensions to the model would be straightforward.

The current IECO-model's node design is based on scholarly papers proposing relationships among innovation/economic growth and ongoing societal factors. All 91 nodes ultimately are involved with creating innovation in the complex environment of an IE. The 43 parameters used data sources from the Global Innovation Index and the Global Entrepreneurship Index and finally from survey results from the World Values Survey among others found in the book "*A World of Three Cultures*."

Additionally, three of those parameters were converted to stock variables, where the data source had reliable data collected with a uniform method over the time period of 2011-2017.

The ten most innovative countries were found in the dynamic innovation index to be: Switzerland, USA, Finland, Netherlands, Iceland, Sweden, Germany, Denmark, United Kingdom, and finally Austria.

The DII is offered as an additional tool that can be used to evaluate a country's level of innovation. The main strength of the DII is its focus on the individual entrepreneur's skillset, ambition, and drive.

5.1 Discussion

The IECO-model is made by using a combination of existing index data sources which emphasize the entrepreneurial skill set, and the importance of the entrepreneur's goal-oriented nature. Nothing will be accomplished if the entrepreneur does not have courage, will power, work ethic, and perseverance. Business ventures involve a period referred to as the "valley of death," which is the period prior to selling products or prior to seeing cashflow from those sales, in which the inventor, entrepreneur or company has no money coming in. Therefore, the entrepreneuer must have have strong willpower, determination, and trust in themselves.

The DII ranking lists Switzerland and the U.S. as most innovative. It is widely believed that in the U.S. entrepreneurs can be successful if they have willpower; however, less is widely known about the entrepreneurial culture in Switzerland. In 1873 Candolle was the first scientist to investigate variation in nations' levels of total creative activity (Simonton, 2003). Candolle used the criteria that the scientists whom he would investigate had to have a verifiable international reputation. Interestingly, Switzerland was the most supreme among the nations of the world. Switzerland exceeded many other countries by a ratio of five-fold. Candolle describes that Swiss scientists were required to present their research and

gain recognition internationally in order to be successful; this led to openness to new ideas and information exchange to ensure staying ahead in their research field. It is part of the Swiss culture to explore the competitors and strive to be best. The author of the current research worked for two months in Bern, Switzerland at the Swizz Railroads, the SBB, as an engineering student, and the author can testify that it is a country of hardworking and proud people who highly value quality, precise work. This dissertation achieves its goal of advancing our understanding of the innovation processes. Additionally, the dissertation was intended to be an enjoyable read that would enrich the reader's understanding of the current innovation-based drivers in society, and would give the reader a deeper understanding of how factors interconnect in an IE.

5.2 Comparison of the proposed IECO-model

In this dissertation, a new IECO-model has been created to illustrate the innovation within an IE, and the model's design is the author's choice based upon 91 relations and 43 parameters selected from scholarly papers. The model is a simulation of the real world and represents some parts of the innovations ongoing in an IE; however, this is a conceptual model and is not postulated to be a complete representation of an IE. Therefore, to validate this model would not be feasible. The methodology for creating the model is described in detail to ensure replicability.

This process did not determine previous years' values for all 43 variable parameters and create stock variables based on those. This is because the various rankings and data sources did not all have longitudinal data, or they were not consistent in their collection methods. This year-to-year inconsistency makes the indices more useful for their main purposes, as they are being adjusted annually to better fit with current events in society. However, this makes successive years not comparable, which is why the current work chose to make only three parameters into stock variables. These three variables from the GII had completely consistent collection methods for the data sources

over the complete 7-year collection period from 2011-2017. The three variables chosen for development of the stock variables were ICTuse = P47, ProofOfConceptCenters = P72, and TargetedPublicPolicies = P80. This year-to-year inconsistency is also why the DII validation is limited to a comparison across all the rankings from the same year or the last year that is possible to retrieve.

The GEI (2017) includes a relevant warning in the methodology section: "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" (p. 77).

In the GEI, in calculating the pillars values, an important note is that the real measurement error is unknown, because the data come from many sources for which confidence intervals are not currently available. Therefore, the real measurement errors are higher than the values reported here. Additionally, because this research is exploratory, the same weight has been given to all 43 parameters.

5.3 Research contribution

This dissertation research helps to improve the current understanding of the IE by developing a dynamic innovation index (DII). This index allows ranking countries' innovation levels based on an aggregation of several innovation and entrepreneurship indicators, including interrelationships between 91 relevant variables and 43 related parameters. The IECO-model, a dynamic modeling platform, also allows experimentation on the effects of the chosen model variables and parameters on the IE using the available data from 32 countries around the world.

A greater understanding of the intricacies of innovation has been achieved, and the model is flexible to subsequent adjustments. Hopefully, the IECO-model can help in planning future innovation initiatives to better spark economic growth, all in the quest of finding out what policies and changes

really would make an impact in societies, countries, and in the world. Although the model advances this understanding, we must acknowledge that the task is extraordinarily complex. Senor and Singer (2011) claim in their book, *Start-up Nation*, that a model is flawed if it maintains that a collection of institutions can be mechanically assembled and out will pop a Silicon Valley. IEs are not that simple; culture is vital for IEs to thrive.

Innovation is a key component in our modern society. Globally there is a wish for prosperity and wealth for all, and many think this is possible through innovation, but it has to be the right type of innovation for that particular area or country, fitting with the culture, the natural resources, human capital, access to capital, funding levels, and other factors.

The main contribution of this work is the development of a system dynamics model created for evaluating innovation within an IE, and the output of the model is a dynamic innovation index.

Other research contributions are:

1. Proposed a simplified IE design through a system dynamics model.
2. Developed a system dynamic model platform for an IE to test the impact of dynamic variables and have a tool for experimentation.
3. Focused variables on the cultural impact on the entrepreneur. Current published innovation indices do not focus so extensively on the entrepreneur's skillset from a cultural perspective.
4. Improved the understanding of the IE and its components.
5. Created a new model that led to an index for evaluating the IE in a country.
6. Improved the understanding about the interdependencies between innovations and entrepreneurial efforts.

5.4 Recommendation for the use of this research

The research can be used in the following ways:

1. To gain a solid introduction to the research topics of innovation and the IE.
2. To gain an introduction to the ways contemporary innovation indices are constructed.
3. To use this newly developed index, the DII, as a complimentary innovation evaluation of a country to make an analysis using another index more complete. The DII looks into the softer issues/entrepreneurial skillsets involved in the innovation process more than other indices have done prior.
4. To rank, evaluate, and study developing countries under the premise that they have data for all 43 parameters that are needed for running the IECO-model.

5.5 Conclusions

"The behavior of a complex system, such as a business ecosystem, (which is one type of an IE), is surprising and hard to predict due to its nonlinearity" (Kortelainen and Jarvi, 2014, p. 9). Davis, Eisenhard, and Bingham (2009) posit that simulation can demonstrate the complex theoretical relationships and interactions among various organizational and strategic processes.

Kortelainen and Jarvi (2014) point out "that much of the existing empirical research about business ecosystems is qualitative, and very few quantitative studies." (p. 9). Although here is focused on the business ecosystem, the same is true for the research level for IEs. "Qualitative studies give a good foundation for understanding the phenomena and building fundamental theories, without effective ways to quantitatively study the ecosystem, proper validation is not possible. Traditional statistical methods of analysis are not designed for an optimal examination of complex systems, such as businesses and IEs" (Kortelainen and Jarvi, 2014, p. 9).

The current work is a step towards a quantitative model enabling experimentation and discussion. It can spark new ideas and approaches to researching IEs and is a starting point for future work. Its validation is in relation to other existing indices.

5.6 Recommendations for future research

The goal is to identify and analyze the most important relationships in creating innovation, from both micro and macroeconomic standpoints. In this dissertation, when looking into innovation and IEs, many other related topics of significant importance surfaced, such as the world's division of wealth, and how growth is spurred. These are complex topics in their own right, and in-depth analysis is beyond the scope of this research.

The model developed here could be the basis for further studies such as:

1. The model could be used to investigate, what parameters had most impact in the country, and it could be done by creating a structured simulation testing plan, where all the different parameters were tested through a systematic testing approach.
2. The model can be upgraded with more advanced equations for the parameters. Also, the variables can be weighted. The author suggests economists and social scientists will join the research team to help with setting weights and creating equations in the next version of the model.
3. The model can be used to study the impact of scarce time-dependent resources in a country.
4. The literature review in this dissertation can serve as an introduction to innovation and the IE and can be the basis for creating a standardized definition for innovation and the IE if doing so would benefit future research.

5.6.1 Spurring innovation in the future

There is still a lot of economic uncertainty in many countries, and therefore the search for a prosperous future increasingly depends on innovation abilities. STEM researchers advocate that innovation is nurtured by teaching more classes in science, technology, engineering, and math; lately, it is more accepted that to foster creativity, art and design should be incorporated earlier in the education.

This helps ensure that the products which engineers and scientists develop are grounded in real needs rather than in farfetched ideas about our future needs. One example of the importance of addressing real needs is when Apple invented the Newton, which was a predecessor to the iPad, but it came almost 20 years too early when customers did not understand the significance of this product or see a need for it. Innovators must also take into account how fast people can adapt to a new technology. Today's consumer technologies are being adopted more quickly than they were 30 years ago, as people now are more familiar with using a computer and smartphone compared to earlier.

The key to increasing innovation in the future is educating students in creativity, so they understand how important it is to think outside of the box. Estrin (2009) points out the remarkable fact that although the U.S. spends more money per student than most countries in the world, in the face of budget cuts the first things eliminated are often art classes and field trips which are not considered mandatory trips. However, these topics are mandatory for inspiring and developing future innovators.

5.6.2 Ideas for future research areas for more advanced versions of the IECO-model

Taking the informal economy into consideration in a future version of the IECO-model would be a fascinating research endeavor. The informal economy is defined by Philip Smith as "market-based production of goods and services, whether legal or illegal, that escape detection in the official estimates of GDP" (Sneider, 2016, p. 36) According to Smith (1994), if the informal economy could be taken into consideration in a new revised model with a focus on the world economy instead of innovation, it would lead to a revision of the concept of GDP and our perception of the division of wealth.

The informal economy is also called the "shadow economy" and is defined as the following according to Schneider (2016). "The shadow economy includes all market-based legal production of goods and services that are deliberately concealed from public authorities" (p.36).

Here are the reasons:

1. To avoid payment of income, value-added, or other taxes;
2. To avoid payment of social security contributions;
3. To avoid having to meet certain legal labor market standards, such as minimum wages, maximum working hours, and safety standards
4. To avoid complying with certain administrative obligations, such as completing statistical questionnaires or other administrative forms.

Additionally, future versions of the IECO-model can aim toward a possible future based on the Sustainable Development Goals from the UN (2015), *Transforming Our World - The 2030 Agenda for Sustainable Development* . Figure 32 lists these goals.

Finally, the OECD (2014) has predicted policy challenges for the next 50 years, which are shown in Figure 33. It would also be interesting to take these predictions into account and create a model with those in mind.

Sustainable Development Goals

Goal 1. End poverty in all its forms everywhere

Goal 2. End hunger, achieve food security and improved nutrition and promote sustainable agriculture

Goal 3. Ensure healthy lives and promote well-being for all at all ages

Goal 4. Ensure inclusive and equitable quality education and promote lifelong learning opportunities for all

Goal 5. Achieve gender equality and empower all women and girls

Goal 6. Ensure availability and sustainable management of water and sanitation for all

Goal 7. Ensure access to affordable, reliable, sustainable and modern energy for all

Goal 8. Promote sustained, inclusive and sustainable economic growth, full and productive employment and decent work for all

Goal 9. Build resilient infrastructure, promote inclusive and sustainable industrialization and foster innovation

Goal 10. Reduce inequality within and among countries

Goal 11. Make cities and human settlements inclusive, safe, resilient and sustainable

Goal 12. Ensure sustainable consumption and production patterns

Goal 13. Take urgent action to combat climate change and its impacts*

Goal 14. Conserve and sustainably use the oceans, seas and marine resources for sustainable development

Goal 15. Protect, restore and promote sustainable use of terrestrial ecosystems, sustainably manage forests, combat desertification, and halt and reverse land degradation and halt biodiversity loss

Goal 16. Promote peaceful and inclusive societies for sustainable development, provide access to justice for all and build effective, accountable and inclusive institutions at all levels

Goal 17. Strengthen the means of implementation and revitalize the Global Partnership for Sustainable Development

* Acknowledging that the United Nations Framework Convention on Climate Change is the primary international, intergovernmental forum for negotiating the global response to climate change.

Source: UN (2015)

Figure 32: UN's 17 Sustainable Development Goals for 2030

SHIFTING GEAR: POLICY CHALLENGES FOR THE NEXT 50 YEARS

Main findings

Growth will slow and economic activity will shift, with skills being crucial and wage inequality rising

- Global growth will slow from 3.6% in 2010-2020 to 2.4% in 2050-2060 -- due to ageing and gradual deceleration in emerging economies -- and will be increasingly driven by innovation and investment in skills.
- The global economic balance will continue to shift towards the current non-OECD area, which will have an economic structure and exports increasingly similar to those of the OECD.
- With technical progress raising the global demand for high-skilled workers, by 2060 average market earnings inequality (before tax and transfers) in the OECD area will reach the level of today's most unequal OECD countries.
- Climate change will curb global GDP by 1.5% on average and almost 6% in South and South-East Asia, unless increases in CO_2 emissions are curbed.

Sustaining growth while addressing rising inequality will be a major policy challenge

- Further reforms to inject dynamism in labour and product markets, combined with re-designed intellectual property right policies, will be needed to sustain innovation, productivity and employment. Such policies could put further pressure on earnings inequality however.
- Efficient redistributive measures and education policies will be crucial to accompany the increasing demand for skills. Financing such policies in the context of rising fiscal pressures requires:
  - shifting from increasingly mobile labour and corporate income tax bases to immobile ones, such as consumption, housing and use of natural resources (*e.g.* extraction taxes),
  - focusing public funding on pre-tertiary education and life-long learning, where some of the largest social benefits can be reaped not least in terms of equality of opportunities, and
  - for tertiary education relying to a greater extent on tuition fees.

More international cooperation will be needed in an increasingly multipolar world

- Increasing trade cooperation spurs growth and technological innovation. With rising international integration and expanding supply chains, the positive effects of lifting border barriers and facilitating trade will be magnified. Trade agreements at global level will bring the greatest global GDP and welfare gains by 2060.
- Rising economic interdependence requires international cooperation in providing global public goods such as basic research, intellectual property rights legislation, competition policy and the climate. Effective cooperation could boost research incentives and make antitrust activity more effective. Coordinated action to curb CO_2 emissions will limit damages to growth and well-being.
- International cooperation on taxation of bases that are mobile across borders (e.g. corporate income) could help recover revenues and avoid possible negative consequences of tax avoidance.

Source: OECD (2014)

Figure 33: Policy challenges for the next 50 years

APPENDIX A
- MODEL VIEW IN FOUR QUADRANTS OF THE IECO-MODEL (ZOOMED IN)

QUADRANT 1 OF IECO-MODEL

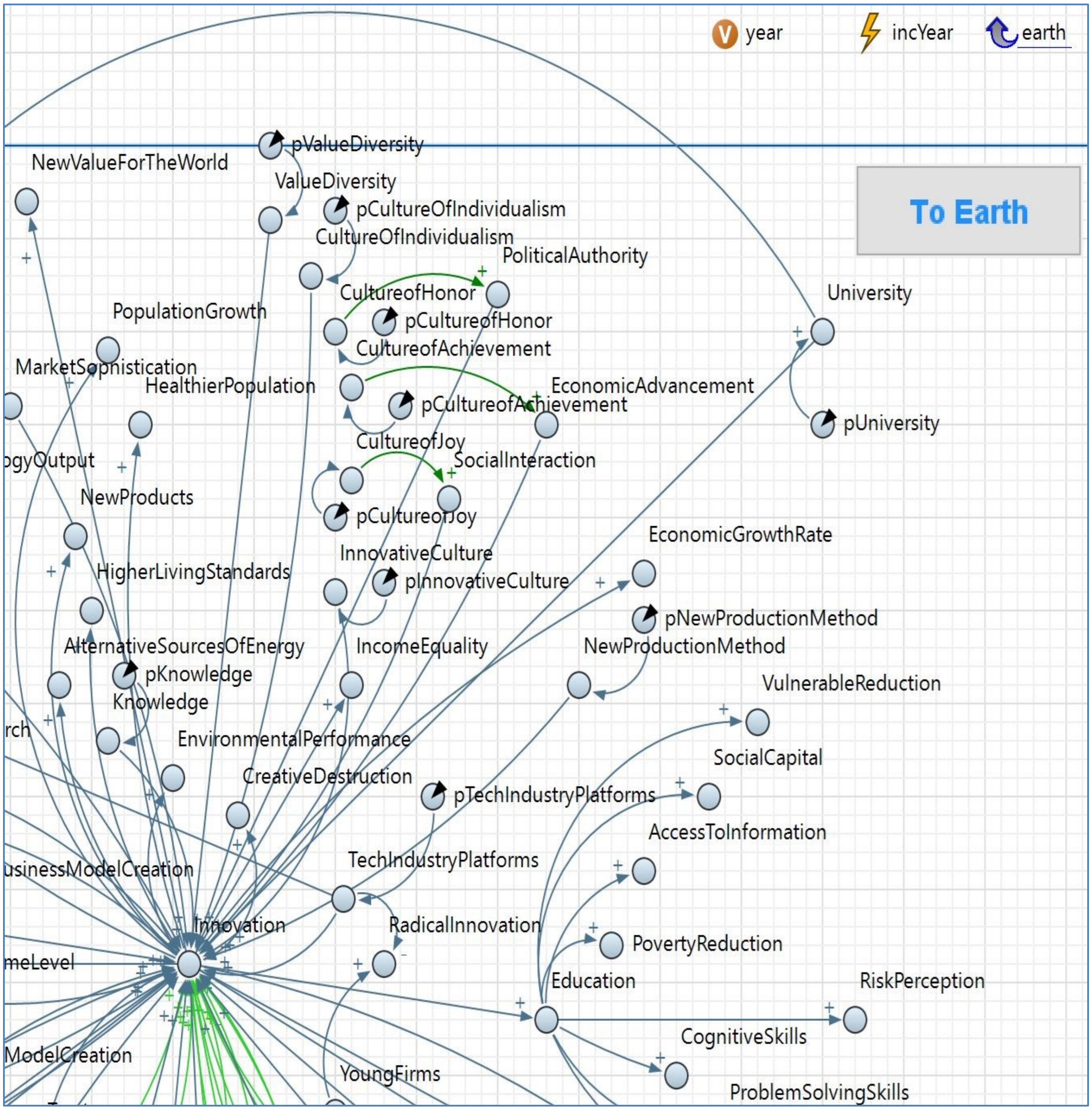


Figure 34: Split view of IECO-model - quadrant 1

QUADRANT 2 OF IECO-MODEL

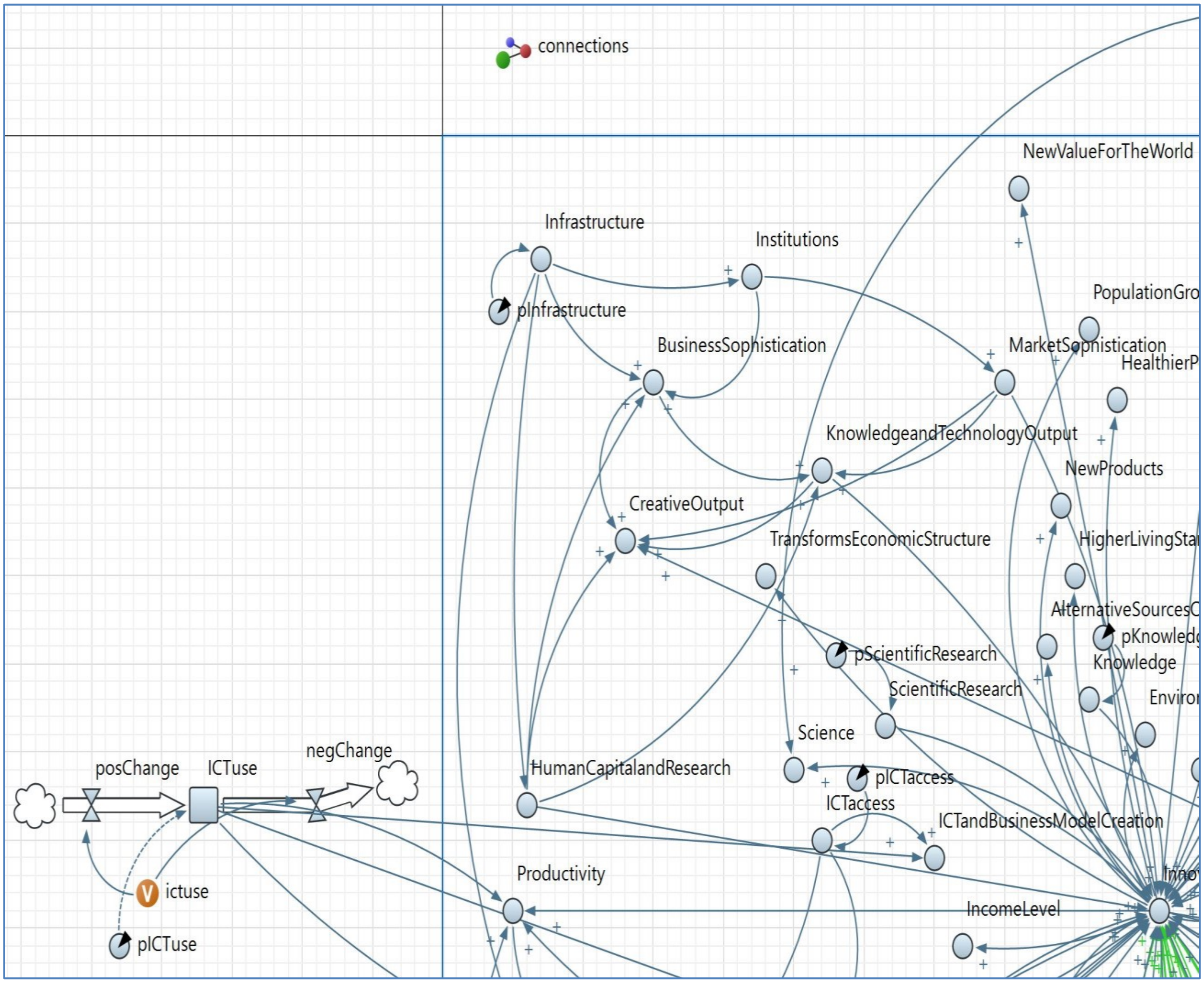


Figure 35: Split view of IECO-model - quadrant 2

QUADRANT 3 OF IECO-MODEL

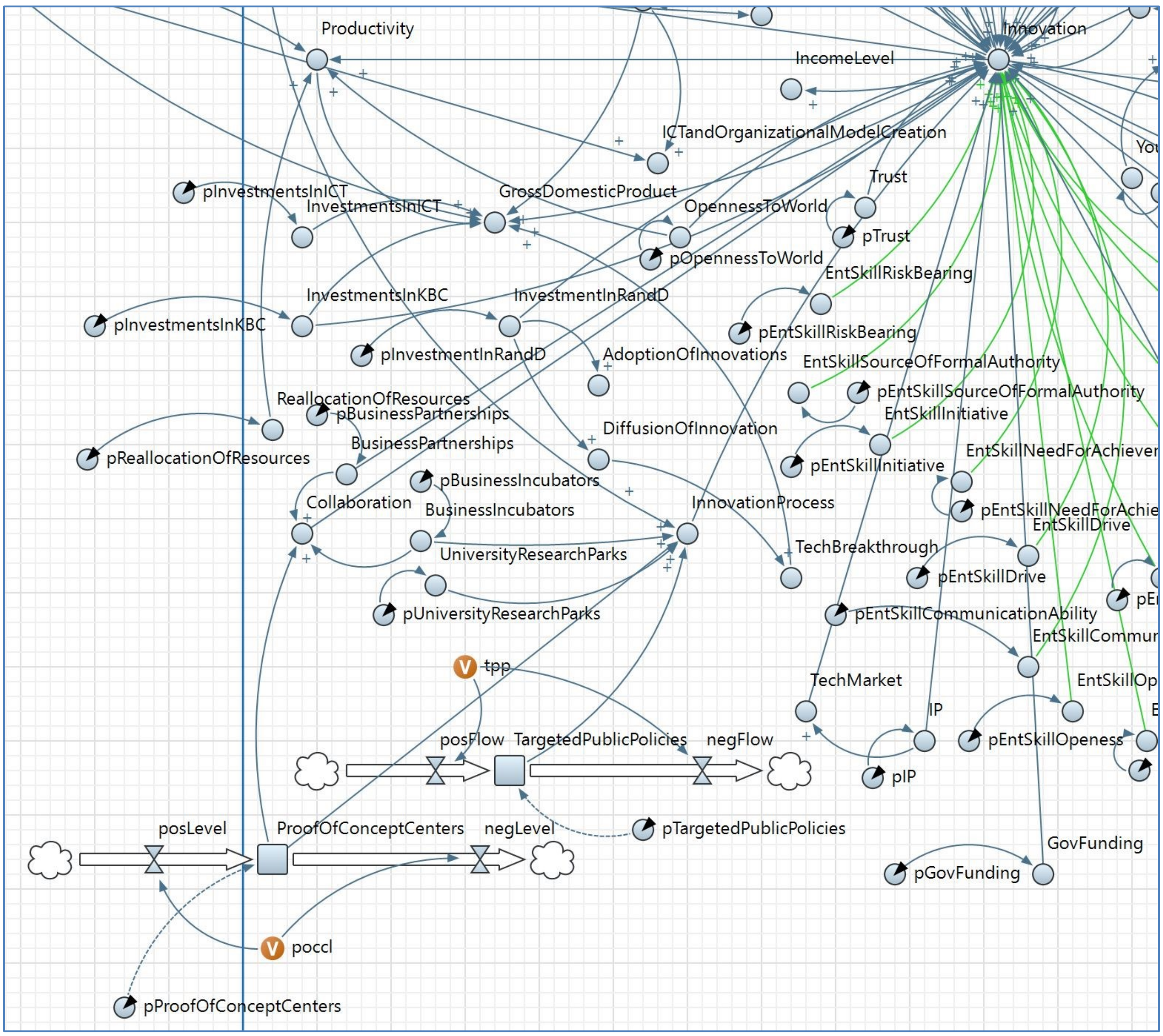


Figure 36: Split view of IECO-model - quadrant 3

QUADRANT 4 OF IECO-MODEL

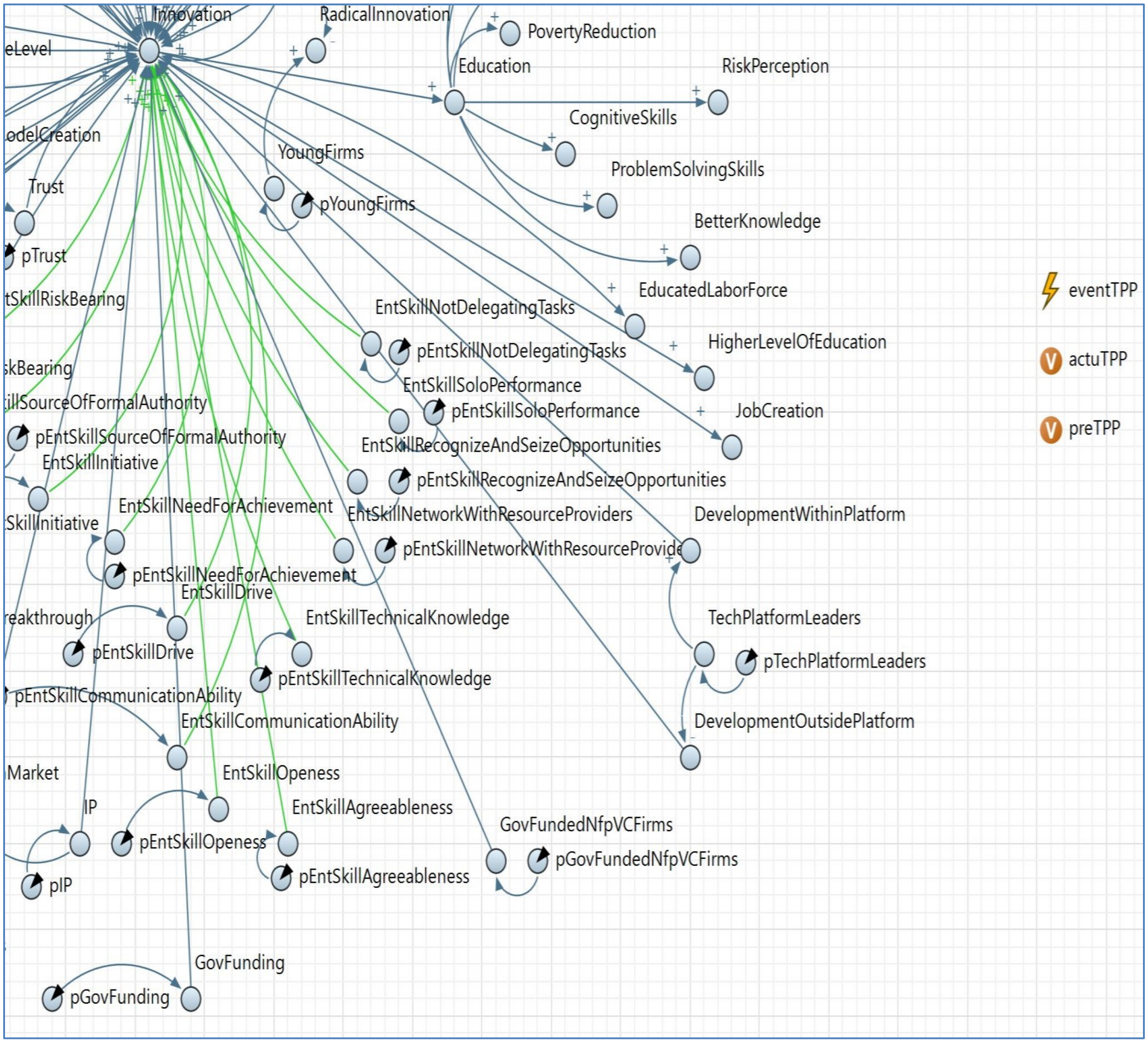


Figure 37: Split view of IECO-model - quadrant 4

APPENDIX B
- THE IECO-MODEL WITH INNOVATION FLOW IN PURPLE COLOR (ZOOMED IN)

QUADRANT 1 OF IECO-MODEL WITH HIGHLIGHTED INNOVATION FLOW

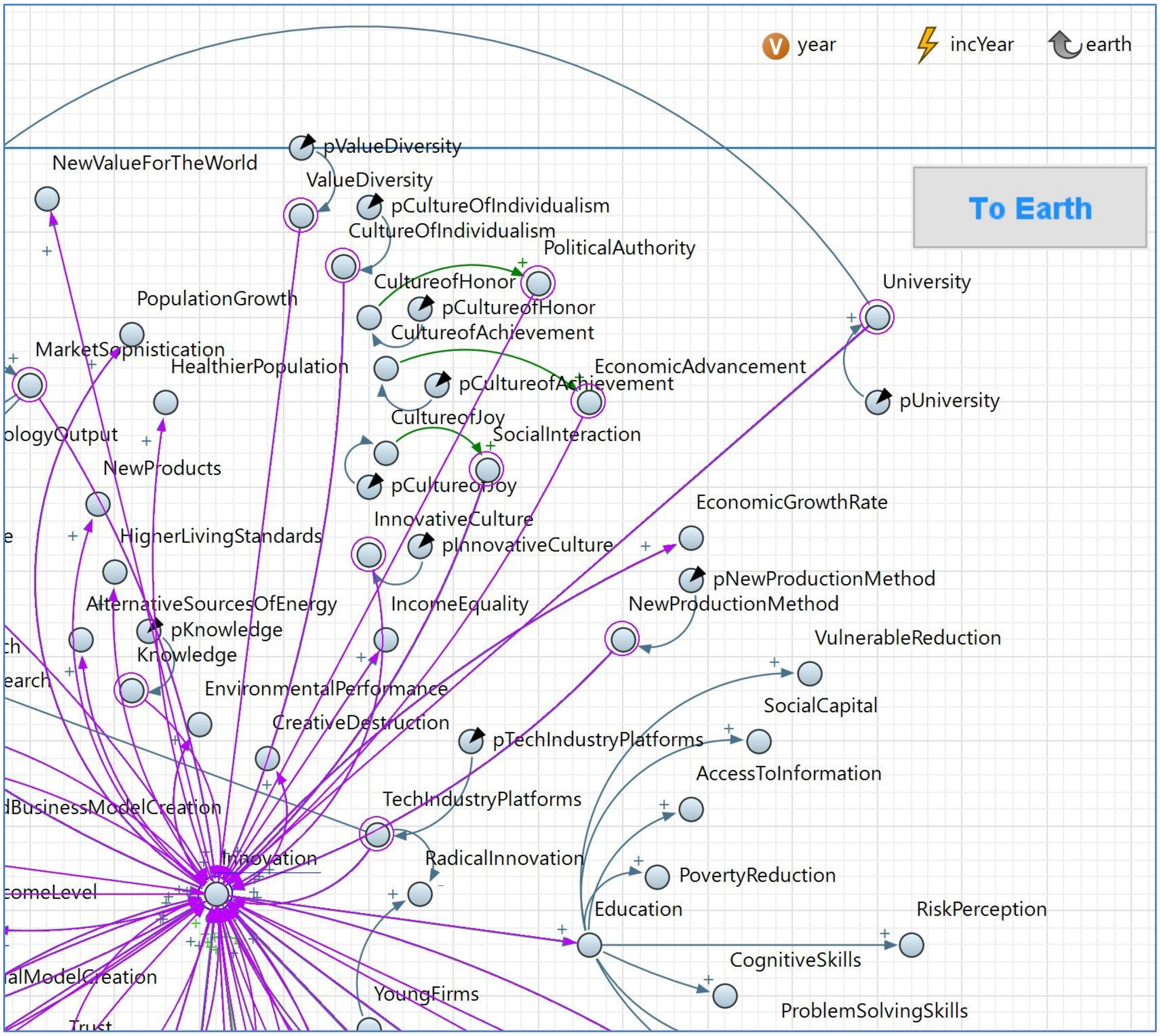


Figure 38: Split view of Innovation flow in IECO-model - Q1

QUADRANT 2 OF IECO-MODEL WITH HIGHLIGHTED INNOVATION FLOW

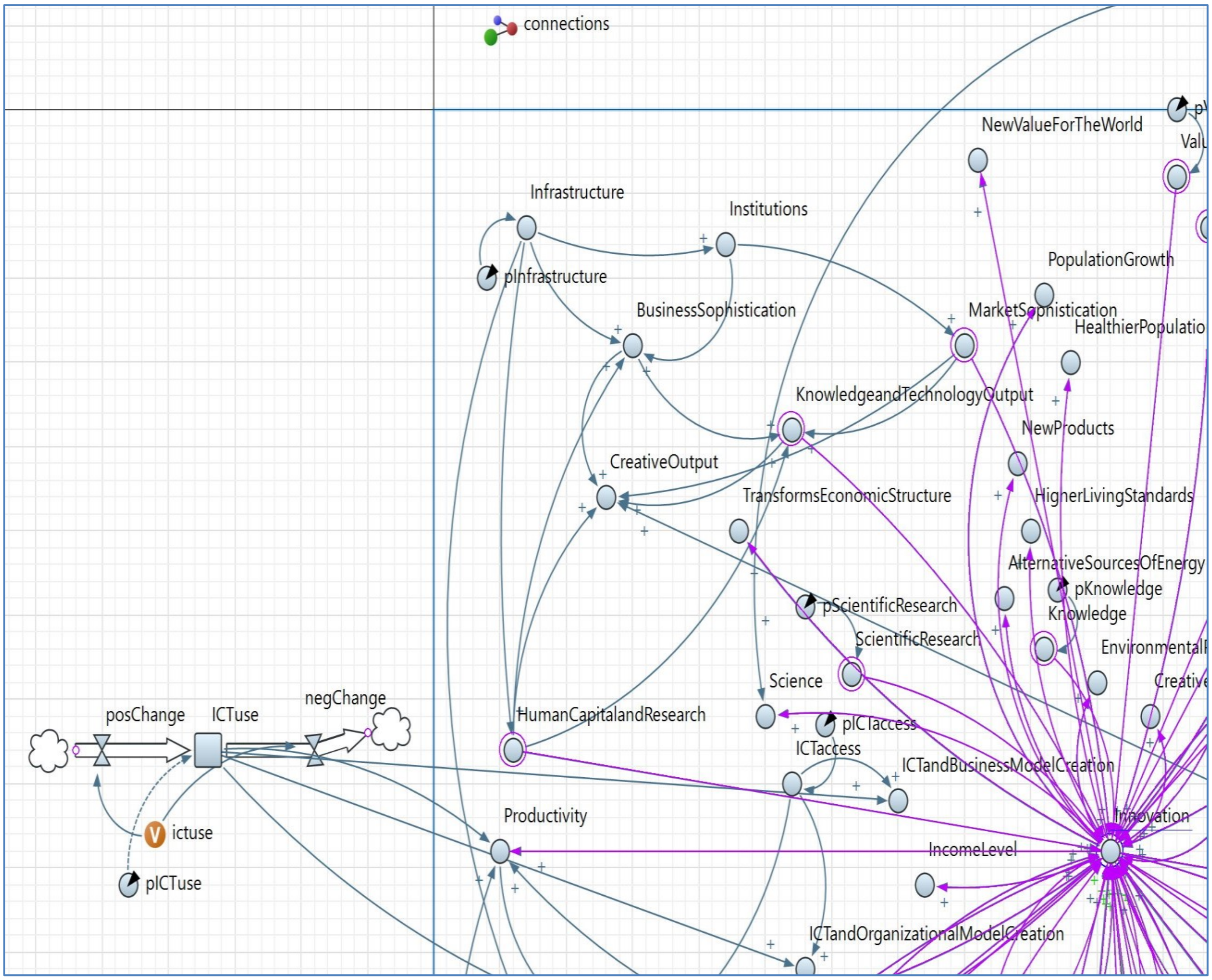


Figure 39: Split view of Innovation flow in IECO-model - Q2

QUADRANT 3 OF IECO-MODEL WITH HIGHLIGHTED INNOVATION FLOW

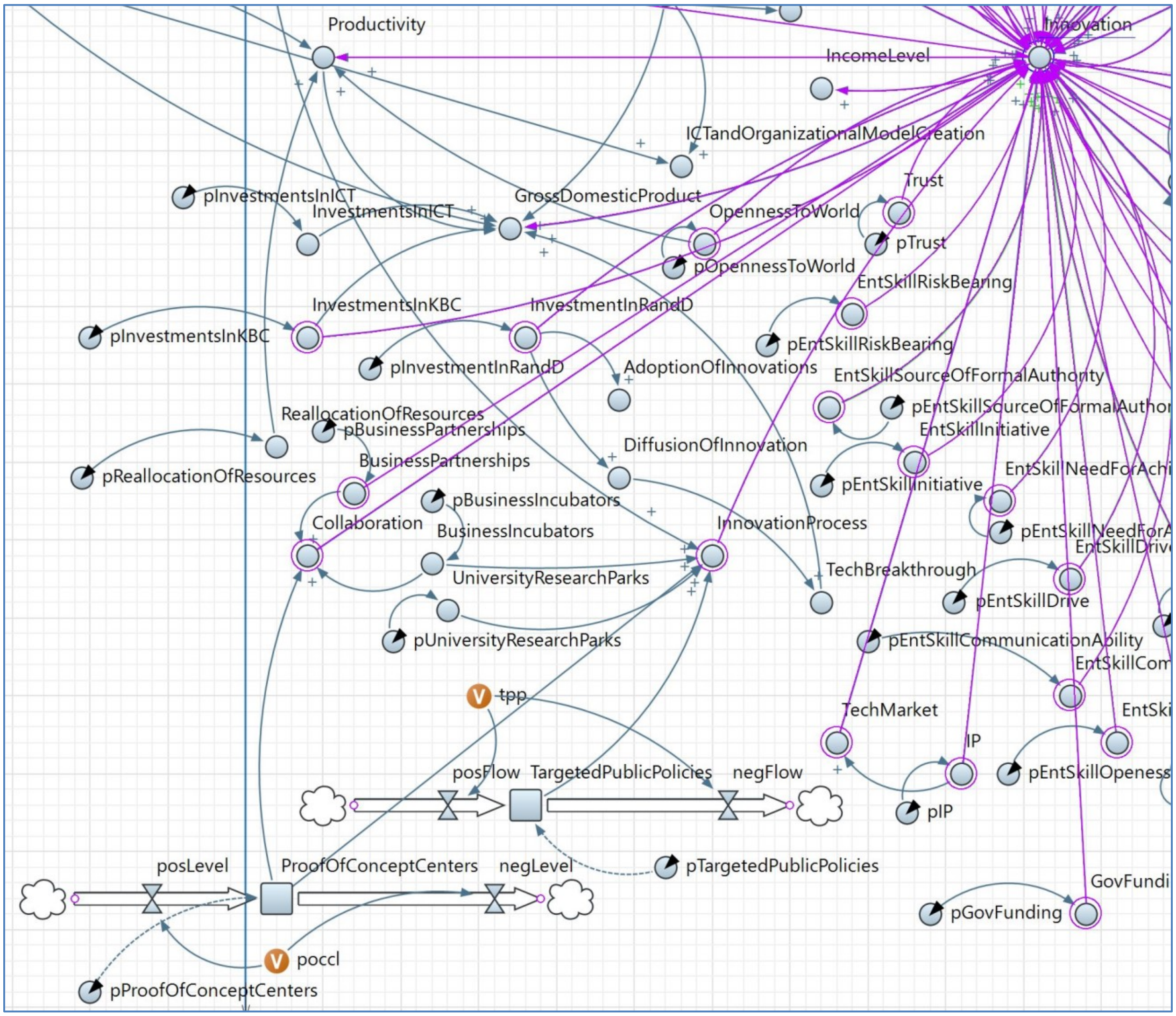


Figure 40: Split view of Innovation flow in IECO-model - Q3

QUADRANT 4 OF IECO-MODEL WITH HIGHLIGHTED INNOVATION FLOW

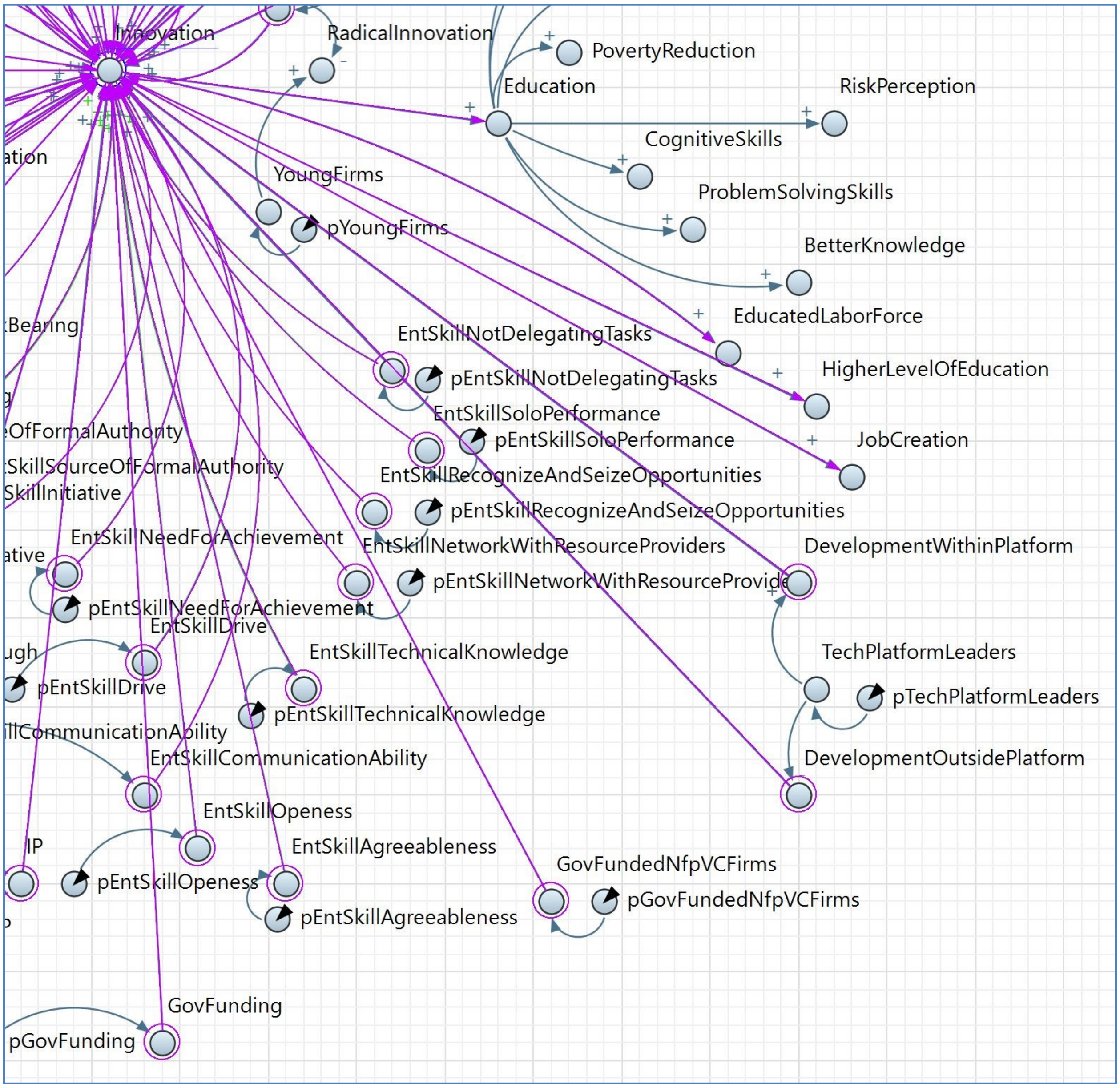


Figure 41: Split view of Innovation flow in IECO-model - Q4

APPENDIX C
- IECO-MODEL VIEW OF SWITZERLAND WITH ALL THE RESULTS (ZOOMED IN)

QUADRANT 1 - IECO-MODEL FLOW RESULTS FOR SWITZERLAND

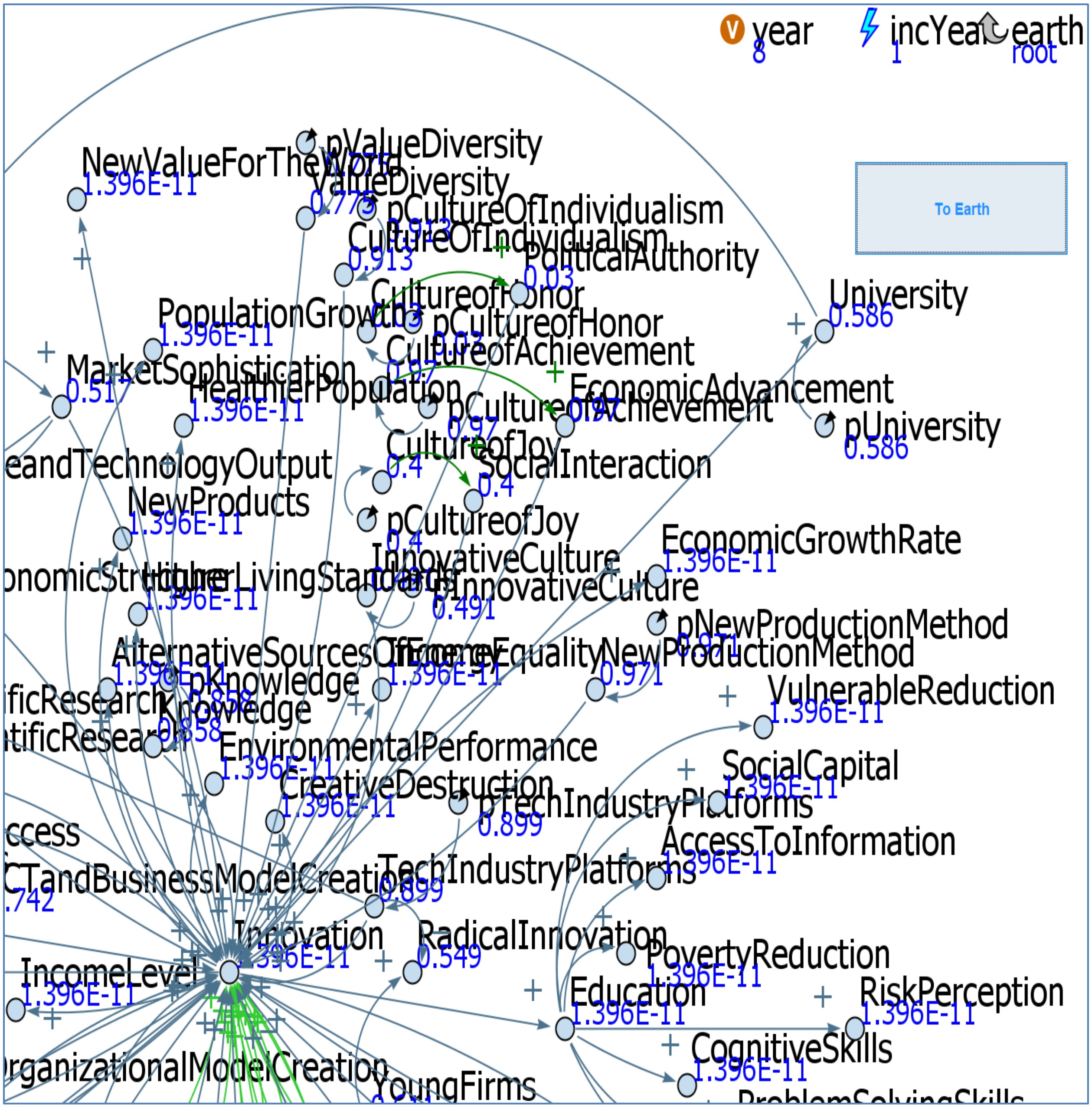


Figure 42: IECO-model flow for Switzerland - Q1

QUADRANT 2 - IECO-MODEL FLOW RESULTS FOR SWITZERLAND

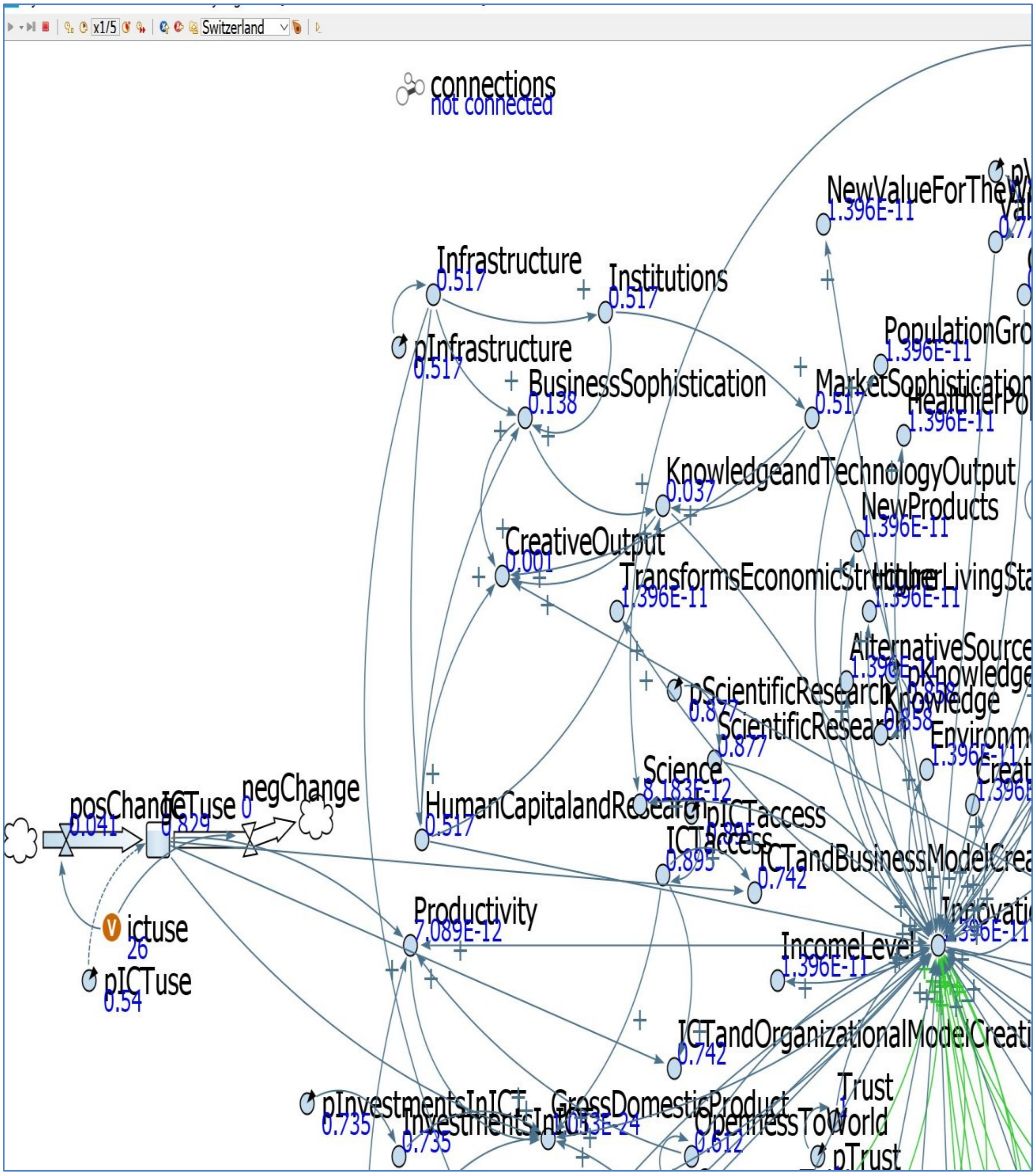


Figure 43: IECO-model flow for Switzerland - Q2

QUADRANT 3 - IECO-MODEL FLOW RESULTS FOR SWITZERLAND

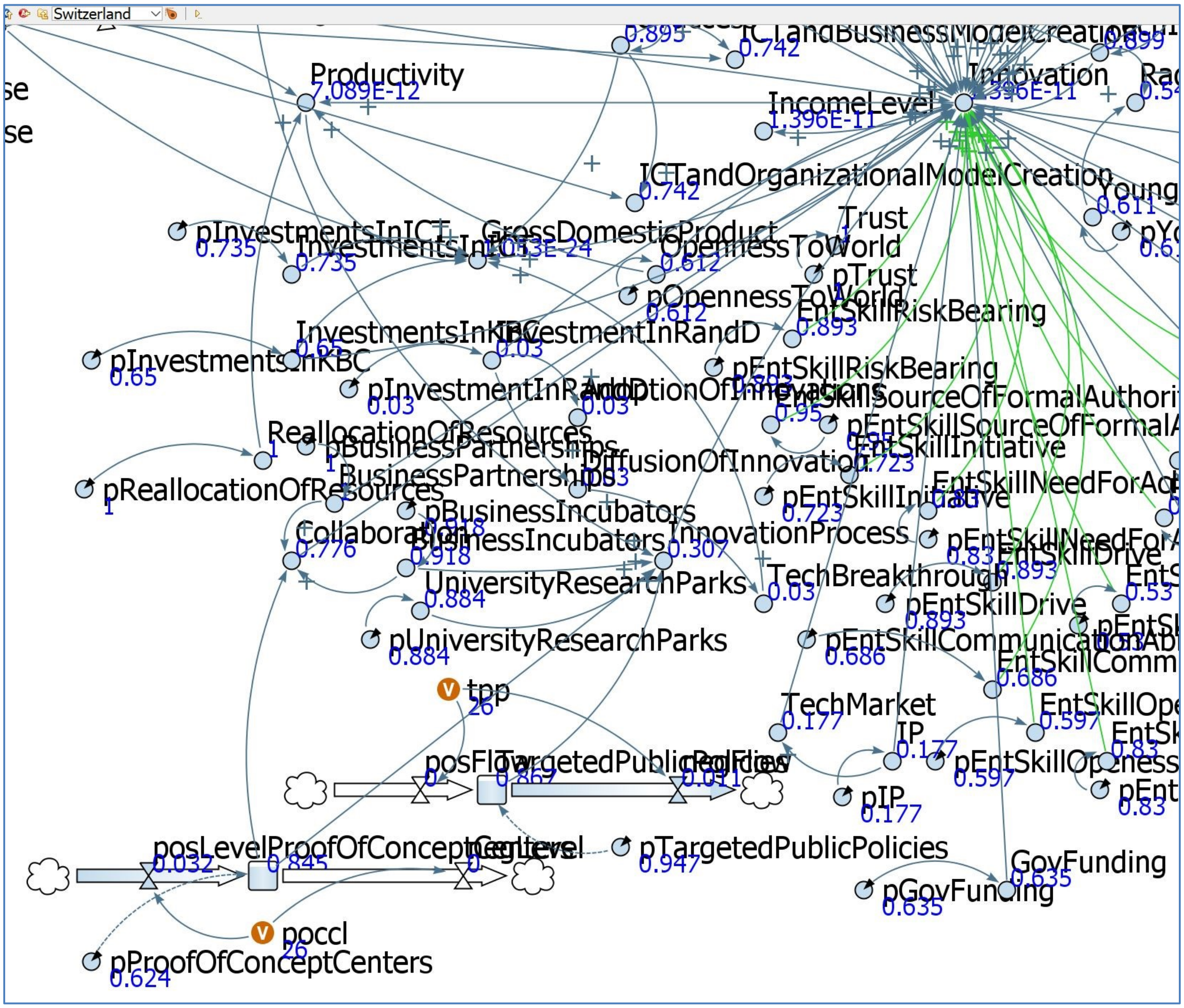


Figure 44: IECO-model flow for Switzerland- Q3

QUADRANT 4 - IECO-MODEL FLOW RESULTS FOR SWITZERLAND

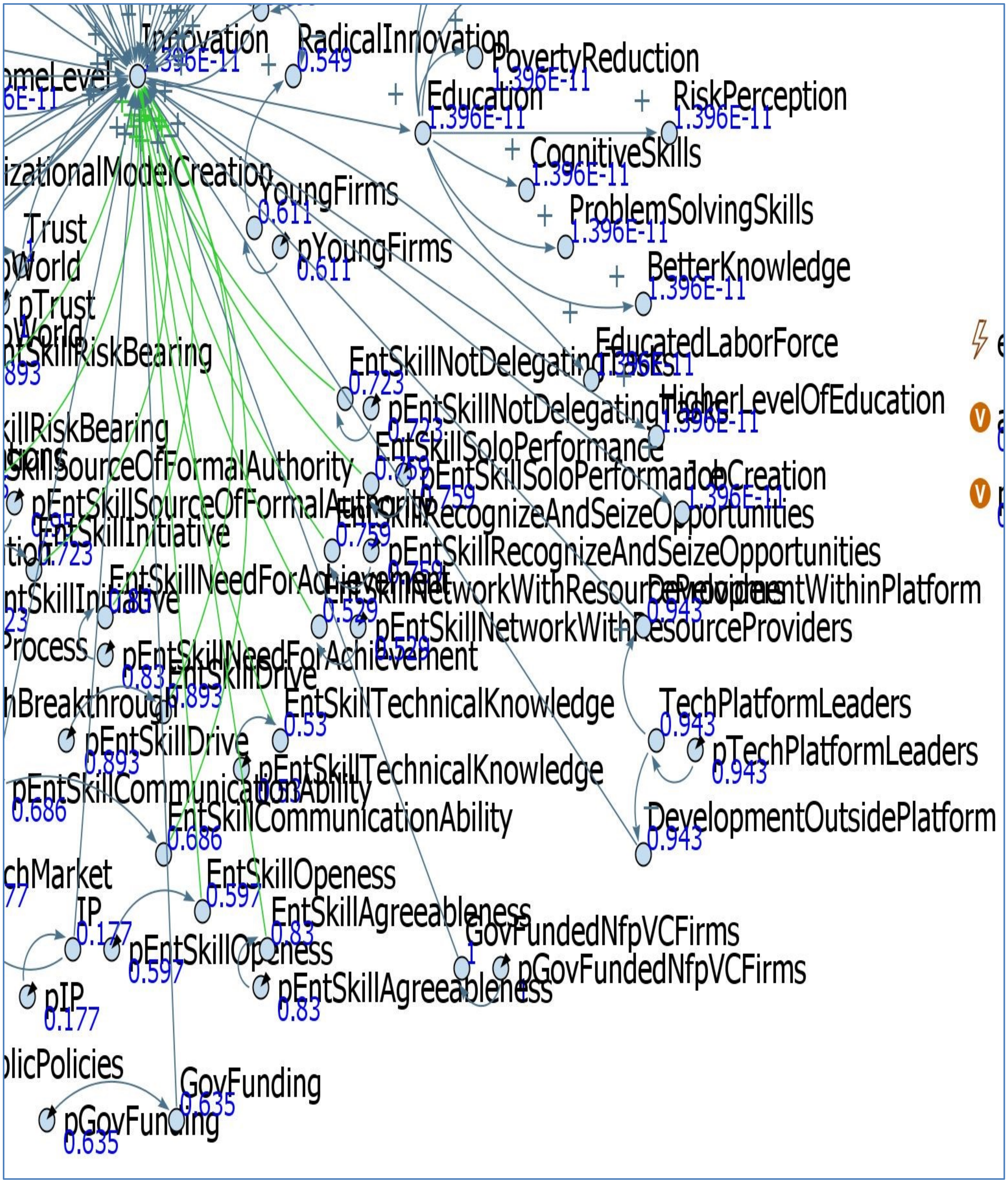


Figure 45: IECO-model flow for Switzerland - Q4

IECO-MODEL VIEW OF DYNAMIC VARIABLE RESULTS FOR SWITZERLAND

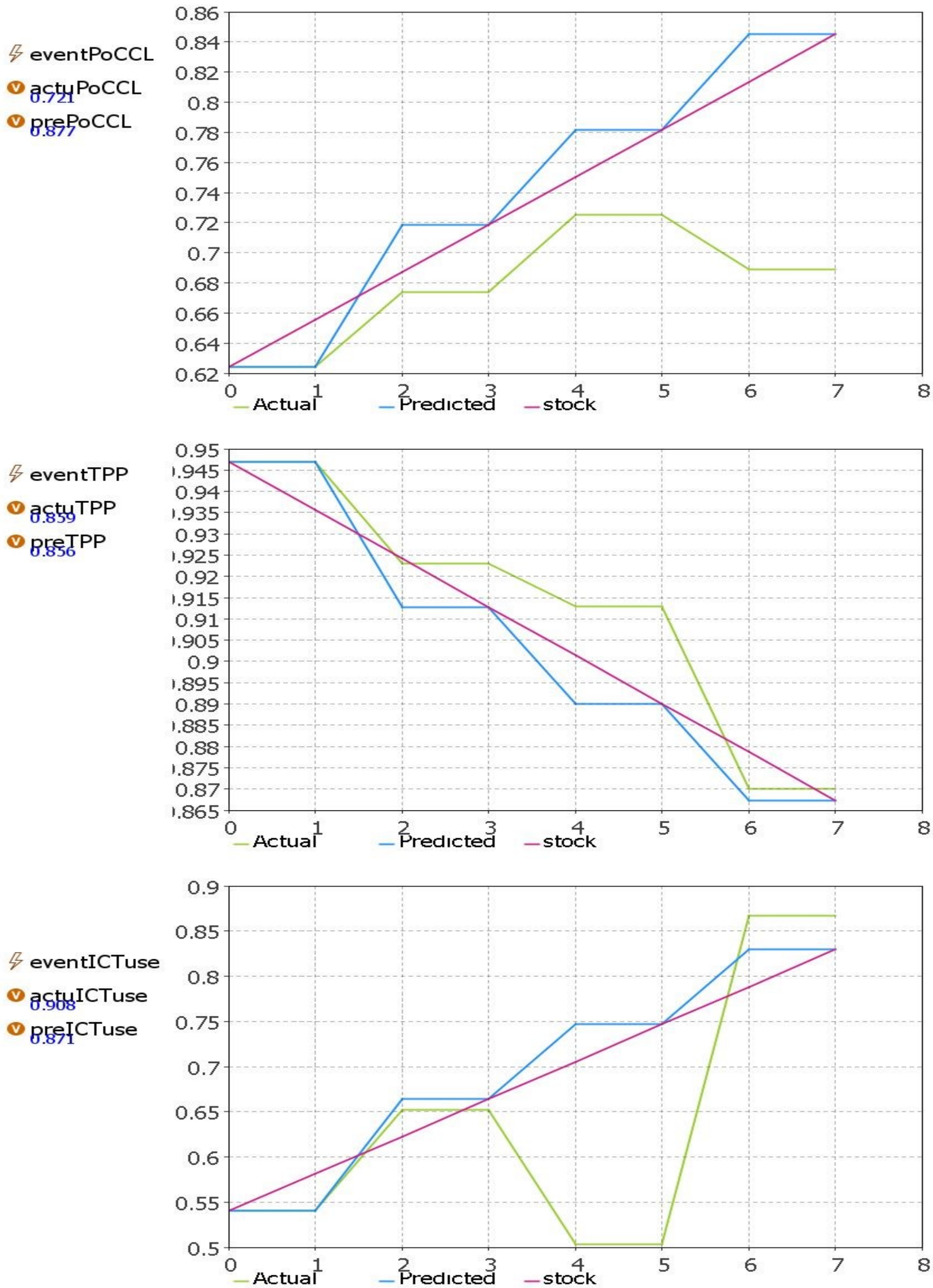


Figure 46: IECO-model view of the three dynamic variable results for Switzerland

APPENDIX D
- TABLES OF THE RELATIONSHIPS/NODES FOUND TO CREATE THE IECO-MODEL

All the relationship found in papers that was the basis for the nodes in the IECO-model

Table 38: Split View of IECO-Model Relationships - Here 1-32

No.	Indicator X	X unit	Indicator Y	Y unit	Relation (effect) between X and Y	References
1	Trust	Level of	Associational activity on innovation	Level of	Partial support for the positive	Entrepreneurship & Regional Development Volume 16, 2004 - Issue 2 Human capital, social capital, and innovation: a multi-country study
2	ICT access (3.1.1)	Level of	ICTs & Business model creation (7.1.3)	Level of	positive relation	From EIS 2017 Methodology explanation p. 5.
3	ICT access (3.1.1)	Level of	ICTs & Organizational model creation (7.1.4)	Level of	positive relation	From EIS 2017 Methodology explanation p. 5.
	ICT access (3.1.1)	Level of	GDP growth (3.2.3)	Level of	positive relation	OECD Strategy 2015
4	ICT use (3.1.2)	Level of	ICTs & Business model creation (7.1.3)	Level of	positive relation	From EIS 2017 Methodology explanation p. 5.
5	ICT use (3.1.2)	Level of	ICTs & Organizational model creation (7.1.3)	Level of	positive relation	From EIS 2017 Methodology explanation p. 5.
6	ICT use (3.1.2)	Level of	GDP growth (3.2.3)	Level of	positive relation	OECD Strategy 2015
7	Cultures of honor	No.	prioritize political authority		Strong positive	A World of Three Cultures: Honor, Achievement and Joy Miguel E. Basáñez
8	Cultures of achievement	No.	emphasize economic advancement;		Strong positive	A World of Three Cultures: Honor, Achievement and Joy Miguel E. Basáñez
9	Cultures of joy	No.	focus on social interactions	how many	Strong positive	A World of Three Cultures: Honor, Achievement and Joy Miguel E. Basáñez
10	information technology ~ ICT use (3.1.2)	Level of	productivity explosion	Level of	Directly positive	Wired for Innovation, Erik Brynjolfsson and Adam Saunders, MIT press
11	investment in (ICT) capital (4.2)	Level of	GDP	Level of	Strong positive	[Figure 1; OECD, 2015b].
12	Investments in Knowledge Based Capital - intangibles (4.2)	Level of	GDP	Level of	Strong positive	OECD Strategy 2015
13	Multifactor productivity	Level of	GDP	Level of	Strong positive	[OECD, 2015b].
14	resulting (reallocation of resources)	Level of	driving aggregate (productivity) growth	Level of	Strong positive	(OECD, 2015c).
15	Results from innovation	Level of	Creative destruction that results from innovation, as new firms enter the market, sometimes growing quickly and thus increasing their market share, replacing other firms with low productivity	No. of companies	Strong negative for the firms with low prod	(Andrews and Criscuolo, 2013). http://dx.doi.org/10.1787/5k46bj546kzs-en
16	young firms possess a comparative advantage	Age	commercializing more radical innovations	No.	Strong Positive	OECD Strategy 2015
17	openness to world, to intern. Trade, FDI, integr. in global value chains (GVCs) to benefit from the	Level of	productivity growth between firms at the global frontier	Level of	Strong Positive	OECD Strategy 2015
18	innovation can help to decouple growth from natural capital depletion	Level of	make alternative sources of energy and raw materials cheaper and more sustainab		Strong Positive	OECD Strategy 2015
19	Innovation is therefore a key in enabling	Level of	"green growth" Environmental performance (3.3.2) - An index	No.	Strong Positive	OECD Strategy 2015
20	This value creation increases aggregate incomes (=innovation)	Level of	positive impact on overall living standards	Level of	Strong Positive	OECD Strategy 2015
21	Innovation	Level of	may contribute to growing income inequality	Level of	Strong (Positive)	OECD Strategy 2015
22	Innovation	Level of	general income level has risen for the whole country, China	Level of	Strong Positive	OECD Strategy 2015
23	Technological platforms	Level of	are associated with a positive impact on innovation		Strong positive	OECD Strategy 2015
24	Technological platforms	Level of	can have negative effect on the competition and possibly on innovation and espec		Strong Negative	OECD Strategy 2015
25	innovative culture	Level of	has a positive effect on innovation output at 1 %	Level of	Strong Positive	OECD Strategy 2015
26	tech platform leaders	No.	encourage development within the platform	Level of	Strong Positive	OECD Strategy 2015
27	tech platform leaders	No.	discourage innovations that does not help the platform.	Level of	Strong Negative	OECD Strategy 2015
28	Entrepreneurial skillset: Risk-bearing	Level of	Innovation	Level of	Positive	Mill (1848)
29	Entrepreneurial skillset: Source of formal authority	Level of	Innovation	Level of	Positive	Weber (1917)
30	Entrepreneurial skillset: Initiative	Level of	Innovation	Level of	Positive	Schumpter (1934)
31	Entrepreneurial skillset: Need for Achievement	Level of	Innovation	Level of	Positive	McClelland (1961)
32	Entrepreneurial skillset: Drive	Level of	Innovation	Level of	Positive	Pickle (1964)

Table 39: Split View of IECO-Model Relationships - Here 33-61

A	B	C	D	E	F	G
No.	Indicator X	X unit	Indicator Y	Y unit	Relation (effect) between X and Y	References
33	Entrepreneurial skillset: Communication ability	Level of	Innovation	Level of		
34	Entrepreneurial skillset: Technical knowledge	Level of	Innovation	Level of	Positive	Pickle (1964)
35	Entrepreneurial skillset:Networking with resouce providers	Level of	Innovation	Level of	Positive	Aldrich & Zimmer (1987)
36	Entrepreneurial skillset: Recognizing and seizing opportunities	Level of	Innovation	Level of	Positive	Timmons et al. (1987)
37	Entrepreneurial skillset: Solo-performance	Level of	Innovation	Level of	Negative	McGrath et al. (1992)
38	Entrepreneurial skillset: Difficulties in delegating tasks	Level of	Innovation	Level of	Negative	McGrath et al. (1992)
39	Entrepreneurial skillset: Avoidance of insecurity	Level of	Innovation	Level of	Negative	McGrath et al. (1992)
40	Scientific Research	Level of	Innovation	Level of	Positive	WIPO (2015)
41	Innovation	Level of	Capital deepening (=GDP) - investments in equipment (InvestICT)	Level of	Positive	WIPO (2015)
42	Innovation	Level of	Population growth	Level of	Positive	WIPO (2015)
43	Innovation	Level of	Healthier population	Level of	Positive	WIPO (2015)
44	Innovation	Level of	Better educated labor force	Level of	Positive	WIPO (2015)
45	Innovation	Level of	Productivity increase of firms (= Productivity)	Level of	Positive	WIPO (2015)
46	Innovation	Level of	Transforms conomic structure	Level of	Positive	WIPO (2015)
47	IP	Level of	Innovation (incentivized by IP)	Level of	Positive	WIPO (2015)
48	IP	Level of	Enables technology markets	Level of	Positive	WIPO (2015)
49	Education 2.1	Level of	Cognitive skills	Level of	Positive	UNESCO(2015)
50	Education 2.1	Level of	Problem solving skills	Level of	Positive	UNESCO(2015)
51	Education 2.1	Level of	Better knowledge	Level of	Positive	UNESCO(2015)
52	Education 2.1	Level of	Risk perception	Level of	Positive	UNESCO(2015)
53	Education 2.1	Level of	Poverty reduction	Level of	Indirect	UNESCO(2015)
54	Education 2.1	Level of	Access to information	Level of	Indirect	UNESCO(2015)
55	Education 2.1	Level of	Social capital	Level of	Indirect	UNESCO(2015)
56	Education 2.1	Level of	Vulnerability reduction	Level of	Strong positive	UNESCO(2015)
57	Infrastruture 3	Level of	Institutions	Level of	Positiv	Malecki (1991), Blind and Grupp (1999), Bronzini and Piselli (2009), De la Fuente (2010), Del Bo and Florio (2012) cited by Sohn et al. (2016)
58	Infrastruture 3	Level of	Human capital and research	Level of	Positiv	Malecki (1991), Blind and Grupp (1999), Bronzini and Piselli (2009), De la Fuente (2010), Del Bo and Florio (2012) cited by Sohn et al. (2016)
59	Infrastruture 3	Level of	Business sophistication factors 5	Level of	Positiv	Malecki (1991), Blind and Grupp (1999), Bronzini and Piselli (2009), De la Fuente (2010), Del Bo and Florio (2012) cited by Sohn et al. (2016)
60	Institution 1	Level of	Business sophistication factors 5	Level of	Direct effect	North (1990), Williamson (1985), Niosi and Bellon (1996), Balasubramanyam, Salisu, and Sapsford (1996) cited by Sohn et al. (2016)
61	Institution 1	Level of	Market sophistication factors 4	Level of	Direct effect	North (1990), Williamson (1985), Niosi and Bellon (1996), Balasubramanyam, Salisu, and Sapsford (1996) cited by Sohn et al. (2016)

Table 40: Split View of IECO-Model Relationships - Here 62-104

A	B	C	D	E	F	G
No.	Indicator X	X unit	Indicator Y	Y unit	Relation (effect) between X and Y	References
62	Market sophistication 4 set it equal to Business sophiscation here	Level of	Knowledge and technology outputs 6	Level of	Direct effect	Balasubramanyam, Salisu, and Sapsford (1996), Lumpkin and Dess (1996), Abdolmohammadi (2005), Hall, Jaffe, and Trajtenberg (2005), Horbach (2008) cited by Sohn et al. (2016)
63	Market sophistication 4 set it equal to Business sophiscation here	Level of	Creative outputs 7	Level of	Direct effect	Balasubramanyam, Salisu, and Sapsford (1996), Lumpkin and Dess (1996), Abdolmohammadi (2005), Hall, Jaffe, and Trajtenberg (2005), Horbach (2008) cited by Sohn et al. (2016)
64	Human capital & Research 2	Level of	Business sophistication factors 5	Level of	Direct effect	Jaffe (1989), Edvinsson and Sullivan (1996), Kilkenny, Nalbarte, and Besser (1999), Bianchi (2001) cited by Sohn et al. (2016)
65	Human capital & Research 2	Level of	Knowledge and technology outputs 6	Level of	Direct effect	Jaffe (1989), Edvinsson and Sullivan (1996), Kilkenny, Nalbarte, and Besser (1999), Bianchi (2001) cited by Sohn et al. (2016)
66	Human capital & Research 2	Level of	Creative outputs 7	Level of	Direct effect	Jaffe (1989), Edvinsson and Sullivan (1996), Kilkenny, Nalbarte, and Besser (1999), Bianchi (2001) cited by Sohn et al. (2016)
67	Business sophistication factors 4	Level of	Knowledge and technology outputs 6	Level of	Direct effect	Hall and Bagchi-Sen (2002), Hernan, Marin, and Siotis (2003), Connolly (2003) cited by Sohn et al. (2016)
68	Business sophistication factors 4	Level of	Creative outputs 7	Level of	Direct effect	Hall and Bagchi-Sen (2002), Hernan, Marin, and Siotis (2003), Connolly (2003) cited by Sohn et al. (2016)
69	Knowledge and technology output 6	Level of	Creative outputs 7	Level of	Direct effect	Feldman (1994), Stolpe (2002), Dakhli and De Clercq (2004), Alcacer and Gittelman (2006) cited by Sohn et al. (2016)
70	Industry platforms can facilitate	Level of	generation of potentially very large number of complementary innova	Level of	Strong Positive	OECD Strategy 2015
71	Scientific Research	Level of	Innovation	Level of	Positive	Fleming and Sorenson (2004)
72	Codified = Explicit Knowledge (= Knowledge)	Level of	Innovation	Level of	Positive	Medcalfe (2002)
73	Investments in R&D	Level of	Creation of Innovation	Level of	Positive	Barlevy (2007)
74	Investments in R&D	Level of	Diffusion of Innovations	Level of	Positive	Barlevy (2007)
75	Investments in R&D	Level of	Adoption of Innovations	Level of	Positive	Barlevy (2007)
76	Business Incubators	Level of	Support the Innovation Process	Level of	Positive	Hackett and Dilts (2004)
77	University Research Parks	No.	Support the Innovation Process	Level of	Positive	Link and Scott (2007)
78	Proof of Concept Centers	No.	Support the Innovation Process	Level of	Positive	Gulbrandson and Audretsch (2008)
79	Infrastructures (such as National Labs)	No.	Support the Innovation Process	Level of	Positive	Jaffe and Lerner (2001)
80	Targeted Public Policies	No.	Support the Innovation Process	Level of	Positive	Mohnen and Roller, 2005: Jaffe, Newell, and Stavins, 2005
81	Innovation	Level of	Producing New Products	Level of	Direct effect	J. A. Schumpeter (
82	Introducing new production methods and techniques	Level of	Innovation	Level of	Positive	J. A. Schumpeter (
83	Opening up to new markets (=OpenessToWorld)	Level of	Innovation	Level of	Positive	J. A. Schumpeter (
84	Exploiting and utilizing new raw materials	Level of	Innovation	Level of	Positive	J. A. Schumpeter (
85	New techniques	Level of	Innovation	Level of	Positive	J. A. Schumpeter (
86	Applying new organization modes	Level of	Innovation	Level of	Positive	J. A. Schumpeter (
87	Investments in Knowledge Based Capital - intangibles (4.2)	Level of	Innovation	Level of	Positive	OECD (2010)
88	Data stimulates	Level of	Innovation	Level of	Positive	OECD (2013)

No.	Indicator X	X unit	Indicator Y	Y unit	Relation (effect) between X and Y	References
89	Entrepreneur Skillset: Openess	Level of	Innovation	Level of	Positive	Steel et al. (2012)
90	Entrepreneur Skillset: Agreeableness	Level of	Innovation	Level of	Positive	Steel et al. (2012)
91	Value Diversity	Level of	Innovation	Level of	Positive	Ramasamy & Yeung (2016)
92	BusinessPartnerships	Level of	Innovation	Level of	Positive	Block (2008, p. 19)
93	Collaboration	Level of	Innovation	Level of	Positive	Block (2008, p. 19)
94	Government funding	Level of	Innovation	Level of	Positive	Block (2008, p. 19)
95	GovFundedNfpVCFirms	Level of	Innovation	Level of	Positive	Block (2008, p. 23)
96	GovFundingValidatesIdea	Level of	Innovation	Level of	Positive	Block (2008, p. 27)
97	PatentOwnershipIssues	Level of	Innovation	Level of	Negative	Block (2008, p. 28)
98	NoGovFundingCoordination	Level of	Innovation	Level of	Negative	Block (2008, p. 28)
99	Innovation	Level of	Job creation	Level of	Positive	Andrew, DeRocco, & Taylor (2009) in Steel et al. (2012)
100	Innovation	Level of	Higher levels of Education (=Education)	Level of	Positive	Andrew, DeRocco, & Taylor (2009) in Steel et al. (2012)
101	CultureOfIndividualism	Level of	Innovation	Level of	Positive	Ezell & Marxgut (n.y.)
102	TechInnovation (=Innovation)	Level of	Economic GrowthRate	Level of	Positive	Ezell & Marxgut (n.y.)
103	Innovation	Level of	New Value for the world	Level of	Positive	Ezell & Marxgut (n.y.)
104	University	Level of	University Support of Science and Innovation. Universities serve as an	Level of	Positive	Link & Antonelli (2013)

APPENDIX E
- THE 43 PARAMETER DATA SOURCES

Table 41: Description of the 43-Parameter Data-Sources with Color Coding

Color legends	Data info
(light green)	Data found in the GII 2017 - Global Innovation Index 2017
(orange)	Data found in the book *A World of Three Cultures* by Basañez
(blue)	Data found in the GEI 2017 - Global Entrepreneurship Index 2017
(green)	A stock variable with data from GII 2011 - 2017

Parameter 1 – Business Incubators.

- The data used here comes from the GEI 2017 and is the pillar they call the **"Opportunity Startups,"** and the variables are opportunity motivation and governance (taxation * good governance). This 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 service (GEI, 2017).
- 2017
- Choice of data: A business incubator is an entity, where entrepreneurs normally join due to they have an opportunity-driven company, have an idea they "burn for" or are genuinely passionate about.

Parameter 2 – Business Partnerships.

- The data comes from GEI 2017, and the pillar is "**Internationalization,"** and the variables are export and economic complexity. This 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 (GEI, 2017).
- The reasoning for choosing this specific data input: If entrepreneurs have a high degree of internationalization, that is a sign of being good at creating business partnerships, while going international is much more demanding than setting up business relations locally.
- High level of internationalization is equal to value = 1

Parameter 3 – Culture of Achievement

- The data comes from the Word of Three Cultures, p. 127 where **"Countries of Achievement, Punctuality, and Efficiency,"** 2010. Here the data is high when it is close to 0 or the smaller, the better, and Sweden and Denmark are topping this ranking.
- The reasoning for choosing this data input: The three elements in the ranking; achievement, punctuality, and efficiency is representing the parameter of the culture of achievement.
- A high value here is close to 0.

Parameter 4 – Culture of Honor

- The data comes from the Word of Three Cultures, p. 121 where **"Countries of Honor and Respect and Authority,"** 2010 are ranked. Here 0 = very low in this ranking, and Denmark and Sweden are both ranking very scores here and having low respect for authorities is probably the reason. Scandinavians

are “free thinkers,” and just because you have a title will not make a Scandinavian person believe in you without evaluating what is being said. They are not used to be dictated, and here it is countries, who have had strict rulers, that are scoring high in this.

- The reasoning for choosing this data input: This survey represents the wished parameter.
- High = 1

Parameter 5 – Culture of Individualism

- The data comes from the Word of Three Cultures, and the Objective Development Index is chosen instead of table 2.3 on p. 49 from 2001 called the **“Individualism versus Collectivism Index.”** This table could not be used, while data for nine countries were missing.
- The reasoning for choosing this data input: This survey represents the wished parameter.
- High = 1

Parameter 6 – Culture of Joy

- The data comes from the Word of Three Cultures, p. 128. Here **“Countries of Joy and Friendship”** from 2010 are ranked. Here 1 represents a low value in the ranking, and it is Sweden who has the lowest ranking. It must be that the Swedes might not see themselves as having that many friendships, and therefore rank themselves low. The result might be due to self-reporting, that the relative level of joy is high in Sweden, but from a Swedes perspective, it does not feel that high, while they are a bit “spoiled” with the society providing such a carefree life for them. Normally the Scandinavian countries are ranked high in regards to “joy and happiness,” and Denmark and Norway have been deemed by Forbes the happiest countries in the world several years in the row. A general comment that could be given is that in surveys it all depends upon how the question is formulated.
- The reasoning for choosing this data input: This data represents the needed parameter.
- Low = 1.

Parameter 7 – Entrepreneurial Skill (ES): Agreeableness

- The data comes from the Word of Three Cultures, p. 152. The data is from 2000. This data is called **“Tolerance (of homosexuality),”** and if the countries can handle/accept homosexuality, they must be considered very agreeable. Here the country is very “Agreeable,” when the score is close to 0 or the smaller, the better.
- The reasoning for choosing this data input: This ranking shows a lot about the mentality in the country, so it is perfect to gauge the agreeableness in the country.
- Being very agreeable = 0.

Parameter 8 – Entrepreneurial Skill (ES): Communication Ability

- The data comes from the Global Innovation Index 2017, variable 7.3 that is a part of the pillar “Creative outputs.” Here the variable is called **“Online Creativity.”** The data consists of the average of

4 sublevel variables: Generic top-level domains (gTLDs), and Country-code-top-level domains (ccTLDs), and Wikipedia yearly edits by country, and finally the number of Video uploads on YouTube, (GII, 2017).

- The reasoning for choosing this data input: Online creativity is showing something about a country's communication ability.
- High level = 1

Parameter 9 – Entrepreneurial Skill (ES): Drive

- The data comes from the Word of Three Cultures, p. 150. The data is from 2010. Here it is a table that ranks the countries on **"Competition (Is Good),"** and it stimulates people to work hard and develop new ideas, which is more or less equal to having a "drive" in business.
- Here the value is high when it is close to 1, H = 1.

Parameter 10 – Entrepreneurial Skill (ES): Initiative

- The data comes from the GEI 2017, from the pillar called **"Startup Skill,"** which consists of sub-pillars; skill perception and education (tertiary education * quality of education). Startup skill captures the perception of start-up skills in the population and weights this aspect with the quality of education (GEI, 2017).
- The reasoning for choosing this data input: This pillar seems to capture the essence of what the entrepreneurial skill, initiative, actually is consisting of some part of skills and education. One of the reasons for varying levels in the top ten countries must be found in the cultural heritage.
- High level = 1.

Parameter 11 – Entrepreneurial Skill (ES): Need for Achievement

- The data comes from the GEI 2017, from the pillar called **"Cultural Support,"** which consists of sub-pillars; career status and corruption. This 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 (GEI, 2017).
- The reasoning for choosing this data input: This pillar has the sub-pillar; career status, which is related to the Need for Achievement, and found a good data point for this parameter.
- High level = 1.

Parameter 12 – Entrepreneurial Skill (ES): Network With Resource Providers

- The data comes from the GEI 2017, from the pillar called **"Networking,"** which consists of sub-pillars; know entrepreneurs and agglomeration (urbanization * infrastructure). Here two aspects of networking are combined in 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 each other (GEI, 2017).

- The reasoning for choosing this data input: These parts described in this pillar is networking at its core. Therefore this pillar is very descriptive of this situation.
- High level = 1.

Parameter 13 – Entrepreneurial Skill (ES): Not Delegating Tasks

- The data comes from the Global Innovation Index 2017, and it is variable 6.3 that is called "**knowledge diffusion,"** and it consists of the average of 4 sub-variables, Intellectual property receipts, and High-tech exports, and ICT services exports, and Foreign Direct Investment net outflows. The parameter here is about not delegating tasks, sharing knowledge, having no knowledge diffusion. The data here in GII is about the charges of used IP, amount of exporting is indirectly sharing, products, FDI outflows and then the results were normalized. The data is from 2017 (GII, 2017, p. 413).
- The reasoning for choosing this data input: Not Delegating Tasks, is the opposite of Knowledge Diffusion, or at least can be, while the knowledge will stay with only that person, who has the acquired knowledge.
- High level = Here Not Delegating Tasks is happening when the value is close to 0

Parameter 14 – Entrepreneurial Skill (ES): Openness

- The data comes from the Word of Three Cultures, p. 130. The data is from 2000. Here people in countries are ranking themselves on the level of **"Feeling of Happiness."**
- The reasoning for choosing this data input: Having the entrepreneurial skill: Openness and finding data that correctly shows that skill is hard, but if a feeling of happiness is a part of the life, the author postulates, that then there will be a bigger openness to new things, and learning from other, and other countries. Therefore, this data source is chosen.
- High level = 1

Parameter 15 – Entrepreneurial Skill (ES): Recognize and Seize Opportunity

- The data comes from the GEI 2017, from the pillar called **"Opportunity Perception,"** which consists of sub-pillars; opportunity recognition and freedom (economic freedom * property rights). This pillar refers to the entrepreneurial opportunity perception potential of the population and weights this against the freedom of the country and property rights (GEI, 2017).
- The reasoning for choosing this data input: This pillar description fits very well with this node of ES: Recognize and Seize Opportunity.
- High level =1.

Parameter 16 – Entrepreneurial Skill (ES): Risk Bearing

- The data comes from the GEI 2017, from the pillar called **"Risk Acceptance,"** which consists of sub-pillars; risk perception and country risk. This pillar captures the inhibiting effect of fear of failure of the population on entrepreneurial action combined with a measure of the country's risk (GEI, 2017).

- The reasoning for choosing this data input: This pillar is an excellent description of the entrepreneurial skill: Risk-Bearing.
- High level =1.

Parameter 17 – Entrepreneurial Skill (ES): Solo Performance

- The data source here is the World of Three Cultures, Appendix 12, p. 334 - 336. The data is the "**Subjective Development Index (SDI)"** that is derived from Inglehart's World Cultural Map. The SDI combines the maps' two axes (survival-self-expression and traditional-secular/rational) into a single line, and a unique value for each country is generated. This type of data is found very appropriate to illustrate Solo Performance and is used here in the model.
- High = 1

Parameter 18 – Entrepreneurial Skill (ES): Source Of Formal Authority

- The data comes from the Word of Three Cultures, Appendix 7, p. 287. Political Rights and Civil Liberties in the World. In the literature, entrepreneurs are seen as people with some kind of formal authority, and therefore this appendix showed how people and authority are evaluated in the world.
- High = 1

Parameter 19 – Entrepreneurial Skill (ES): Technical Knowledge

- The data comes from the Global Innovation Index 2017, and it is variable 5.1.1 and shows the percentage of **"Employment in knowledge-intensive services"** in a country. Sum of people in categories 1 to 3 as a percentage of total people employed, according to the International Standard Classification of Occupations (ISCO). Categories included are ISCO-08, ISCO-88, and ISCO-68. Data is from 2015. (GII, 2017, p. 410).
- The reasoning for choosing this data input: It is the best fitting variable to show this situation in the workplace.
- High level = 1.

Parameter 20 – Government Funded Not for Profit VC Firms

- The data comes from the GEI 2017, from the pillar called **"Risk Capital,"** which consists of sub-pillars; "informal investment and depth of capital market." 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 (GEI, 2017).
- The reasoning for choosing this data input: Due to informal investment in start-ups are included in this data, it was found very relevant for this unique parameter, while it has been realized that these government funded not for profit VC firms make much impact and are extremely important for science and technology. (Block (2008, p. 19))
- High level =1.

Parameter 21 – Government Funding

- The data comes from the Global Innovation Index 2017, and it is variable 4.2 that is called **"Investment."** It consists of the average of 3 sub-variables: Ease of protecting minority investors [2016], Market capitalization [2015], and Venture capital deals [2016]. (GII, 2017, p. 409).
- The reasoning for choosing this data input: Government funding is often happening in an indirect way as (Block, 2008) describes, and therefore it is hard to find any data that shows the true investment level, and therefore this value is probably one of the best possible data that can be retrieved.
- High level = 1.

Parameter 22 – ICT Access

- The data comes from the Global Innovation Index 2017, and it is variable 3.1.1 that is called **"ICT Access."** This value is a composite index that weights five ICT indicators with 20% each: 10 Fixed telephone subscriptions/100 inhabitants, 20 Mobile cellular telephone subscriptions/100 inhabitants; 3) International Internet bandwidth (bit/s) per Internet user; 4) Percentage of households with a computer: and 5) Percentage of households with Internet access. It is the first sub-index in ITU's ICT development Index (IDI). Data is from 2016. (GII, 2017, p. 407).
- The reasoning for choosing this data input: It is the best fitting variable to show this situation in the workplace, the culture of the country.
- High level = 1.

Parameter 23 – ICT Use

- The data comes from the Global Innovation Index 2017, and it is variable 3.1.2 that is called **"ICT Use."** The ICT Use index is a composite index that weight three ICT indicators (33% each): 1) Percentage of individuals using the Internet; 20 Fixed (wired)-broadband Internet subscriptions/100 inhabitants; 3) Active mobile-broadband subscriptions/100 inhabitants. It is the second sub-index in ITU's ICT Development Index (IDI). Data is from 2016. (GII, 2017, p. 407).
- This parameter is converted to dynamic variables, while the data for this parameter had been collected consistently from 2011 to 2017, and therefore the data is very reliable. This parameter was therefore created as a stock variable.
- High level = 1.

Parameter 24 – Infrastructure

- The data comes from the Global Innovation Index 2017, and it is variable 3.2 that is called **"General Infrastructure."** It consists of the average of 3 sub-variables: Electricity output [2014], Logistics performance [2016], and Gross capital formation [2016]. (GII, 2017, p. 408).
- The reasoning for choosing this data input: This data source was chosen as the best fitting variable.

- High level = 1.

Parameter 25 – Innovative Culture

- The data comes from the Global Innovation Index 2017, and it is variable 6.2 **"Knowledge Impact,"** It consists of the average of 5 sub-variables: the Growth rate of GDP per person engaged [2015}, New business density [2014], Total computer software spending [2016], ISO 9001 quality certificates [2015], and High-tech and medium-high-tech-output [2014]. (GII, 2017, p. 413).
- This value is chosen while the level of knowledge impact in a country is correlating with how innovative a culture is normally. This data source was evaluated as appropriate.
- High level = 1.

Parameter 26 – Investments in R and D

- The data comes from the Global Innovation Index 2017, and it is variable 2.3.2." It is the total domestic intramural expenditure on R&D during a given period as a percentage of GDP. Intramural R&D expenditure is all expenditure for R&D performed within a statistical unit or sector of the economy during a specific period, whatever the source of funds. Data is from 2015. (GII, 2017, p. 407).
- The reasoning for choosing this data input: This data source represents the parameter.
- High level = 1.

Parameter 27 – Investments in ICT

- The data comes from the Global Innovation Index 2017, and it is variable 3.1 that is called **"Information & communication technologies (ICTs)."** It consists of 4 sub-variables: ICT access [2016], ICT use [2016], Government's online service [2016], and finally Online e-participation [2016]. (GII, 2017, p. 407).
- The reasoning for choosing this data input: This data source represents the parameter.
- High level = 1.

Parameter 28 – Investments in Knowledge BC

- The data comes from the Global Innovation Index 2017, and it is variable 7.1 that is called **"Intangible assets."** It consists of 4 sub-variables: Trademark application class count by origin [2015]. A number of trademark applications issued to residents at a given national or regional office (per billion PPP$ GDP); Industrial designs by origin [2015]. A number of designs contained in industrial design applications filed at a given national or regional office (per billion PPP$ GDP); ICTs and business model creation [2016]. Is based on the average answer to the question: In your country, to what extent do ICTs enable new business models? [1=not at all, 7= to a great extent]; and ICTs and organizational model creation. [2016]. Is based upon the average answer to the question: In your country, to what extent do ICTs enable new organizational models (e.g., virtual teams, remote working, telecommuting) within companies? [1=not at all, 7= to a great extent]. (GII, 2017, p. 414).

- The reasoning for choosing this data input: This mix of sub-variable demonstrates the investments done by Knowledge-Based Companies, while companies will get trademarks, and ICT equipment, but many of these values creating processes or products are what is considered intangible assets due to they are so hard to evaluate the value-creating effect off.
- High level = 1.

Parameter 29 – Intellectual Property

- The data comes from the Global Innovation Index 2017, and it is variable 6.1.1 that is called **"Patent by origin."** It is the number of resident patent applications filed at a given national or regional patent office (per billion PPP$ GDP) [2015]. (GII, 2017, p. 412).
- The reasoning for choosing this data input: This data source are covering the thought IP information.
- High level = 1.

Parameter 30 – Knowledge

- The data comes from the Global Innovation Index 2017, and it is variable 6.1 that is called **"knowledge creation.".** It consists of 5 sub-variables: Patent applications by origin [2015]. It is the number of resident patent applications filed at a given national or regional patent office (per billion PPP$ GDP); PCT international application by origin [2016]. Number of international patent applications filed by residents at the Patent Cooperation Treaty (per billion PPP$ GDP); Utility model applications by origin. [2015] Number of utility model applications filed by residents at the national patent office (per billion PPP$ GDP); Scientific and technical publications. [2016]. A number of scientific and technical journal articles (per billion PPP$ GDP); Citable documents H index. [2016] The H index is the economy's number of published articles (H) that have received at least H citations. (GII, 2017, p. 412).
- The reasoning for choosing this data input: It is an excellent data source to demonstrate knowledge.
- High level = 1.

Parameter 31 – New Production Method

- The data comes from the GEI 2017, from the pillar called **"Product Innovation,"** which consists of sub-pillars; new product and tech transfer. The pillar captures the tendency of entrepreneurial firms to create new products weighted by the technology transfer capacity of a country (GEI, 2017).
- The reasoning for choosing this data input: The data is a good representation of the parameter.
- High level =1.

Parameter 32 – Openness to World

- The data comes from the Word of Three Cultures, p. 144. The data is from 2000, and the survey is called **"Trust in People."** The respondents have been asked:" Generally speaking, would you say that most people can be trusted or that you need to be very careful in dealing with people?" (BASAÑEZ , 2016)

- The reasoning for choosing this data input: If a person is open to new people then it is indirectly also showing openness to the world.
- High level = **1**

Parameter 33 – Proof Of Concept Centers

- The data comes from the Global Innovation Index 2017, and it is variable 5.2.2 that is called **"State of cluster development**." It is data based upon an answer to the survey question on the role of clusters in the economy: In your country, how widespread are well-developed and deep clusters (geographic concentrations of firms, suppliers, producers of related products and services, and specialized institutions in a particular field)? [1=not at all, 7= to a great extent]. (GII, 2017, p. 411).
- This parameter was converted to a dynamic variable, while the data for this parameter had been collected consistently from 2011 to 2017, and therefore the data is very reliable. This parameter is now a stock variable.
- High level = 1.

Parameter 34 – Reallocation of Resources

- The data comes from the GEI 2017, from the pillar called "**Competition**," which consists of sub-pillars; competitors and competitiveness (market dominance * regulation). 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. It reflects the technology-intensity of a country's start-up activity combined with a country's capacity for firm-level technology adoption (GEI, 2017).
- The reasoning for choosing this data input: Reallocation of resources is something companies do to stay competitive, and that is therefore seen as relevant to use this pillar as the parameter data.
- High level =1.

Parameter 35 – Scientific Research

- The data comes from the GEI 2017, from the pillar called **"Process Innovation,"** which consists of sub-pillars; new technology and science (GERD * (average quality of scientific institutions + availability of scientist and engineers)). This pillar captures the use of the new technologies by start-ups combines with the Gross Domestic Expenditure on Research and Development (GERD) and the potential of a country to conduct applied research (GEI, 2017).
- The reasoning for choosing this data input: This data is a good representation of the parameter.
- High level =1.

Parameter 36 – Targeted Public Policies

- The data comes from the Global Innovation Index 2011 - 2017, and it is variable 1.2.1 that is called **"regulatory quality."** It is an index that reflects perceptions of the ability of the government to

formulate and implement sound policies and regulations that permit and promote private-sector development. Scores are standardized. [2015]. (GII, 2017, p. 404).

- This parameter was converted to a dynamic variable, while the data for this parameter had been collected consistently from 2011 to 2017, and therefore the data is very reliable. This parameter is now a stock variable.
- High level = 1.

Parameter 37 – Tech Industry Platforms

- The data comes from the GEI 2017, from the pillar called "Technology Absorption," which consists of sub-pillars; technology level and technology absorption. It reflects the technology-intensity of a country's start-up activity combined with a country's capacity for firm-level technology adoption (GEI, 2017).
- The reasoning for choosing this data input: Tech Industry Platforms usually are focusing very intensely on the particular technology the platform is focusing upon, and therefore this pillar is a good choice.
- High level =1.

Parameter 38 – Tech Platform Leaders

- The data comes from the Global Innovation Index 2017, and it is variable 2.3.3. that is called **"Global R&D Companies."** It is data that is an average expenditure of the top 3 global companies by R&D in each country, mn $US [2016]. (GII, 2017, p. 407).
- The reasoning for choosing this data input: The 3 top global companies are very likely also the tech platform leaders, they set the pace and decide the rules, while they are the leaders.
- High level = 1.

Parameter 39 – Trust

- The data comes from the Word of Three Cultures, p. 138. The data is from 2000, and the data source is a survey about **"Belong to Religious Denomination,"** and the question asked were: "Do you belong to a religious denomination?" (BASAÑEZ , 2016)
- The reasoning for choosing this data input: If a person says they are religious, they do also show trust in the Universe, life in general, while they have their "God" by their side. It represents well, the entrepreneurial skill, Trust.
- High = 1

Parameter 40 – University

- The data comes from the Global Innovation Index 2017, and it is variable 2.1 that is called **"Education."** It consists of 5 sub-variables: Expenditure on education. Government expenditure on education (% of GDP) [2013]; Government expenditure on education per pupil, secondary. Government expenditure per pupil, secondary (% of GDP per capita) [2013]; School life expectancy.

School life expectancy, primary to tertiary education 9years) [2014]; Assessment in reading, mathematics, and science. PISA average scales in reading, mathematics, and science [2015]; Pupil-teacher ratio, secondary. [2015] (GII, 2017, p. 406).

- The reasoning for choosing this data input: This data source really gives a value for the Education in a country. It covers many areas.
- High level = 1.

Parameter 41 – University Research Parks

- The data comes from the Global Innovation Index 2017, and it is variable 1.3.1 that is called **"Ease of starting a business."** It consists of data from the ease of starting a business (distance to frontier) [2016].
- The reasoning for choosing this data input: This data source helps to demonstrate the level of the parameter, while ease of starting a business matters for how many companies are in the University Research Park.
- High level = 1.

Parameter 42 – Value Diversity

- The data comes from the GEI 2017, from the pillar called **"Human Capital,"** with consists of the sub-pillars, which consists of educational level and labor market (staff training * labor freedom). This 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 (GEI, 2017).
- The reasoning for choosing this data input: Value diversity can be seen as diversity in the span of education level, and span of the diversity of the labor market.
- High level =1.

Parameter 43 – Young Firms

- The data comes from the GEI 2017, from the pillar called **"High Growth,"** which consists of sub-pillars; gazelle and finance and strategy (venture capital * business sophistication). High Growth 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 (GEI, 2017).
- The reasoning for choosing this data input: In the literature, it is primarily the Young Firms within tech and IT that are having a super-fast development and gain the high amounts of VC Funding, so this pillar is very descriptive of this situation.
- High level =1.

APPENDIX F
- THE 11 WOTC (YELLOW CODED) PARAMETER DATA SOURCES

TAKEN FROM MIGUEL BASAÑEZ' BOOK

'THE WORLD OF THREE CULTURES – HONOR, ACHIEVEMENT AND JOY'

Parameter 3 – Culture of Achievement

Table 42: WOTC Table 5.7, p. 127

TABLE 5.7 Countries of Achievement, Punctuality, and Efficiency (Highest to Lowest), 2010*			
1 Sweden	27 Uruguay	53 Singapore	79 Georgia
2 Norway	28 Northern Ireland	54 Mexico	80 Colombia
3 Denmark	29 Croatia	55 Chile	81 Puerto Rico
4 Switzerland	30 United States	56 China	82 Malta
5 Andorra	31 Slovakia	57 Poland	83 Iran
6 Netherlands	32 Ireland	58 Belarus	84 Azerbaijan
7 Finland	33 Moscow	59 Montenegro	85 Burkina Faso
8 Iceland	34 Slovenia	60 Ethiopia	86 El Salvador
9 West Germany	35 Argentina	61 Latvia	87 Uganda
10 France	36 Cyprus	62 Kyrgyzstan	88 Guatemala
11 Australia	37 Serbia	63 Hungary	89 Egypt
12 Belgium	38 Bosnia	64 Turkey	90 Tanzania
13 Austria	39 Portugal	65 South Africa	91 Romania
14 Luxemburg	40 Hong Kong	66 Armenia	92 Bangladesh
15 Britain	41 Brazil	67 Moldova	93 Trinidad
16 New Zealand	42 Vietnam	68 Saudi Arabia	94 Rwanda
17 Czech Republic	43 India	69 South Korea	95 Algeria
18 East Germany	44 Bulgaria	70 Albania	96 Iraq
19 Greece	45 Lithuania	71 Indonesia	97 Ghana
20 Galicia	46 Thailand	72 Philippines	98 Morocco
21 Canada	47 Malaysia	73 Mali	99 Jordan
22 Slovenia	48 Macedonia	74 Zambia	100 Pakistan
23 Japan	49 Ukraine	75 Venezuela	101 Zimbabwe
24 Italy	50 Estonia	76 Russia	
25 Spain	51 Taiwan	77 Peru	
26 Israel	52 Dominican Republic		
**The ranking is derived from the World Values Survey map (Figure 2.4) as described in Appendix 5*			

Normalization of the data is made with following formula:

Normalized value, $y = [\max(x) - x_i] / [\max(x) - \min(x)] = (101 - x_i) / (101 - 1) = \underline{(101 - x_i) / 10}$

P 3. WOTC, Table 5.7, p. 127. Countries of Achievement, Punctuality, and Efficiency			
No	**WOTC Rank = x_i**	**Country**	**Normalized value, y**
1	1	Sweden	1
2	3	Denmark	0.98
3	4	Switzerland	0.97
4	6	Netherlands	0.95
5	7	Finland	0.94
6	8	Iceland	0.93
7	9	West Germany	0.92
8	11	Australia	0.9
9	13	Austria	0.88
10	15	Britain	0.86
11	21	Canada	0.8
12	23	Japan	0.78
13	25	Spain	0.76
14	30	United States	0.71
15	32	Ireland	0.69
16	38	Bosnia & Herzegovina	0.63
17	41	Brazil	0.6
18	44	Bulgaria	0.57
19	49	Ukraine	0.52
20	53	Singapore	0.48
21	54	Mexico	0.47
22	56	China	0.45
23	57	Poland	0.44
24	64	Turkey	0.37
25	71	Indonesia	0.30
26	72	Philippines	0.29
27	77	Peru	0.24
28	78	Nigeria	0.23
29	83	Iran	0.18
30	86	El Salvador	0.15
31	90	Tanzania	0.11
32	92	Bangladesh	0.09

Parameter 4 – Culture of Honor

Table 43: WOTC Table 5.6, p. 121

TABLE 5.6 Countries of Honor and Respect for Tradition and Authority (Highest to Lowest), 2010*			
1 Zimbabwe	27 Venezuela	53 Ukraine	79 Japan
2 Pakistan	28 Zambia	54 Macedonia	80 Slovenia
3 Jordan	29 Mali	55 Malaysia	81 Canada
4 Morocco	30 Philippines	56 Thailand	82 Galicia
5 Ghana	31 Indonesia	57 Lithuania	83 Greece
6 Iraq	32 Albania	58 Bulgaria	84 East Germany
7 Algeria	33 South Korea	59 India	85 Czech Republic
8 Rwanda	34 Saudi Arab.	60 Vietnam	86 New Zealand
9 Trinidad	35 Armenia	61 Hong Kong	87 Britain
10 Bangladesh	36 Moldova	62 Brazil	88 Luxemburg
11 Tanzania	37 Turkey	63 Portugal	89 Austria
12 Romania	38 South Africa	64 Bosnia	90 Belgium
13 Egypt	39 Hungary	65 Serbia	91 Australia
14 Guatemala	40 Kyrgyzstan	66 Cyprus	92 France
15 Uganda	41 Latvia	67 Argentina	93 West Germany
16 El Salvador	42 Ethiopia	68 Slovenia	94 Iceland
17 Burkina Faso	43 Montenegro	69 Moscow	95 Finland
18 Azerbaijan	44 Belarus	70 Ireland	96 Netherlands
19 Iran	45 Poland	71 Slovakia	97 Andorra
20 Malta	46 China	72 United States	98 Switzerland
21 Colombia	47 Chile	73 Croatia	99 Denmark
22 Puerto Rico	48 Mexico	74 Northern Ireland	100 Norway
23 Georgia	49 Singapore	75 Uruguay	101 Sweden
24 Nigeria	50 Dominican Republic	76 Israel	
25 Russia	51 Taiwan	77 Spain	
26 Peru	52 Estonia	78 Italy	
**The ranking is derived from the World Values Survey map (Figure 2.4) as described in Appendix 5*			

Normalization of the data made with following formula, due to ranking = 1 is the highest value:

Normalized value, y = [max(x) - x_i] / [max(x) - min(x)] = (101 - x_i) / (101 - 1) = <u>(101 - x_i) / 100</u>

Sweden's result is equal to zero. Here it is made ~ 0.01 to avoid having a zero in the calculation

P 4. WOTC, Table 5.6, p. 121. Countries of Honor and Respect for Trad. & Authority			
No	WOTC Rank = x_i	Country	Normalized value, y
1	10	Bangladesh	0.91
2	11	Tanzania	0.9
3	16	El Salvador	0.85
4	19	Iran	0.82
5	24	Nigeria	0.77
6	26	Peru	0.75
7	30	Philippines	0.71
8	31	Indonesia	0.7
9	37	Turkey	0.64
10	45	Poland	0.56
11	46	China	0.55
12	48	Mexico	0.53
13	49	Singapore	0.52
14	53	Ukraine	0.48
15	58	Bulgaria	0.43
16	62	Brazil	0.39
17	64	Bosnia & Herzegovina	0.37
18	70	Ireland	0.31
19	72	United States	0.29
20	77	Spain	0.24
21	79	Japan	0.22
22	81	Canada	0.20
23	87	Britain	0.14
24	89	Austria	0.12
25	91	Australia	0.10
26	93	West Germany	0.08
27	94	Iceland	0.07
28	95	Finland	0.06
29	96	Netherlands	0.05
30	98	Switzerland	0.03
31	99	Denmark	0.02
32	101	Sweden	0.00 ~ 0.01

Parameter 5 – Culture of Individualism

Table 44: WOTC Appendix 11, p. 312-319. Objective Development Index (ODI)

Rank ODI	Country	Score ODI*
1	Norway	1.000
2	Sweden	0.992
3	Denmark	0.980
4	Finland	0.958
5	Netherlands	0.952
6	Iceland	0.950
7	Germany	0.948
8	Austria	0.919
9	Switzerland	0.913
10	Canada	0.899
11	France	0.897
12	Slovenia	0.896
13	Belgium	0.896
14	Australia	0.891
15	San Marino	0.889
16	Luxembourg	0.889
17	Ireland	0.885
18	Liechtenstein	0.884
19	Czech Republic	0.883
20	Cyprus	0.875
21	Slovakia	0.874
22	Spain	0.872
23	Andorra	0.860
24	Malta	0.854
25	South Korea	0.854
26	New Zealand	0.854
27	Monaco	0.849
28	Italy	0.840
29	Japan	0.827
30	Poland	0.822
31	Estonia	0.818
32	United Kingdom	0.817
33	Portugal	0.810
34	Greece	0.809
35	Israel	0.783
36	Hungary	0.782
37	Croatia	0.779
38	Lithuania	0.778
39	Montenegro	0.777
40	Bulgaria	0.776
41	United States	0.776
42	Serbia	0.764
43	Latvia	0.739
44	Hong Kong	0.728
45	Romania	0.718
46	Singapore	0.650

Rank ODI	Country	Score ODI*
47	Barbados	0.649
48	Ukraine	0.646
49	Albania	0.645
50	Uruguay	0.639
51	Bahamas	0.637
52	Trinidad and Tobago	0.637
53	Mauritius	0.634
54	Mongolia	0.633
55	Macedonia	0.618
56	Chile	0.601
57	Moldova	0.599
58	Taiwan	0.599
59	Libya	0.599
60	Argentina	0.596
61	Saint Lucia	0.589
62	Belarus	0.585
63	Costa Rica	0.581
64	Kuwait	0.576
65	Dominica	0.563
66	Armenia	0.560
67	Tunisia	0.557
68	Grenada	0.557
69	Saint Kitts and Nevis	0.551
70	Kazakhstan	0.550
71	Bosnia and Herzeg.	0.549
72	Turkey	0.543
73	Saint Vincent and the Grenadines	0.539
74	Timor-Leste	0.538
75	United Arab Emirates	0.537
76	Palau	0.532
77	Antigua and Barbuda	0.524
78	Bahrain	0.522
79	Malaysia	0.520
80	Lebanon	0.510
81	Peru	0.506
82	Mexico	0.505
83	Brunei	0.503
84	Georgia	0.503
85	Thailand	0.499
86	Maldives	0.498
87	Jamaica	0.496
88	Indonesia	0.494
89	Azerbaijan	0.492
90	Russia	0.483
91	Belize	0.482

Rank ODI	Country	Score ODI*
1	Norway	1.000
2	Sweden	0.992
3	Denmark	0.980
4	Finland	0.958
5	Netherlands	0.952
6	Iceland	0.950
7	Germany	0.948
8	Austria	0.919
9	Switzerland	0.913
10	Canada	0.899
11	France	0.897
12	Slovenia	0.896
13	Belgium	0.896
14	Australia	0.891
15	San Marino	0.889
16	Luxembourg	0.889
17	Ireland	0.885
18	Liechtenstein	0.884
19	Czech Republic	0.883
20	Cyprus	0.875
21	Slovakia	0.874
22	Spain	0.872
23	Andorra	0.860
24	Malta	0.854
25	South Korea	0.854
26	New Zealand	0.854
27	Monaco	0.849
28	Italy	0.840
29	Japan	0.827
30	Poland	0.822
31	Estonia	0.818
32	United Kingdom	0.817
33	Portugal	0.810
34	Greece	0.809
35	Israel	0.783
36	Hungary	0.782
37	Croatia	0.779
38	Lithuania	0.778
39	Montenegro	0.777
40	Bulgaria	0.776
41	United States	0.776
42	Serbia	0.764
43	Latvia	0.739
44	Hong Kong	0.728
45	Romania	0.718
46	Singapore	0.650

Rank ODI	Country	Score ODI*
47	Barbados	0.649
48	Ukraine	0.646
49	Albania	0.645
50	Uruguay	0.639
51	Bahamas	0.637
52	Trinidad and Tobago	0.637
53	Mauritius	0.634
54	Mongolia	0.633
55	Macedonia	0.618
56	Chile	0.601
57	Moldova	0.599
58	Taiwan	0.599
59	Libya	0.599
60	Argentina	0.596
61	Saint Lucia	0.589
62	Belarus	0.585
63	Costa Rica	0.581
64	Kuwait	0.576
65	Dominica	0.563
66	Armenia	0.560
67	Tunisia	0.557
68	Grenada	0.557
69	Saint Kitts and Nevis	0.551
70	Kazakhstan	0.550
71	Bosnia and Herzeg.	0.549
72	Turkey	0.543
73	Saint Vincent and the Grenadines	0.539
74	Timor-Leste	0.538
75	United Arab Emirates	0.537
76	Palau	0.532
77	Antigua and Barbuda	0.524
78	Bahrain	0.522
79	Malaysia	0.520
80	Lebanon	0.510
81	Peru	0.506
82	Mexico	0.505
83	Brunei	0.503
84	Georgia	0.503
85	Thailand	0.499
86	Maldives	0.498
87	Jamaica	0.496
88	Indonesia	0.494
89	Azerbaijan	0.492
90	Russia	0.483
91	Belize	0.482

Rank ODI	Country	Score ODI*
92	Tuvalu	0.481
93	Panama	0.480
94	Nauru	0.478
95	Algeria	0.477
96	Marshall Islands	0.472
97	El Salvador	0.471
98	Philippines	0.466
99	Oman	0.465
100	Kyrgyzstan	0.461
101	Sri Lanka	0.460
102	Samoa	0.458
103	Tajikistan	0.457
104	Brazil	0.456
105	Dominican Republic	0.454
106	Kiribati	0.454
107	India	0.447
108	Occupied Palestinian Territory	0.440
109	Guyana	0.439
110	Tonga	0.437
111	Ecuador	0.432
112	Kosovo	0.430
113	Suriname	0.427
114	Jordan	0.427
115	Ghana	0.423
116	Vietnam	0.421
117	Bangladesh	0.417
118	Vanuatu	0.416
119	Egypt	0.409
120	Nicaragua	0.403
121	Venezuela	0.402
122	China	0.402
123	Micronesia	0.399
124	Seychelles	0.397
125	Cape Verde	0.397
126	Qatar	0.392
127	Senegal	0.391
128	Fiji	0.391
129	Morocco	0.380
130	Bhutan	0.379
131	Turkmenistan	0.378
132	Colombia	0.377
133	Paraguay	0.376
134	Nepal	0.374
135	Tanzania	0.372
136	Bolivia	0.370
137	Gabon	0.370

Rank ODI	Country	Score ODI*
138	Pakistan	0.368
139	Benin	0.368
140	Iran	0.365
141	Uzbekistan	0.359
142	Cuba	0.355
143	Iraq	0.349
144	South Africa	0.341
145	North Korea	0.340
146	Solomon Islands	0.328
147	Botswana	0.327
148	Cambodia	0.324
149	Sao Tome and Principe	0.319
150	Togo	0.313
151	Namibia	0.313
152	Myanmar	0.310
153	Malawi	0.309
154	Saudi Arabia	0.295
155	Syria	0.288
156	Honduras	0.286
157	Burundi	0.284
158	Lesotho	0.282
159	Laos	0.274
160	Guatemala	0.265
161	Liberia	0.264
162	Kenya	0.261
163	Sierra Leone	0.255
164	Uganda	0.250
165	Ethiopia	0.237
166	Burkina Faso	0.231
167	Madagascar	0.221
168	Papua New Guinea	0.220
169	Djibouti	0.218
170	Niger	0.218
171	Mauritania	0.211
172	Mozambique	0.209
173	Cameroon	0.209
174	Afghanistan	0.207
175	Nigeria	0.198
176	Guinea-Bissau	0.198
177	Cote d’Ivoire	0.192
178	Zambia	0.191
179	Republic of Congo	0.191
180	Rwanda	0.188
181	Somalia	0.186
182	Guinea	0.182
183	Mali	0.179

Rank ODI	Country	Score ODI*
184	Swaziland	0.173
185	Sudan	0.171
186	Eritrea	0.170
187	South Sudan	0.157
188	Yemen	0.155
189	Gambia	0.133
190	Zimbabwe	0.123
191	Haiti	0.117
192	Chad	0.112
193	Comoros	0.111
194	Angola	0.090
195	Democratic Republic of Congo	0.047
196	Central African Republic	0.038
197	Equatorial Guinea	0.000
*Standardized		

P 5. World of Three Cultures, Appendix 11, p. 312-319. Objective Development Index (ODI)			
No	**WOTC Rank**	**Country**	**Score**
1	2	Sweden	0.992
2	3	Denmark	0.980
3	4	Finland	0.958
4	5	Netherlands	0.952
5	6	Iceland	0.950
6	7	Germany	0.948
7	8	Austria	0.919
8	9	Switzerland	0.913
9	10	Canada	0.899
10	14	Australia	0.891
11	17	Ireland	0.885
12	22	Spain	0.872
13	29	Japan	0.827
14	30	Poland	0.822
15	32	United Kingdom	0.817
16	40	Bulgaria	0.776
17	41	United States	0.776
18	46	Singapore	0.650
19	48	Ukraine	0.646
20	71	Bosnia & Herzegovina	0.549
21	72	Turkey	0.543
22	81	Peru	0.506
23	82	Mexico	0.505
24	88	Indonesia	0.494
25	97	El Salvador	0.471
26	98	Philippines	0.466
27	104	Brazil	0.456
28	117	Bangladesh	0.417
29	122	China	0.402
30	135	Tanzania	0.372
31	140	Iran	0.365
32	175	Nigeria	0.198

Parameter 6 – Culture of Joy

Table 45: WOTC Table 5.8

TABLE 5.8 Countries of Joy and Friendship (Highest to Lowest), 2010*			
1 Italy	26 Finland	51 Slovakia	76 Iraq
2 Spain	27 Singapore	52 Philippines	77 Trinidad
3 Northern Ireland	28 Canada	53 Mali	78 Russia
4 Croatia	29 Australia	54 Peru	79 Bangladesh
5 Uruguay	30 Chile	55 Ukraine	80 China
6 Israel	31 Poland	56 Zambia	81 Rwanda
7 Galicia	32 Iceland	57 Albania	82 Lithuania
8 Argentina	33 Netherlands	58 Slovenia	83 South Korea
9 Brazil	34 Ethiopia	59 Georgia	84 Latvia
10 Portugal	35 Germany	60 Switzerland	85 Algeria
11 Luxembourg	36 Kyrgyzstan	61 Azerbaijan	86 Ghana
12 Cyprus	37 Macedonia	62 El Salvador	87 Japan
13 Greece	38 Czech Republic	63 Malta	88 Montenegro
14 Belgium	39 Mexico	64 Iran	89 Belarus
15 Austria	40 Saudi Arabia	65 Burkina Faso	90 Bulgaria
16 Vietnam	41 Venezuela	66 Hungary	91 Morocco
17 India	42 Serbia	67 Puerto Rico	92 Hong Kong
18 Slovenia	43 South Africa	68 Guatemala	93 Norway
19 Britain	44 Bosnia & Herzegovina	69 Denmark	94 Moscow
20 Thailand	45 Turkey	70 Uganda	95 Taiwan
21 France	46 United States	71 Romania	96 Jordan
22 Malaysia	47 Nigeria	72 Moldova	97 Pakistan
23 Dominican Republic	48 Colombia	73 Tanzania	98 Estonia
24 New Zealand	49 Indonesia	74 Egypt	99 Zimbabwe
25 Ireland	50 Andorra	75 Armenia	100 Sweden
**The ranking is derived from the World Values Survey map (Figure 2.4) as described in Appendix 5*			

Here we have the score right away from the ranking of the countries, and if we divide with 100, then we gain a value between 0.01-1 for all the countries. The only cavity is that no. 1 needs to be equal 1.

The formula is, therefore **(100 – x)/100** to create the higher score for the smaller numbers.

P 6. World of Three Cultures, Table 5.8, p. 128. Countries of Joy and Friendship			
No	**WOTC Rank = x**	**Country**	**New Score: (100 – x)/100**
1	2	Spain	0.98
2	9	Brazil	0.91
3	15	Austria	0.85
4	19	Britain	0.81
5	25	Ireland	0.75
6	26	Finland	0.74
7	27	Singapore	0.73
8	28	Canada	0.72
9	29	Australia	0.71
10	31	Poland	0.69
11	32	Iceland	0.68
12	33	Netherlands	0.67
13	35	Germany	0.65
14	39	Mexico	0.61
15	44	Bosnia & Herzegovina	0.56
16	45	Turkey	0.55
17	46	United States	0.54
18	47	Nigeria	0.53
19	49	Indonesia	0.51
20	52	Philippines	0.48
21	54	Peru	0.46
22	55	Ukraine	0.45
23	60	Switzerland	0.40
24	62	El Salvador	0.38
25	64	Iran	0.36
26	69	Denmark	0.31
27	73	Tanzania	0.27
28	79	Bangladesh	0.21
29	80	China	0.2
30	87	Japan	0.13
31	90	Bulgaria	0.10
32	100	Sweden	~ 0.01

Parameter 7 – Entrepreneurial Skill (ES): Agreeableness

Table 46: WOTC Table 6.13. Tolerance (of Homosexuality)

WVS: V208; EVS: V232	
RANKING	
Country	2000
Egypt	100
Bangladesh	99
Jordan	98
Pakistan	96
Zimbabwe	96
Indonesia	95
Tanzania	94
Iran	94
Algeria	93
China	92
Uganda	91
Azerbaijan	89
Hungary	88
Montenegro	86
Turkey	85
Georgia	82
Vietnam	82
El Salvador	81
Albania	81
Romania	80
Lithuania	78
Nigeria	78
Latvia	77
Macedonia	76
Serbia	75
Bosnia & Herz.	72
Armenia	71
Ukraine	71
India	71
Russian Fed.	71
Croatia	70
Taiwan	65
Moldova	65
Venezuela	62
Columbia	61
Malta	61
Poland	60
Bulgaria	60
Belarus	57
Estonia	57
Peru	57
Brazil	56
Singapore	55
Mexico	53
Dominican Rep.	53
Korea South	53
Puerto Rico	50
South Africa	48
Uruguay	46
Portugal	43
Northern Ireland	42
Slovenia	42
Argentina	40
Israel	38
Chile	37
Ireland	37
United States	32
Australia	31
Italy	30
Japan	30
New Zealand	30
Philippines	29
Finland	29
Norway	27
Czech Republic	27
Canada	27
Belgium	27
Austria	26
Great Britain	25
Greece	24
Slovakia	24
France	23
Denmark	21
Luxembourg	20
Germany	19
Switzerland	17
Spain	17
Iceland	12
Sweden	9
Netherlands	7
TOTAL	56

Here in this table a score of 100 means it is never justifiable (%) – tolerance (of Homosexuality) – that means that what is illustrated in the numbers right now is the intolerance for Homosexuality.

To convert to tolerance for Homosexuality the following formula is used:

(100 – x) / 100 = y,

where y = 1, means there is huge tolerance for Homosexuality.

P 7. World of Three Cultures, Table 6.13, p. 152. Tolerance (of Homosexuality)				
No	**WOTC Rank**	**Country**		**New score**
1	2	Bangladesh	99	0.01
2	6	Indonesia	95	0.05
3	7	Tanzania	94	0.06
4	8	Iran	94	0.06
5	10	China	92	0.08
6	15	Turkey	85	0.15
7	18	El Salvador	81	0.19
8	22	Nigeria	78	0.22
9	26	Bosnia & Herzegovina	72	0.28
10	28	Ukraine	71	0.29
11	37	Poland	60	0.40
12	38	Bulgaria	60	0.40
13	41	Peru	57	0.43
14	42	Brazil	56	0.44
15	43	Singapore	55	0.45
16	44	Mexico	53	0.47
17	56	Ireland	37	0.63
18	57	United States	32	0.68
19	58	Australia	31	0.69
20	60	Japan	30	0.70
21	62	Philippines	29	0.71
22	63	Finland	29	0.71
23	66	Canada	27	0.73
24	68	Austria	26	0.74
25	69	Great Britain	25	0.75
26	73	Denmark	21	0.79
27	75	Germany	19	0.81
28	76	Switzerland	17	0.83
29	77	Spain	17	0.83
30	78	Iceland	12	0.88
31	79	Sweden	9	0.91
32	80	Netherlands	7	0.93

Parameter 9 – Entrepreneurial Skill (ES): Drive

Table 47: WOTC Table 6.12, p. 150. Competition (is Good)

WVS: V144; EVS: V1881	
RANKING	
Country	**2000**
Iceland	84
Morocco	83
Zimbabwe	82
China	80
Albania	80
Romania	79
Uganda	78
Macedonia	77
Czech Republic	77
Malta	76
Australia	76
Switzerland	75
Singapore	75
Tanzania	75
Croatia	75
Austria	74
Bosnia & Herz.	74
Sweden	74
Georgia	73
Montenegro	73
Puerto Rico	73
Slovenia	73
Dominican Rep.	72
United States	71
Bangladesh	71
Serbia	70
Norway	70
Canada	70
Brazil	69
New Zealand	69
Slovakia	68
Latvia	68
Peru	67
Germany	66
El Salvador	66
Bulgaria	66
Venezuela	65
Belarus	65
Ireland	65
South Africa	65
Turkey	65
Northern Ireland	64
India	64
Azerbaijan	64
Ukraine	62
Hungary	61
Moldova	61
Denmark	61
Taiwan	60
Lithuania	60
Mexico	60
Great Britain	59
Poland	59
Finland	59
Argentina	59
Vietnam	59
Russian Fed.	58
Korea, South	58
Italy	57
Japan	56
Armenia	56
Philippines	56
Greece	55
Estonia	55
Luxembourg	52
Spain	52
Netherlands	50
Uruguay	50
Portugal	49
Belgium	48
Chile	46
France	46
TOTAL	**66**

Due to three countries are missing in the table, these three countries have received an estimated value. The method that was used here was giving those countries, the country value, from the WOTC data Table 6.12 that is geographically closest to the country.

The following countries have been compared with these countries:

- Nigeria ~ Tanzania
- Iran ~ Turkey
- Indonesia ~ Philippines

P 9. World of Three Cultures, Table 6.12, p. 150. Competition (is Good)				
No	**WOTC Rank**	**Country**	**WOTC Score**	**x/84**
1	1	Iceland	84	1.000
2	4	China	80	0.952
3	11	Australia	76	0.905
4	12	Switzerland	75	0.893
5	13	Singapore	75	0.893
6	14	Tanzania	75	0.893
7	16	Austria	74	0.881
8	17	Bosnia & Herzegovina	74	0.881
9	18	Sweden	74	0.881
10	24	United States	71	0.845
11	25	Bangaledesh	71	0.845
12	28	Canada	70	0.833
13	29	Brazil	69	0.821
14	33	Peru	67	0.798
15	34	Germany	66	0.786
16	35	El Salvador	66	0.786
17	36	Bulgaria	66	0.786
18	39	Ireland	65	0.774
19	41	Turkey	65	0.774
20	45	Ukraine	62	0.738
21	48	Denmark	61	0.726
22	51	Mexico	60	0.714
23	52	Great Britain	59	0.702
24	53	Poland	59	0.702
25	54	Finland	59	0.702
26	60	Japan	56	0.667
27	62	Philippines	55	0.655
28	66	Spain	52	0.619
29	67	Netherlands	50	0.595
30	NA	Nigeria ~ Tanzania	75	0.893
31	NA	Iran ~ Turkey	65	0.774
32	NA	Indonesia ~ Philippines	55	0.655

Parameter 14 – Entrepreneurial Skill (ES): Openness

Table 48: WOTC Table 6.1. Feeling of Happiness

WVS: V11	
RANKING	
Country	2000
Nigeria	67
Tanzania	57
Mexico	57
Venezuela	57
El Salvador	56
Puerto Rico	54
Vietnam	49
Columbia	47
Iceland	47
Northern, Ireland	47
Netherlands	46
Denmark	45
Canada	44
Australia	43
Belgium	43
Ireland	42
Switzerland	40
United States	39
South Africa	39
Philippines	38
Sweden	37
Chile	36
Austria	36
Luxembourg	36
Argentina	33
New Zealand	33
Dominican Rep.	32
France	31
Malta	31
Turkey	31
Peru	31
Norway	30
Taiwan	30
Singapore	29
Japan	29
Israel	28
Morocco	26
Uganda	26
India	26
Iran	25
Finland	24
Brazil	22
Bosnia & Herz.	22
Uruguay	21
Indonesia	21
Zimbabwe	20
Pakistan	20
Spain	20
Germany	20
Macedonia	19
Greece	19
Italy	18
Egypt	18
Portugal	18
Poland	18
Hungary	17
Algeria	17
Slovenia	16
Bangladesh	15
Croatia	13
Jordan	13
Serbia	12
Georgia	12
China	12
Azerbaijan	11
Czech Republic	11
Korea, South	10
Montenegro	9
Slovenia	8
Bulgaria	8
Estonia	7
Latvia	7
Armenia	6
Moldova	6
Russian Fed.	6
Ukraine	6
Belarus	5
Lithuania	5
Romania	4
	27

Due to three countries are missing in the table, these three countries have received an estimated value. The method that was used here was giving those countries, the country value, from the WOTC data Table 6.12 that is geographically closest to the country.

The following countries have been compared with these countries:

- Nigeria ~ Tanzania
- Iran ~ Turkey
- Indonesia ~ Philippines

P 14. World of Three Cultures, Table 6.1, p. 130. Feeling of Happiness				
No	**WOTC Rank**	**Country**	**WOTC Score**	**Score x/67**
1	1	Nigeria	67	1.000
2	2	Tanzania	57	0.851
3	3	Mexico	57	0.851
4	5	El Salvador	56	0.836
5	9	Iceland	47	0.701
6	11	Netherlands	46	0.687
7	12	Denmark	45	0.672
8	13	Canada	44	0.657
9	14	Australia	43	0.642
10	16	Ireland	42	0.627
11	17	Switzerland	40	0.597
12	18	United States	39	0.582
13	20	Philippines	38	0.567
14	21	Sweden	37	0.552
15	23	Austria	36	0.537
16	30	Turkey	31	0.463
17	31	Peru	31	0.463
18	34	Singapore	29	0.433
19	35	Japan	29	0.433
20	40	Iran	25	0.373
21	41	Finland	24	0.358
22	42	Brazil	22	0.328
23	43	Bosnia & Herzegovina	22	0.328
24	45	Indonesia	21	0.313
25	48	Spain	20	0.299
26	49	Germany	20	0.299
27	55	Poland	18	0.269
28	59	Bangladesh	15	0.224
29	64	China	12	0.179
30	70	Bulgaria	8	0.119
31	76	Ukraine	6	0.090
32	NA	Great Britain ~ Ireland	42	0.627

Parameter 17 – Entrepreneurial Skill (ES): Solo Performance

Table 49: WOTC Table A12.3. The Subjective Development Index (SDI)

Rank SDI	Country	Score SDI*
1	Sweden 5*	1.000
2	Norway 5*	0.900
3	Denmark 4*	0.833
4	Switzerland 5*	0.759
5	Andorra 5*	0.745
6	Netherlands 5*	0.703
7	Finland 5*	0.683
8	Iceland 4*	0.682
9	West Germany 5*	0.671
10	France 5*	0.657
11	Australia 5*	0.648
12	Belgium 4*	0.638
13	Austria 4*	0.630
14	Luxembourg 4*	0.625
15	Britain 5*	0.615
16	New Zealand 5*	0.614
17	Czech 4*	0.598
18	East Germany 5*	0.588
19	Greece 4*	0.586
20	Galicia 3*	0.570
21	Canada 5*	0.565
22	Slovenia 5*	0.550
23	Japan 5*	0.538
24	Italy 5*	0.511
25	Spain 5*	0.497
26	Israel 4*	0.494
27	Uruguay 5*	0.478
28	Northern Ireland 4*	0.469
29	Croatia 4*	0.462
30	United States 5*	0.451
31	Slovakia 4*	0.404
32	Ireland 4*	0.397
33	Moscow 2*	0.380
34	Slovenia 2*	0.367
35	Argentina 5*	0.361
36	Cyprus 5*	0.345
37	Serbia	0.341
38	Bosnia & Herzegovina 4*	0.335
39	Portugal 4*	0.334
40	Hong Kong 5*	0.333
41	Brazil 5*	0.333
42	Vietnam 5*	0.326
43	India 5*	0.325
44	Bulgaria 5*	0.324
45	Lithuania 4*	0.318
46	Thailand 5*	0.317
47	Malaysia 5*	0.314
48	Macedonia 4*	0.300
49	Ukraine 5*	0.299
50	Estonia 4*	0.295
51	Taiwan 5*	0.292
52	Dominican Republic 3*	0.291
53	Singapore 4*	0.290
54	Mexico 5*	0.281
55	Chile 5*	0.280
56	China 5*	0.277
57	Poland 5*	0.276
58	Belarus 4*	0269
59	Montenegro 4*	0.265
60	Ethiopia 5*	0.264
61	Latvia 4*	0.251
62	Kyrgyz 4*	0.239
63	Hungary 4*	0.237
64	Turkey 5*	0.233
65	South Africa 5*	0.233
66	Armenia 3*	0.231
67	Moldova 5*	0.231
68	Saudi Arabia 4*	0.228
69	South Korea 5*	0.224
70	Albania 4*	0.222
71	Indonesia 5*	0.220
72	Philippines 4*	0.213
73	Mali 5*	0.211
74	Zambia 5*	0.209
75	Venezuela 4*	0.207
76	Russia 5*	0.206
77	Peru 4*	0.206
78	Nigeria 4*	0.204
79	Georgia 3*	0.181
80	Colombia 5*	0.173
81	Puerto Rico 4*	0.173
82	Malta 4*	0.171
83	Iran 4*	0.168
84	Azerbaijan 3*	0.159
85	Burkina Faso 5*	0.148
86	El Salvador 4*	0.133
87	Uganda 1*	0.131
88	Guatemala 4*	0.127
89	Egypt 4*	0.107
90	Tanzania 4*	0.105
91	Romania 5*	0.105
92	Bangladesh 4*	0.103
93	Trinidad 5*	0.095
94	Rwanda 5*	0.092
95	Algeria 4*	0.090
96	Iraq 5*	0.081
97	Ghana 5*	0.073
98	Morocco 5*	0.072
99	Jordan 4*	0.029
100	Pakistan 4*	0.027
101	Zimbabwe 4*	0.0

*This number refers to the most recent survey available for each country

P 17. World of Three Cultures, App. 12, p. 334-336. Subjective Development Index (SDI)			
No	**WOTC Rank**	**Country**	**SDI Value**
1	1	Sweden	1
2	3	Denmark	0.833
3	4	Switzerland	0.759
4	6	Netherlands	0.703
5	7	Finland	0.683
6	8	Iceland	0.682
7	9	West Germany	0.671
8	11	Australia	0.648
9	13	Austria	0.630
10	15	Britain	0.615
11	21	Canada	0.565
12	23	Japan	0.538
13	25	Spain	0.497
14	30	United States	0.451
15	32	Ireland	0.397
16	38	Bosnia & Herzegovina	0.335
17	41	Brazil	0.333
18	44	Bulgaria	0.324
19	49	Ukraine	0.299
20	53	Singapore	0.290
21	54	Mexico	0.281
22	56	China	0.277
23	57	Poland	0.276
24	64	Turkey	0.233
25	71	Indonesia	0.220
26	72	Phillippines	0.213
27	77	Peru	0.206
28	78	Nigeria	0.204
29	83	Iran	0.168
30	86	El Salvador	0.133
31	90	Tanzania	0.105
32	92	Bangladesh	0.103

Parameter 18 – Entrepreneurial Skill (ES): Source of Formal Authority

Table 50: WOTC Appendix 7, p. 287-291. Political Rights and Civil Liberties in the World, 2013

Freedom House Index		
Rank	**Country**	**Score (2013)**
1	Finland	1.000
2	Iceland	1.000
3	Luxembourg	1.000
4	Norway	1.000
5	San Marino	1.000
6	Sweden	1.000
7	Barbados	0.990
8	Netherlands	0.990
9	Canada	0.980
10	Denmark	0.980
11	Liechtenstein	0.980
12	Australia	0.970
13	Belgium	0.970
14	Ireland	0.970
15	Malta	0.970
16	New Zealand	0.970
17	Portugal	0.970
18	United Kingdom	0.970
19	Uruguay	0.970
20	Andorra	0.960
21	Austria	0.960
22	Bahamas	0.960
23	Chile	0.960
24	Germany	0.960
25	Spain	0.960
26	Switzerland	0.960
27	Czech Republic	0.950
28	Dominica	0.950
29	Estonia	0.950
30	France	0.950
31	Tuvalu	0.940
32	Cyprus	0.930
33	Micronesia	0.930
34	Nauru	0.930
35	Poland	0.930
36	Saint Lucia	0.930
37	United States	0.930
38	Palau	0.920
39	Slovakia	0.910
40	Costa Rica	0.910
41	Kiribati	0.910
42	Marshall Islands	0.910
43	Slovenia	0.910
44	Saint Kitts and Nevls	0.910
45	Cape Verde	0.900
46	Lithuania	0.900
47	Mauritius	0.900
48	Grenada	0.890
49	Saint Vincente and Gren.	0.890
50	Belize	0.880
51	Hungary	0.880
52	Italy	0.880
53	Japan	0.880
54	Taiwan	0.880
55	Monaco	0.870
56	Croatia	0.860
57	Mongolia	0.860
58	South Korea	0.860
59	Ghana	0.840
60	Latvia	0.840
61	Greece	0.830
62	Benin	0.820
63	Panama	0.820
64	Brazil	0.810
65	Bulgaria	0.810
66	Israel	0.810
67	Romania	0.810
68	Samoa	0.810

Freedom House Index		
Rank	**Country**	**Score (2013)**
69	Sao Tome and Prin.	0.810
70	South Africa	0.810
71	Trinidad and Tobago	0.810
72	Antigua and Barbude	0.800
73	Argentina	0.800
74	Vanuatu	0.790
75	Serbia	0.780
76	El Salvador	0.770
77	Suriname	0.770
78	India	0.760
79	Namibia	0.760
80	Dominican Republic	0.750
81	Senegal	0.750
82	Botswana	0.740
83	Jamaica	0.730
84	Tonga	0.730
85	Lesotho	0.720
86	Montenegro	0.720
87	Guyana	0.710
88	Peru	0.710
89	Sierra Leone	0.700
90	Bolivia	0.690
91	Seychelles	0.670
92	Tanzania	0.660
93	Indonesia	0.650
94	Mexico	0.650
95	Moldova	0.650
96	Solomon Islands	0.650
97	Macedonia	0.640
98	Albania	0.630
99	East Timor	0.630
100	Philippines	0.630
101	Bosnia & Herzegovina	0.620
102	Paraguay	0.620
103	Zambia	0.620
104	Colombia	0.610
105	Turkey	0.610
106	Ecuador	0.600
107	Georgia	0.600
108	Liberia	0.600
109	Malawi	0.600
110	Mozambique	0.590
111	Papua New Guinea	0.590
112	Tunisia	0.580
113	Guatemala	0.570
114	Ukraine	0.570
115	Bangladesh	0.560
116	Niger	0.560
117	Comoros	0.550
118	Kenya	0.550
119	Burkina Faso	0.530
120	Thailand	0.530
121	Singapore	0.520
122	Honduras	0.510
123	Nicaragua	0.510
124	Lebanon	0.490
125	Malaysia	0.480
126	Bhutan	0.470
127	Nepal	0.470
128	Maldives	0.460
129	Nigeria	0.460
130	Haiti	0.430
131	Kosovo	0.430
132	Libya	0.430
133	Morocco	0.430
134	Sri Lanka	0.430
135	Togo	0.430
136	Armenia	0.420

Freedom House Index		
Rank	**Country**	**Score (2013)**
137	Pakistan	0.420
138	Kuwait	0.410
139	Kyrgyzstan	0.410
140	Uganda	0.400
141	Guinea	0.390
142	Venezuela	0.390
143	Egypt	0.380
144	Fiji	0.370
145	Algeria	0.350
146	Central Africa Rep.	0.350
147	Madagascar	0.350
148	Burundi	0.340
149	Cote d'Ivoire	0.340
150	Gabon	0.340
151	Jordan	0.340
152	Mauritania	0.340
153	South Sudan	0.310
154	Angola	0.300
155	Guinea-Bissau	0.300
156	Brunei	0.290
157	Burma	0.290
158	Cambodia	0.290
159	Congo. Republic of	0.290
160	Djibouti	0.290
161	Afghanistan	0.260
162	Kazakhstan	0.260
163	Russia	0.260
164	Iraq	0.250
165	Mali	0.250
166	Qatar	0.250
167	Yemen	0.250
168	Zimbabwe	0.250
169	Rwanda	0.240
170	Tajikistan	0.240
171	Azerbaijan	0.230
172	Cameroon	0.230
173	The Gambia	0.230
174	Oman	0.230
175	Chad	0.210
176	Swaziland	0.210
177	Bahrain	0.200
178	Congo (Dem. Rep.)	0.200
179	United Arab Emirates	0.190
180	Vietnam	0.190
181	China	0.180
182	Ethiopia	0.180
183	Iran	0.160
184	Belarus	0.140
185	Cuba	0.110
186	Laos	0.110
187	Sudan	0.110
188	Equatorial Guinea	0.080
189	Saudi Arabia	0.080
190	Syria	0.070
191	Turkmenistan	0.070
192	Uzbekistan	0.040
193	Eritrea	0.030
194	North Korea	0.030
195	Somalia	0.020

P 18. World of Three Cultures, App. 7, p. 287 - 291. Political Rights and Civil Liberties in the World			
No	**WOTC Rank**	**Country**	**Score**
1	1	Finland	1
2	2	Iceland	1
3	6	Sweden	1
4	8	Netherlands	0.99
5	9	Canada	0.98
6	10	Denmark	0.98
7	12	Australia	0.97
8	14	Ireland	0.97
9	18	United Kingdom	0.97
10	21	Austria	0.96
11	24	Germany	0.96
12	25	Spain	0.96
13	26	Switzerland	0.95
14	35	Poland	0.93
15	37	United States	0.93
16	53	Japan	0.88
17	64	Brazil	0.81
18	65	Bulgaria	0.81
19	76	El Salvador	0.77
20	88	Peru	0.71
21	92	Tanzania	0.66
22	93	Indonesia	0.65
23	94	Mexico	0.65
24	100	Philippines	0.63
25	101	Bosnia & Herzegovina	0.62
26	105	Turkey	0.60
27	114	Ukraine	0.57
28	115	Bangladesh	0.56
29	121	Singapore	0.52
30	129	Nigeria	0.46
31	181	China	0.180
32	183	Iran	0.160

Parameter 32 – Openness to World

Table 51: WOTC Table 6.8. Trust in People

WVS: V25: EVS: V66	
RANKING	
Country	**2000**
Denmark	67
Sweden	66
Iran	65
Norway	65
Netherlands	60
Finland	56
China	55
Indonesia	51
New Zealand	48
Japan	43
Belarus	42
Vietnam	41
Iceland	41
India	41
Switzerland	41
Australia	40
Northern Ireland	40
Canada	39
Taiwan	38
Egypt	38
Spain	36
United States	36
Ireland	35
Germany	35
Austria	34
Montenegro	34
Italy	33
Pakistan	31
Belgium	31
Great Britain	30
Jordan	28
Korea, South	27
Ukraine	27
Bulgaria	27
Dominican Rep.	26
Luxembourg	26
Nigeria	26
Lithuania	25
Armenia	25
Albania	24
Czech Republic	24
Greece	24
Russian Fed.	24
Bangladesh	24
Morocco	24
Israel	23
Chile	23
Estonia	23
Puerto Rico	23
France	22
Uruguay	22
Hungary	22
Slovenia	22
Mexico	21
Malta	21
Azerbaijan	21
Poland	19
Serbia	19
Georgia	19
Croatia	18
Latvia	17
Singapore	17
Venezuela	16
Bosnia & Herz.	16
Slovakia	16
Turkey	16
Argentina	15
Moldova	15
El Salvador	15
Macedonia	14
Zimbabwe	12
South Africa	12
Algeria	11
Colombia	11
Peru	11
Romania	10
Portugal	10
Philippines	8
Tanzania	8
Uganda	8
Brazil	3
Total	**28**

P 32. World of Three Cultures, Table 6.8, p. 144. Trust in People				
No	**WOTC Rank**	**Country**	**WOTC Score**	**New Score x/67**
1	1	Denmark	67	1
2	2	Sweden	66	0.96
3	3	Iran	65	0.97
4	5	Netherlands	60	0.896
5	6	Finland	58	0.866
6	7	China	55	0.821
7	8	Indonesia	51	0.761
8	10	Japan	43	0.642
9	13	Iceland	41	0.612
10	15	Switzerland	41	0.612
11	16	Australia	40	0.597
12	18	Canada	39	0.582
13	21	Spain	36	0.537
14	22	United States	36	0.537
15	23	Ireland	35	0.522
16	24	Germany	35	0.522
17	25	Austria	34	0.507
18	30	Great Britain	30	0.448
19	33	Ukraine	27	0.403
20	34	Bulgaria	27	0.403
21	37	Nigeria	26	0.388
22	44	Bangladesh	24	0.358
23	54	Mexico	21	0.313
24	57	Poland	19	0.284
25	62	Singapore	17	0.254
26	64	Bosnia & Herzegovina	16	0.239
27	66	Turkey	16	0.239
28	69	El Salvador	15	0.224
29	75	Peru	11	0.164
30	78	Philippines	8	0.119
31	79	Tanzania	8	0.119
32	81	Brazil	3	0.045

Parameter 39 – Trust

Table 52: WOTC Table 6.5. Belong to Religious Denomination

WVS: *V184: EVS: V101	
RANKING	
Country	2000
Jordan	100
Moldova	100
Morocco	100
Zimbabwe	100
Switzerland	100
Egypt	100
Bangladesh	100
Israel	100
Indonesia	100
Nigeria	99
Uganda	99
Iran	99
Malta	99
Tanzania	98
Turkey	98
Romania	98
Montenegro	97
Greece	96
Iceland	96
Poland	96
Peru	95
Azerbaijan	94
Serbia	94
Georgia	94
India	93
Colombia	92
Ireland	91
Norway	91
Philippines	90
Denmark	90
Portugal	89
Croatia	89
Puerto Rico	88
Austria	88
Finland	88
Brazil	88
Albania	88
Argentina	87
South Africa	86
Northern Ireland	86
Macedonia	86
El Salvador	84
Great Britain	83
Spain	83
Italy	82
New Zealand	82
Lithuania	81
Australia	81
Mexico	81
Singapore	80
Taiwan	79
United States	79
Slovakia	77
Germany	77
Dominican Rep.	76
Sweden	76
Bosnia & Herz.	75
Venezuela	73
Luxembourg	72
Pakistan	71
Bulgaria	70
Slovenia	70
Canada	69
Chile	66
Belgium	64
Korea, South	63
Latvia	59
France	58
Hungary	57
Ukraine	56
Vietnam	54
Belarus	52
Uruguay	52
Russian Fed.	51
Netherlands	45
Japan	41
Czech Republic	34
Estonia	25
China	6
Total	**80**

P 39. World of Three Cultures, Table 6.5 p. 138. Belong to Religi. Denomination ~ Trust in Life				
No	WOTC Rank	Country	WOTC Score	Score/100 = New Score
1	5	Switzerland	100	1
2	7	Bangladesh	100	1
3	9	Indonesia	100	1
4	10	Nigeria	99	0.99
5	12	Iran	99	0.99
6	14	Tanzania	98	0.98
7	15	Turkey	98	0.98
8	19	Iceland	96	0.96
9	20	Poland	96	0.96
10	21	Peru	95	0.95
11	27	Ireland	91	0.91
12	29	Philippines	90	0.90
13	30	Denmark	90	0.90
14	34	Austria	88	0.88
15	35	Finland	88	0.88
16	36	Brazil	88	0.88
17	43	El Salvador	84	0.84
18	44	Great Britain	83	0.83
19	45	Spain	81	0.83
20	49	Australia	81	0.81
21	50	Mexico	81	0.81
22	51	Singapore	80	0.80
23	53	United States	79	0.79
24	55	Germany	77	0.77
25	57	Sweden	76	0.76
26	58	Bosnia & Herzegovina	75	0.75
27	62	Bulgaria	70	0.70
28	64	Canada	69	0.69
29	71	Ukraine	56	0.56
30	76	Netherlands	45	0.45
31	77	Japan	41	0.41
32	80	China	6	0.06

APPENDIX G
- THE 14 PARAMETER DATA ENTRIES FROM THE GEI (BLUE CODED)

The Global Entrepreneurship Index 2017

Sub-indices, Pillars, and Variables

Table 53: GEI Framework With Sub-Indices, Pillars, and Variables

	Sub-indexes	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*INFRASTUCTURE)
		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*
			COMPETETIVNESS (MARKET DOMINANCE*REGULATION)
	ASPIRATION SUB-INDEX	PRODUCT INNOVATION	*NEW PRODUCT*
			TECH TRANSFER
		PROCESS INNOVATION	*NEW TECHLOLOGY*
			SCIENCE (GERD*(AVERAGEQUALITY OF SCIENTIFICAL INSTITUTIONS +AVAILABILITY OF SCIENTISTS AND ENGENEERS))
		HIGH GROWTH	*GAZELLE*
			FINANCE AND STRATEGY (VENTURE CAPITAL*BUSINESS SOPHISTICATION)
		INTERNATIONALIZATION	*EXPORT*
			ECONOMIC COMPLEXITY
		RISK CAPITAL	*INFORMAL INVESTMENT*
			DEPTH OF CAPITAL MARKET

Table 54: GEI 2017 Data Entries for 32 Countries (Color-Coded) From the 14 Pillars

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O
1	Country	1. Oppor	2. Startu	3. Risk Ac	4. Netwo	5. Cultur	6. Oppor	7. Techn	8.Human	9. Compe	10. Prod	11. Proce	12. High	13. Inter	14. Risk (
2	Parameter No.	P15	P10	P16	P12	P11	P1	P37	P42	P34	P31	P35	P43	P2	P20
3	Trinidad & Toba	0.528	0.170	0.749	0.036	0.327	0.388	0.115	0.516	0.239	0.100	0.054	0.404	0.286	0.139
4	Burundi	0.265	0.033	0.025	0.052	0.108	0.224	0.131	0.122	0.162	0.073	0.107	0.199	0.094	0.050
5	Sri Lanka	0.325	0.173	0.071	0.085	0.216	0.181	0.101	0.206	0.489	0.569	0.217	0.283	0.162	0.118
6	Cambodia	0.133	0.110	0.036	0.089	0.112	0.344	0.164	0.432	0.266	0.251	0.081	0.141	0.057	0.182
7	Egypt	0.225	0.137	0.066	0.094	0.323	0.163	0.248	0.237	0.190	0.184	0.449	0.461	0.263	0.498
8	Ethiopia	0.338	0.063	0.017	0.096	0.299	0.362	0.089	0.203	0.388	0.122	0.503	0.226	0.020	0.059
9	Malawi	0.438	0.007	0.028	0.097	0.048	0.247	0.055	0.053	0.279	0.431	0.168	0.019	0.073	0.029
10	Chad	0.138	0.026	0.025	0.098	0.117	0.057	0.135	0.096	0.084	0.073	0.141	0.192	0.032	0.055
11	**Bangladesh**	0.265	0.040	0.022	0.104	0.200	0.322	0.125	0.126	0.153	0.026	0.146	0.116	0.015	0.068
12	Myanmar	0.253	0.073	0.010	0.108	0.121	0.247	0.122	0.367	0.115	0.214	0.153	0.091	0.123	0.402
13	**Bosnia & Herze**	0.098	0.105	0.015	0.110	0.316	0.140	0.394	0.231	0.252	0.128	0.254	0.356	0.506	0.243
14	Uganda	0.279	0.051	0.106	0.112	0.212	0.331	0.047	0.103	0.193	0.059	0.170	0.077	0.086	0.097
15	India	0.294	0.160	0.388	0.115	0.175	0.320	0.026	0.233	0.652	0.735	0.588	0.203	0.280	0.172
16	Libya	0.103	0.305	0.018	0.123	0.093	0.267	0.309	0.580	0.107	0.173	0.089	0.274	0.235	0.292
17	Guyana	0.251	0.133	0.027	0.133	0.189	0.291	0.017	0.415	0.287	0.066	0.148	0.080	0.350	0.036
18	Burkina Faso	0.253	0.037	0.024	0.138	0.222	0.203	0.194	0.035	0.172	0.112	0.144	0.135	0.045	0.040
19	Pakistan	0.278	0.067	0.020	0.143	0.191	0.114	0.148	0.099	0.195	0.332	0.228	0.336	0.151	0.050
20	Georgia	0.389	0.203	0.066	0.146	0.475	0.220	0.309	0.597	0.184	0.132	0.075	0.292	0.481	0.152
21	Guinea	0.184	0.083	0.025	0.149	0.144	0.163	0.146	0.143	0.145	0.064	0.137	0.196	0.121	0.065
22	Tajikistan	0.150	0.166	0.014	0.161	0.160	0.285	0.170	0.541	0.212	0.206	0.115	0.561	0.217	0.326
23	Swaziland	0.476	0.049	0.063	0.167	0.370	0.335	0.101	0.274	0.176	0.355	0.145	0.210	0.266	0.430
24	Mozambique	0.364	0.051	0.093	0.169	0.204	0.219	0.164	0.086	0.157	0.110	0.229	0.247	0.070	0.077
25	Moldova	0.248	0.220	0.013	0.177	0.224	0.276	0.340	0.388	0.140	0.164	0.188	0.398	0.275	0.282
26	Madagascar	0.512	0.036	0.025	0.183	0.173	0.231	0.167	0.105	0.142	0.102	0.119	0.278	0.058	0.060
27	**Philippines**	0.272	0.513	0.335	0.188	0.289	0.342	0.014	0.450	0.302	0.579	0.197	0.208	0.153	0.116
28	Sierra Leone	0.137	0.017	0.025	0.191	0.183	0.180	0.139	0.098	0.124	0.075	0.136	0.212	0.095	0.065
29	Guatemala	0.185	0.130	0.235	0.192	0.242	0.248	0.162	0.093	0.358	0.635	0.066	0.185	0.021	0.071
30	Romania	0.295	0.380	0.238	0.192	0.418	0.292	0.471	0.451	0.288	0.298	0.305	0.580	0.691	0.730
31	Kyrgyz Republic	0.165	0.257	0.014	0.196	0.180	0.285	0.169	0.820	0.158	0.146	0.116	0.432	0.217	0.217
32	**Tanzania**	0.286	0.034	0.093	0.197	0.193	0.255	0.150	0.128	0.198	0.102	0.235	0.266	0.077	0.135
33	Vietnam	0.166	0.279	0.072	0.212	0.215	0.199	0.201	0.461	0.240	0.303	0.194	0.151	0.137	0.474
34	Kenya	0.301	0.053	0.093	0.218	0.144	0.236	0.182	0.156	0.251	0.137	0.391	0.362	0.089	0.116
35	Croatia	0.169	0.422	0.102	0.220	0.290	0.384	0.414	0.180	0.311	0.154	0.528	0.487	0.888	0.375

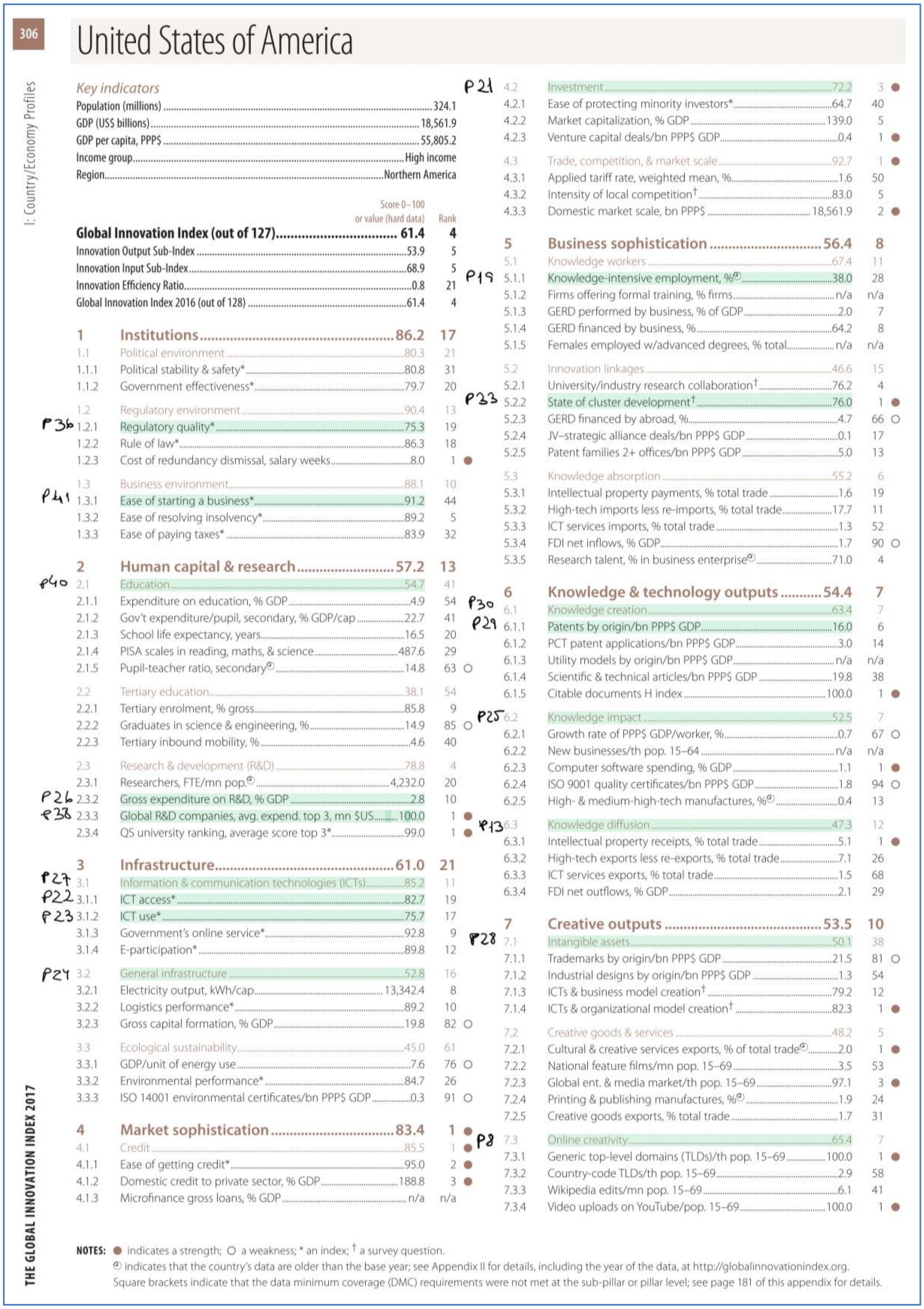
	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O
1	Country	1. Oppor	2. Startu	3. Risk Ac	4. Netwo	5. Cultur	6. Oppor	7. Techn	8.Human	9. Compe	10. Prod	11. Proce	12. High	13. Inter	14. Risk (
36	Parameter No.	P15	P10	P16	P12	P11	P1	P37	P42	P34	P31	P35	P43	P2	P20
37	Lao PDR	0.156	0.146	0.010	0.222	0.149	0.309	0.165	0.434	0.325	0.289	0.074	0.145	0.058	0.402
38	Colombia	0.662	0.442	0.233	0.223	0.267	0.209	0.395	0.360	0.320	0.544	0.233	0.916	0.696	0.292
39	Paraguay	0.317	0.222	0.152	0.223	0.164	0.189	0.119	0.142	0.209	0.171	0.077	0.172	0.125	0.139
40	Benin	0.356	0.115	0.025	0.224	0.230	0.138	0.135	0.111	0.170	0.107	0.024	0.191	0.077	0.058
41	Thailand	0.385	0.413	0.229	0.225	0.288	0.358	0.118	0.496	0.297	0.384	0.320	0.214	0.093	0.281
42	Albania	0.211	0.666	0.056	0.226	0.264	0.146	0.362	0.343	0.214	0.110	0.134	0.323	0.354	0.171
43	Barbados	0.691	1.000	0.343	0.234	0.710	0.310	0.290	0.633	0.298	0.216	0.109	0.205	0.508	0.163
44	Angola	0.167	0.048	0.120	0.235	0.068	0.194	0.133	0.182	0.051	0.200	0.133	0.117	0.192	0.237
45	Nicaragua	0.110	0.093	0.023	0.238	0.185	0.139	0.099	0.200	0.195	0.248	0.051	0.087	0.116	0.077
46	Italy	0.325	0.333	0.367	0.250	0.328	0.376	0.406	0.199	0.292	0.877	0.675	0.177	0.554	0.656
47	Honduras	0.246	0.184	0.085	0.258	0.232	0.151	0.117	0.140	0.382	0.427	0.073	0.137	0.162	0.115
48	Macedonia	0.326	0.361	0.110	0.259	0.294	0.201	0.385	0.427	0.314	0.206	0.311	0.455	0.367	0.295
49	Rwanda	0.357	0.101	0.025	0.267	0.502	0.264	0.185	0.188	0.320	0.132	0.171	0.384	0.091	0.084
50	Morocco	0.302	0.137	0.334	0.270	0.213	0.389	0.230	0.128	0.101	0.441	0.648	0.247	0.161	0.387
51	Mali	0.257	0.065	0.025	0.271	0.248	0.133	0.160	0.105	0.262	0.106	0.332	0.287	0.077	0.065
52	Czech Republic	0.361	0.508	0.709	0.281	0.091	0.467	0.695	0.386	0.417	0.566	0.719	0.594	1.000	0.431
53	Cyprus	0.303	0.571	0.243	0.286	0.513	0.649	0.335	0.588	0.438	0.319	0.353	0.165	0.608	0.489
54	Armenia	0.179	0.234	0.060	0.287	0.238	0.197	0.264	0.609	0.206	0.160	0.110	0.368	0.305	0.133
55	Argentina	0.124	0.718	0.019	0.300	0.148	0.186	0.322	0.269	0.212	0.303	0.278	0.275	0.147	0.295
56	Serbia	0.255	0.620	0.076	0.307	0.253	0.151	0.135	0.296	0.203	0.269	0.459	0.192	0.149	0.236
57	South Africa	0.419	0.074	0.434	0.311	0.380	0.342	0.214	0.248	0.629	0.535	0.498	0.549	0.486	0.179
58	Greece	0.182	0.731	0.243	0.315	0.324	0.450	0.304	0.490	0.321	0.270	0.474	0.131	0.560	0.604
59	Mauritania	0.271	0.040	0.025	0.315	0.204	0.052	0.162	0.091	0.087	0.063	0.138	0.185	0.068	0.055
60	**Nigeria**	0.368	0.099	0.204	0.316	0.169	0.077	0.145	0.424	0.222	0.174	0.164	0.232	0.188	0.168
61	**Japan**	0.183	0.152	0.639	0.327	0.378	0.592	0.969	1.000	0.580	1.000	1.000	1.000	0.600	0.554
62	Ghana	0.618	0.210	0.198	0.329	0.570	0.319	0.115	0.091	0.281	0.085	0.171	0.222	0.107	0.120
63	**Ukraine**	0.130	0.595	0.013	0.331	0.162	0.234	0.348	0.502	0.156	0.259	0.378	0.484	0.381	0.548
64	Slovenia	0.296	0.837	0.793	0.332	0.486	0.589	0.656	0.510	0.411	0.584	0.729	0.360	0.849	0.406
65	Liberia	0.312	0.133	0.025	0.335	0.272	0.167	0.149	0.110	0.225	0.102	0.100	0.333	0.062	0.065
66	Slovakia	0.283	0.375	0.688	0.340	0.301	0.386	0.558	0.396	0.246	0.497	0.533	0.625	1.000	0.574
67	Venezuela	0.051	0.623	0.023	0.341	0.094	0.020	0.129	0.110	0.077	0.115	0.298	0.147	0.031	0.063
68	Jamaica	0.519	0.373	0.020	0.345	0.408	0.228	0.074	0.333	0.310	0.112	0.079	0.125	0.379	0.087
69	Belgium	0.711	0.592	0.549	0.346	0.563	0.565	0.876	0.808	0.850	0.858	0.916	0.508	0.886	0.614
70	Belize	0.355	0.221	0.093	0.352	0.183	0.254	0.152	0.124	0.156	0.064	0.131	0.208	0.104	0.065

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O
1	Country	1. Oppor	2. Startu	3. Risk Ac	4. Netwo	5. Cultur	6. Oppor	7. Techn	8.Human	9. Compe	10. Prod	11. Proce	12. High	13. Inter	14. Risk (
71	Parameter No.	P15	P10	P16	P12	P11	P1	P37	P42	P34	P31	P35	P43	P2	P20
72	Cameroon	0.232	0.134	0.082	0.356	0.131	0.097	0.165	0.199	0.162	0.175	0.135	0.234	0.132	0.086
73	Hungary	0.316	0.327	0.168	0.362	0.342	0.439	0.495	0.476	0.253	0.302	0.441	0.481	0.762	0.316
74	Portugal	0.451	0.661	0.627	0.366	0.533	0.573	0.468	0.332	0.448	0.322	0.641	0.340	0.752	0.424
75	**Poland**	0.389	0.688	0.391	0.369	0.468	0.425	0.381	0.512	0.373	0.605	0.375	0.477	0.705	0.580
76	Senegal	0.443	0.102	0.105	0.371	0.528	0.108	0.127	0.086	0.264	0.053	0.385	0.448	0.083	0.060
77	Puerto Rico	0.501	0.717	0.572	0.371	0.192	0.552	0.266	1.000	0.833	0.423	0.328	0.141	0.432	0.199
78	Botswana	0.695	0.315	0.748	0.371	0.711	0.380	0.227	0.447	0.331	0.216	0.162	0.485	0.243	0.134
79	Costa Rica	0.411	0.723	0.326	0.377	0.462	0.341	0.176	0.218	0.346	0.275	0.309	0.283	0.222	0.185
80	Latvia	0.420	0.579	0.190	0.377	0.387	0.599	0.649	0.493	0.404	0.382	0.269	0.691	0.643	0.510
81	**Germany**	0.761	0.569	0.624	0.381	0.832	0.763	0.789	0.452	0.921	0.757	0.841	0.607	0.779	0.758
82	**Ireland**	0.664	0.904	0.738	0.391	0.743	0.907	0.801	0.926	0.920	0.842	0.756	0.833	0.827	0.630
83	**Bulgaria**	0.130	0.379	0.188	0.396	0.277	0.276	0.291	0.243	0.164	0.054	0.464	0.176	0.252	0.204
84	Bolivia	0.125	0.406	0.124	0.396	0.253	0.051	0.097	0.165	0.211	0.560	0.137	0.338	0.149	0.256
85	**El Salvador**	0.269	0.240	0.192	0.397	0.303	0.162	0.094	0.244	0.356	0.199	0.035	0.279	0.099	0.188
86	Zambia	0.456	0.029	0.211	0.398	0.285	0.275	0.060	0.232	0.285	0.156	0.183	0.096	0.499	0.105
87	**Brazil**	0.393	0.199	0.276	0.401	0.362	0.137	0.193	0.100	0.312	0.134	0.163	0.175	0.063	0.161
88	Ecuador	0.165	0.508	0.063	0.416	0.190	0.256	0.137	0.230	0.282	0.315	0.202	0.131	0.065	0.255
89	Suriname	0.236	0.098	0.100	0.418	0.269	0.350	0.016	0.405	0.273	0.046	0.076	0.050	0.350	0.036
90	Lithuania	0.446	0.472	0.326	0.422	0.511	0.503	0.553	0.743	0.329	0.457	0.481	0.623	0.751	0.665
91	**Iran**	0.086	0.623	0.016	0.430	0.148	0.269	0.303	0.392	0.198	0.126	0.187	0.313	0.147	0.317
92	**Turkey**	0.336	0.645	0.249	0.435	0.331	0.337	0.623	0.386	0.314	0.716	0.383	0.750	0.389	0.761
93	Singapore	0.482	0.033	0.798	0.439	0.724	1.000	0.741	1.000	0.638	0.659	1.000	1.000	1.000	0.807
94	Tunisia	0.456	0.316	0.196	0.446	0.290	0.474	0.687	0.622	0.244	0.389	0.590	0.551	0.223	0.672
95	Uruguay	0.583	0.562	0.397	0.447	0.618	0.373	0.322	0.299	0.316	0.437	0.221	0.494	0.307	0.111
96	Russia	0.134	0.349	0.202	0.462	0.166	0.211	0.233	0.732	0.199	0.188	0.298	0.430	0.083	0.228
97	**Peru**	0.446	0.309	0.445	0.468	0.295	0.374	0.122	0.330	0.248	0.162	0.122	0.278	0.186	0.233
98	Brunei Darussal	0.243	0.004	0.528	0.469	0.331	0.708	0.302	1.000	0.465	0.304	0.083	0.494	0.648	0.440
99	Azerbaijan	0.212	0.171	0.075	0.482	0.157	0.116	1.000	0.531	0.222	0.248	0.144	0.784	1.000	0.223
100	Norway	1.000	0.594	0.985	0.485	1.000	1.000	0.758	0.404	0.680	0.243	0.424	0.465	0.275	0.838
101	Lebanon	0.182	0.708	0.015	0.485	0.220	0.380	0.136	0.359	0.435	0.378	0.413	0.188	0.656	0.367
102	**China**	0.131	0.152	0.525	0.491	0.271	0.261	0.213	0.445	0.254	0.863	0.665	0.606	0.255	0.890
103	Oman	0.632	0.239	0.661	0.501	0.470	0.589	0.211	0.712	0.270	0.351	0.213	0.676	0.418	0.930
104	Namibia	0.410	0.090	0.379	0.504	0.499	0.389	0.186	0.252	0.410	0.629	0.187	0.317	0.411	0.193
105	**United Kingdo**	0.835	0.583	0.844	0.506	0.913	0.892	0.984	0.752	0.759	0.646	0.712	0.741	0.636	0.560

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O
1	Country	1. Oppor	2. Startu	3. Risk Ac	4. Netwo	5. Cultur	6. Oppor	7. Techn	8.Human	9. Compe	10. Prod	11. Proce	12. High	13. Inter	14. Risk (
106	Parameter No.	P15	P10	P16	P12	P11	P1	P37	P42	P34	P31	P35	P43	P2	P20
107	**Australia**	0.955	1.000	0.678	0.509	0.748	0.880	0.774	0.937	0.526	0.587	0.765	0.654	0.721	0.964
108	Algeria	0.335	0.284	0.387	0.509	0.324	0.171	0.251	0.309	0.159	0.216	0.098	0.199	0.200	0.307
109	Montenegro	0.344	0.755	0.014	0.516	0.394	0.281	0.217	0.350	0.235	0.236	0.322	0.390	0.838	0.428
110	Gabon	0.426	0.066	0.176	0.524	0.241	0.202	0.202	0.285	0.278	0.338	0.336	0.334	0.288	0.123
111	**Canada**	1.000	0.733	0.755	0.525	0.848	0.975	0.607	0.920	0.707	0.788	0.657	0.693	0.977	1.000
112	**United States**	0.850	1.000	0.984	0.529	0.877	0.766	0.812	1.000	0.970	0.909	0.932	1.000	1.000	1.000
113	**Switzerland**	0.759	0.723	0.893	0.529	0.683	0.918	0.899	0.775	0.898	0.971	0.877	0.611	1.000	1.000
114	**Indonesia**	0.240	0.390	0.251	0.530	0.296	0.285	0.026	0.187	0.241	0.490	0.198	0.088	0.045	0.166
115	Estonia	0.896	0.669	0.584	0.533	0.573	0.591	0.500	0.523	0.609	0.581	0.746	0.563	0.708	0.318
116	Dominican Repu	0.264	0.463	0.147	0.535	0.332	0.205	0.054	0.391	0.214	0.234	0.192	0.346	0.323	0.101
117	Kuwait	0.476	0.246	0.661	0.542	0.540	0.566	0.209	0.605	0.250	0.342	0.314	0.636	0.491	0.692
118	Kazakhstan	0.236	0.439	0.113	0.543	0.205	0.375	0.123	0.768	0.234	0.217	0.171	0.563	0.334	0.369
119	Gambia, The	0.293	0.021	0.025	0.562	0.173	0.161	0.172	0.154	0.270	0.108	0.120	0.299	0.088	0.065
120	**Austria**	0.815	0.844	0.692	0.574	0.691	0.821	0.892	0.530	0.767	0.739	0.710	0.328	0.843	0.585
121	Panama	0.307	0.298	0.639	0.574	0.266	0.174	0.083	0.269	0.493	0.205	0.198	0.104	0.366	0.156
122	Côte d'Ivoire	0.436	0.116	0.025	0.591	0.117	0.082	0.173	0.118	0.236	0.123	0.173	0.337	0.078	0.065
123	Taiwan	0.562	0.447	0.594	0.597	0.599	0.702	0.454	0.694	0.385	1.000	0.769	1.000	0.512	0.929
124	Korea	0.294	0.461	0.756	0.610	0.330	0.559	0.782	0.550	0.246	0.913	0.946	0.377	0.423	0.769
125	**Mexico**	0.477	0.179	0.406	0.612	0.148	0.331	0.200	0.154	0.262	0.293	0.220	0.183	0.208	0.160
126	**Jordan**	0.449	0.578	0.121	0.618	0.624	0.346	0.077	0.339	0.339	0.420	0.312	0.517	0.201	0.262
127	**Spain**	0.394	0.682	0.663	0.624	0.333	0.544	0.750	0.395	0.408	0.317	0.551	0.269	0.264	0.557
128	France	0.469	0.451	0.680	0.649	0.646	0.605	0.941	0.549	0.758	0.650	0.891	0.590	0.721	0.747
129	Bahrain	0.709	0.488	0.304	0.654	0.576	0.593	0.230	0.879	0.514	0.422	0.105	0.805	0.501	0.906
130	**Denmark**	1.000	0.634	0.736	0.674	0.923	1.000	1.000	1.000	0.978	1.000	0.727	0.544	0.394	1.000
131	Malaysia	0.515	0.316	0.585	0.681	0.233	0.608	0.004	0.905	0.561	0.235	0.713	0.080	0.382	0.233
132	United Arab Em	0.504	0.330	0.353	0.687	0.791	0.790	0.324	1.000	0.570	0.829	0.457	1.000	0.582	1.000
133	Luxembourg	0.741	0.158	0.567	0.726	0.654	1.000	0.814	0.578	0.983	1.000	0.620	0.500	1.000	0.861
134	**Sweden**	1.000	0.509	0.750	0.738	0.896	0.946	1.000	0.627	0.828	0.806	1.000	0.611	0.868	0.622
135	Hong Kong	0.389	0.283	0.797	0.741	0.488	0.670	0.216	0.803	0.129	1.000	0.429	0.921	0.503	0.758
136	**Netherlands**	0.870	0.902	0.817	0.765	1.000	0.965	0.765	0.380	0.806	0.666	0.787	0.506	0.612	0.656
137	Chile	0.930	0.925	1.000	0.771	0.703	0.665	0.427	0.557	0.392	1.000	0.299	0.756	0.402	0.650
138	Saudi Arabia	0.549	0.865	0.481	0.784	0.693	0.742	0.205	0.576	0.314	0.446	0.178	0.832	0.372	0.774
139	Israel	0.712	0.494	0.474	0.789	0.644	0.644	1.000	0.738	0.217	1.000	1.000	0.798	0.602	0.908
140	Qatar	0.784	0.253	0.466	0.797	0.986	0.668	0.244	0.857	0.833	0.767	0.528	1.000	0.459	0.972
141	**Finland**	0.914	0.943	0.750	0.986	0.905	1.000	0.601	0.457	0.379	0.792	0.867	0.648	0.683	0.591
142	**Iceland**	0.948	1.000	0.903	1.000	0.640	1.000	1.000	0.495	0.476	0.684	0.869	0.625	0.952	0.604

APPENDIX H
- THE 18 GII (LIGHT GREEN CODED) PARAMETER DATA SOURCES

Example of GII 2017 country data sheet, where all 18 parameters are highlighted



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United States of America

I: Country/Economy Profiles

Key indicators

Population (millions)	324.1
GDP (US$ billions)	18,561.9
GDP per capita, PPP$	55,805.2
Income group	High income
Region	Northern America

		Score 0–100 or value (hard data)	Rank
	Global Innovation Index (out of 127)	**61.4**	**4**
	Innovation Output Sub-Index	53.9	5
	Innovation Input Sub-Index	68.9	5
	Innovation Efficiency Ratio	0.8	21
	Global Innovation Index 2016 (out of 128)	61.4	4

Note	Code	Indicator	Score	Rank	
	1	**Institutions**	**86.2**	**17**	
	1.1	Political environment	80.3	21	
	1.1.1	Political stability & safety*	80.8	31	
	1.1.2	Government effectiveness*	79.7	20	
	1.2	Regulatory environment	90.4	13	
P36	1.2.1	Regulatory quality*	75.3	19	
	1.2.2	Rule of law*	86.3	18	
	1.2.3	Cost of redundancy dismissal, salary weeks	8.0	1	●
	1.3	Business environment	88.1	10	
P41	1.3.1	Ease of starting a business*	91.2	44	
	1.3.2	Ease of resolving insolvency*	89.2	5	
	1.3.3	Ease of paying taxes*	83.9	32	
	2	**Human capital & research**	**57.2**	**13**	
P40	2.1	Education	54.7	41	
	2.1.1	Expenditure on education, % GDP	4.9	54	
	2.1.2	Gov't expenditure/pupil, secondary, % GDP/cap	22.7	41	
	2.1.3	School life expectancy, years	16.5	20	
	2.1.4	PISA scales in reading, maths, & science	487.6	29	
	2.1.5	Pupil-teacher ratio, secondary ⓐ	14.8	63	○
	2.2	Tertiary education	38.1	54	
	2.2.1	Tertiary enrolment, % gross	85.8	9	
	2.2.2	Graduates in science & engineering, %	14.9	85	○
	2.2.3	Tertiary inbound mobility, %	4.6	40	
	2.3	Research & development (R&D)	78.8	4	
	2.3.1	Researchers, FTE/mn pop. ⓐ	4,232.0	20	
P26	2.3.2	Gross expenditure on R&D, % GDP	2.8	10	
P38	2.3.3	Global R&D companies, avg. expend. top 3, mn $US	100.0	1	●
	2.3.4	QS university ranking, average score top 3*	99.0	1	●
	3	**Infrastructure**	**61.0**	**21**	
P27	3.1	Information & communication technologies (ICTs)	85.2	11	
P22	3.1.1	ICT access*	82.7	19	
P23	3.1.2	ICT use*	75.7	17	
	3.1.3	Government's online service*	92.8	9	
	3.1.4	E-participation*	89.8	12	
P24	3.2	General infrastructure	52.8	16	
	3.2.1	Electricity output, kWh/cap	13,342.4	8	
	3.2.2	Logistics performance*	89.2	10	
	3.2.3	Gross capital formation, % GDP	19.8	82	○
	3.3	Ecological sustainability	45.0	61	
	3.3.1	GDP/unit of energy use	7.6	76	○
	3.3.2	Environmental performance*	84.7	26	
	3.3.3	ISO 14001 environmental certificates/bn PPP$ GDP	0.3	91	○
	4	**Market sophistication**	**83.4**	**1**	●
P8	4.1	Credit	85.5	1	●
	4.1.1	Ease of getting credit*	95.0	2	●
	4.1.2	Domestic credit to private sector, % GDP	188.8	3	●
	4.1.3	Microfinance gross loans, % GDP	n/a	n/a	
P21	4.2	Investment	72.2	3	●
	4.2.1	Ease of protecting minority investors*	64.7	40	
	4.2.2	Market capitalization, % GDP	139.0	5	
	4.2.3	Venture capital deals/bn PPP$ GDP	0.4	1	●
	4.3	Trade, competition, & market scale	92.7	1	●
	4.3.1	Applied tariff rate, weighted mean, %	1.6	50	
	4.3.2	Intensity of local competition†	83.0	5	
	4.3.3	Domestic market scale, bn PPP$	18,561.9	2	●
	5	**Business sophistication**	**56.4**	**8**	
	5.1	Knowledge workers	67.4	11	
P19	5.1.1	Knowledge-intensive employment, % ⓐ	38.0	28	
	5.1.2	Firms offering formal training, % firms	n/a	n/a	
	5.1.3	GERD performed by business, % of GDP	2.0	7	
	5.1.4	GERD financed by business, %	64.2	8	
	5.1.5	Females employed w/advanced degrees, % total	n/a	n/a	
	5.2	Innovation linkages	46.6	15	
	5.2.1	University/industry research collaboration†	76.2	4	
P33	5.2.2	State of cluster development†	76.0	1	●
	5.2.3	GERD financed by abroad, %	4.7	66	○
	5.2.4	JV–strategic alliance deals/bn PPP$ GDP	0.1	17	
	5.2.5	Patent families 2+ offices/bn PPP$ GDP	5.0	13	
	5.3	Knowledge absorption	55.2	6	
	5.3.1	Intellectual property payments, % total trade	1.6	19	
	5.3.2	High-tech imports less re-imports, % total trade	17.7	11	
	5.3.3	ICT services imports, % total trade	1.3	52	
	5.3.4	FDI net inflows, % GDP	1.7	90	○
	5.3.5	Research talent, % in business enterprise ⓐ	71.0	4	
	6	**Knowledge & technology outputs**	**54.4**	**7**	
P30	6.1	Knowledge creation	63.4	7	
P29	6.1.1	Patents by origin/bn PPP$ GDP	16.0	6	
	6.1.2	PCT patent applications/bn PPP$ GDP	3.0	14	
	6.1.3	Utility models by origin/bn PPP$ GDP	n/a	n/a	
	6.1.4	Scientific & technical articles/bn PPP$ GDP	19.8	38	
	6.1.5	Citable documents H index	100.0	1	●
P25	6.2	Knowledge impact	52.5	7	
	6.2.1	Growth rate of PPP$ GDP/worker, %	0.7	67	○
	6.2.2	New businesses/th pop. 15–64	n/a	n/a	
	6.2.3	Computer software spending, % GDP	1.1	1	●
	6.2.4	ISO 9001 quality certificates/bn PPP$ GDP	1.8	94	○
	6.2.5	High- & medium-high-tech manufactures, % ⓐ	0.4	13	
P13	6.3	Knowledge diffusion	47.3	12	
	6.3.1	Intellectual property receipts, % total trade	5.1	1	●
	6.3.2	High-tech exports less re-exports, % total trade	7.1	26	
	6.3.3	ICT services exports, % total trade	1.5	68	
	6.3.4	FDI net outflows, % GDP	2.1	29	
	7	**Creative outputs**	**53.5**	**10**	
P28	7.1	Intangible assets	50.1	38	
	7.1.1	Trademarks by origin/bn PPP$ GDP	21.5	81	○
	7.1.2	Industrial designs by origin/bn PPP$ GDP	1.3	54	
	7.1.3	ICTs & business model creation†	79.2	12	
	7.1.4	ICTs & organizational model creation†	82.3	1	●
	7.2	Creative goods & services	48.2	5	
	7.2.1	Cultural & creative services exports, % of total trade ⓐ	2.0	1	●
	7.2.2	National feature films/mn pop. 15–69	3.5	53	
	7.2.3	Global ent. & media market/th pop. 15–69	97.1	3	●
	7.2.4	Printing & publishing manufactures, % ⓐ	1.9	24	
	7.2.5	Creative goods exports, % total trade	1.7	31	
P8	7.3	Online creativity	65.4	7	
	7.3.1	Generic top-level domains (TLDs)/th pop. 15–69	100.0	1	●
	7.3.2	Country-code TLDs/th pop. 15–69	2.9	58	
	7.3.3	Wikipedia edits/mn pop. 15–69	6.1	41	
	7.3.4	Video uploads on YouTube/pop. 15–69	100.0	1	●

NOTES: ● indicates a strength; ○ a weakness; * an index; † a survey question.
ⓐ indicates that the country's data are older than the base year; see Appendix II for details, including the year of the data, at http://globalinnovationindex.org.
Square brackets indicate that the data minimum coverage (DMC) requirements were not met at the sub-pillar or pillar level; see page 181 of this appendix for details.

THE GLOBAL INNOVATION INDEX 2017

Figure 47: Example of GII 2017 country results sheet -USA data

APPENDIX I
- THE ACTUAL DATA ENTERED FOR THE 32 COUNTRIES

Table 55: Australia's 43 Parameters

Australia - Country

Name: Australia

☑ Show name ☐ Ignore

◉ Single agent ○ Population of agents

Parameter	Value
pCultureofJoy:	0.71
pCultureofAchievement:	0.9
pInfrastructure:	0.537
pICTuse:	
pInvestmentsInKBC:	0.503
pReallocationOfResources:	0.526
pCultureofHonor:	0.1
pNewProductionMethod:	0.587
pTechPlatformLeaders:	0.686
pGovFundedNfpVCFirms:	0.964
pEntSkillAgreeableness:	0.69
pGovFunding:	0.452
pProofOfConceptCenters:	
pUniversityResearchParks:	0.965
pScientificResearch:	0.765
pICTaccess:	0.823
pValueDiversity:	0.937
pCultureOfIndividualism:	0.891
pYoungFirms:	0.654
pEntSkillNotDelegatingTasks:	0.179
pEntSkillSoloPerformance:	0.648

Australia - Country

Parameter	Value
pEntSkillRecognizeAndSeizeOpportunities:	0.955
pEntSkillTechnicalKnowledge:	0.449
pEntSkillOpeness:	0.642
pEntSkillCommunicationAbility:	0.562
pEntSkillDrive:	0.905
pEntSkillNeedForAchievement:	0.748
pOpennessToWorld:	0.597
pEntSkillRiskBearing:	0.678
pEntSkillSourceOfFormalAuthority:	0.97
pEntSkillInitiative:	1
pIP:	0.02
pInvestmentInRandD:	0.022
pBusinessIncubators:	0.88
pTrust:	0.81
pKnowledge:	0.343
pInnovativeCulture:	0.44
pTechIndustryPlatforms:	0.774
pEntSkillNetworkWithResourceProviders:	0.509
pBusinessPartnerships:	0.721
pTargetedPublicPolicies:	
pInvestmentsInICT:	0.889
pUniversity:	0.586

Table 56: Austria's 43 Parameters

Austria - Country

Name: Austria

☑ Show name ☐ Ignore

◉ Single agent ○ Population of agents

Parameter	Value
pCultureofJoy:	0.85
pCultureofAchievement:	0.88
pInfrastructure:	0.515
pICTuse:	
pInvestmentsInKBC:	0.549
pReallocationOfResources:	0.767
pCultureofHonor:	0.12
pNewProductionMethod:	0.739
pTechPlatformLeaders:	0.517
pGovFundedNfpVCFirms:	0.585
pEntSkillAgreeableness:	0.74
pGovFunding:	0.402
pProofOfConceptCenters:	
pUniversityResearchParks:	0.837
pScientificResearch:	0.710
pICTaccess:	0.835
pValueDiversity:	0.530
pCultureOfIndividualism:	0.919
pYoungFirms:	0.328
pEntSkillNotDelegatingTasks:	0.341
pEntSkillSoloPerformance:	0.63

Austria - Country

Parameter	Value
pEntSkillRecognizeAndSeizeOpportunities:	0.815
pEntSkillTechnicalKnowledge:	0.406
pEntSkillOpeness:	0.537
pEntSkillCommunicationAbility:	0.496
pEntSkillDrive:	0.881
pEntSkillNeedForAchievement:	0.691
pOpennessToWorld:	0.507
pEntSkillRiskBearing:	0.692
pEntSkillSourceOfFormalAuthority:	0.96
pEntSkillInitiative:	0.844
pIP:	0.104
pInvestmentInRandD:	0.031
pBusinessIncubators:	0.821
pTrust:	0.88
pKnowledge:	0.427
pInnovativeCulture:	0.378
pTechIndustryPlatforms:	0.892
pEntSkillNetworkWithResourceProviders:	0.574
pBusinessPartnerships:	0.843
pTargetedPublicPolicies:	
pInvestmentsInICT:	0.824
pUniversity:	0.597

Table 57: Bangladesh's 43 Parameters

Bangladesh - Country

Name: Bangladesh

☑ Show name ☐ Ignore

◉ Single agent ○ Population of agents

Parameter	Value
pCultureofJoy:	0.21
pCultureofAchievement:	0.09
pInfrastructure:	0.355
pICTuse:	
pInvestmentsInKBC:	0.301
pReallocationOfResources:	0.153
pCultureofHonor:	0.91
pNewProductionMethod:	0.026
pTechPlatformLeaders:	0.106
pGovFundedNfpVCFirms:	0.068
pEntSkillAgreeableness:	0.01
pGovFunding:	0.324
pProofOfConceptCenters:	
pUniversityResearchParks:	0.817
pScientificResearch:	0.146
pICTaccess:	0.306
pValueDiversity:	0.126
pCultureOfIndividualism:	0.417
pYoungFirms:	0.116
pEntSkillNotDelegatingTasks:	0.144
pEntSkillSoloPerformance:	0.103

Bangladesh - Country

Parameter	Value
pEntSkillRecognizeAndSeizeOpportunities:	0.265
pEntSkillTechnicalKnowledge:	0.2
pEntSkillOpeness:	0.224
pEntSkillCommunicationAbility:	0.089
pEntSkillDrive:	0.845
pEntSkillNeedForAchievement:	0.2
pOpennessToWorld:	0.358
pEntSkillRiskBearing:	0.022
pEntSkillSourceOfFormalAuthority:	0.56
pEntSkillInitiative:	0.04
pIP:	0.001
pInvestmentInRandD:	0.001
pBusinessIncubators:	0.322
pTrust:	1
pKnowledge:	0.045
pInnovativeCulture:	0.292
pTechIndustryPlatforms:	0.125
pEntSkillNetworkWithResourceProviders:	0.104
pBusinessPartnerships:	0.015
pTargetedPublicPolicies:	
pInvestmentsInICT:	0.39
pUniversity:	0.161

Table 58: Bosnia and Herzegovina's 43 Parameters

BosniaHerz - Country

Name: BosniaHerz

☑ Show name ☐ Ignore

◉ Single agent ○ Population of agents

Parameter	Value
pCultureofJoy:	0.56
pCultureofAchievement:	0.63
pInfrastructure:	0.255
pICTuse:	
pInvestmentsInKBC:	0.265
pReallocationOfResources:	0.252
pCultureofHonor:	0.37
pNewProductionMethod:	0.128
pTechPlatformLeaders:	0.001
pGovFundedNfpVCFirms:	0.243
pEntSkillAgreeableness:	0.28
pGovFunding:	0.384
pProofOfConceptCenters:	
pUniversityResearchParks:	0.651
pScientificResearch:	0.254
pICTaccess:	0.578
pValueDiversity:	0.231
pCultureOfIndividualism:	0.549
pYoungFirms:	0.356
pEntSkillNotDelegatingTasks:	0.185
pEntSkillSoloPerformance:	0.335

BosniaHerz - Country

Parameter	Value
pEntSkillRecognizeAndSeizeOpportunities:	0.098
pEntSkillTechnicalKnowledge:	0.24
pEntSkillOpeness:	0.328
pEntSkillCommunicationAbility:	0.215
pEntSkillDrive:	0.881
pEntSkillNeedForAchievement:	0.316
pOpennessToWorld:	0.239
pEntSkillRiskBearing:	0.015
pEntSkillSourceOfFormalAuthority:	0.62
pEntSkillInitiative:	0.105
pIP:	0.01
pInvestmentInRandD:	0.002
pBusinessIncubators:	0.14
pTrust:	0.75
pKnowledge:	0.059
pInnovativeCulture:	0.272
pTechIndustryPlatforms:	0.394
pEntSkillNetworkWithResourceProviders:	0.11
pBusinessPartnerships:	0.506
pTargetedPublicPolicies:	
pInvestmentsInICT:	0.489
pUniversity:	0.902

Table 59: Brazil’s 43 Parameters

Brazil - Country

Name: Brazil

☑ Show name ☐ Ignore

◉ Single agent ○ Population of agents

Parameter	Value
pCultureofJoy:	0.91
pCultureofAchievement:	0.6
pInfrastructure:	0.309
pICTuse:	
pInvestmentsInKBC:	0.38
pReallocationOfResources:	0.312
pCultureofHonor:	0.39
pNewProductionMethod:	0.134
pTechPlatformLeaders:	0.661
pGovFundedNfpVCFirms:	0.161
pEntSkillAgreeableness:	0.44
pGovFunding:	0.373
pProofOfConceptCenters:	
pUniversityResearchParks:	0.65
pScientificResearch:	0.163
pICTaccess:	0.642
pValueDiversity:	0.1
pCultureOfIndividualism:	0.456
pYoungFirms:	0.175
pEntSkillNotDelegatingTasks:	0.211
pEntSkillSoloPerformance:	0.333

Brazil - Country

Parameter	Value
pEntSkillRecognizeAndSeizeOpportunities:	0.393
pEntSkillTechnicalKnowledge:	0.216
pEntSkillOpeness:	0.328
pEntSkillCommunicationAbility:	0.234
pEntSkillDrive:	0.821
pEntSkillNeedForAchievement:	0.362
pOpennessToWorld:	0.045
pEntSkillRiskBearing:	0.276
pEntSkillSourceOfFormalAuthority:	0.81
pEntSkillInitiative:	0.199
pIP:	0.015
pInvestmentInRandD:	0.012
pBusinessIncubators:	0.137
pTrust:	0.88
pKnowledge:	0.167
pInnovativeCulture:	0.188
pTechIndustryPlatforms:	0.193
pEntSkillNetworkWithResourceProviders:	0.401
pBusinessPartnerships:	0.063
pTargetedPublicPolicies:	
pInvestmentsInICT:	0.666
pUniversity:	0.493

Table 60: Bulgaria's 43 Parameters

Bulgaria - Country

Name: Bulgaria

☑ Show name ☐ Ignore

◉ Single agent ○ Population of agents

pCultureofJoy:	0.1
pCultureofAchievement:	0.57
pInfrastructure:	0.354
pICTuse:	
pInvestmentsInKBC:	0.594
pReallocationOfResources:	0.164
pCultureofHonor:	0.43
pNewProductionMethod:	0.054
pTechPlatformLeaders:	0.001
pGovFundedNfpVCFirms:	0.204
pEntSkillAgreeableness:	0.4
pGovFunding:	0.387
pProofOfConceptCenters:	
pUniversityResearchParks:	0.868
pScientificResearch:	0.464
pICTaccess:	0.686
pValueDiversity:	0.243
pCultureOfIndividualism:	0.776
pYoungFirms:	0.176
pEntSkillNotDelegatingTasks:	0.235
pEntSkillSoloPerformance:	0.324

Bulgaria - Country

pEntSkillRecognizeAndSeizeOpportunities:	0.130
pEntSkillTechnicalKnowledge:	0.323
pEntSkillOpeness:	0.119
pEntSkillCommunicationAbility:	0.312
pEntSkillDrive:	0.786
pEntSkillNeedForAchievement:	0.277
pOpennessToWorld:	0.403
pEntSkillRiskBearing:	0.188
pEntSkillSourceOfFormalAuthority:	0.81
pEntSkillInitiative:	0.379
pIP:	0.023
pInvestmentInRandD:	0.01
pBusinessIncubators:	0.276
pTrust:	0.7
pKnowledge:	0.231
pInnovativeCulture:	0.495
pTechIndustryPlatforms:	0.291
pEntSkillNetworkWithResourceProviders:	0.396
pBusinessPartnerships:	0.252
pTargetedPublicPolicies:	
pInvestmentsInICT:	0.633
pUniversity:	0.471

Table 61: Canada's 43 Parameters

Canada - Country

Name: Canada

☑ Show name ☐ Ignore

◉ Single agent ○ Population of agents

Parameter	Value
pCultureofJoy:	0.72
pCultureofAchievement:	0.8
pInfrastructure:	0.597
pICTuse:	
pInvestmentsInKBC:	0.508
pReallocationOfResources:	0.101
pCultureofHonor:	0.2
pNewProductionMethod:	0.441
pTechPlatformLeaders:	0.732
pGovFundedNfpVCFirms:	0.387
pEntSkillAgreeableness:	0.73
pGovFunding:	0.743
pProofOfConceptCenters:	
pUniversityResearchParks:	0.982
pScientificResearch:	0.648
pICTaccess:	0.799
pValueDiversity:	0.128
pCultureOfIndividualism:	0.899
pYoungFirms:	0.247
pEntSkillNotDelegatingTasks:	0.391
pEntSkillSoloPerformance:	0.565

Canada - Country

Parameter	Value
pEntSkillRecognizeAndSeizeOpportunities:	0.302
pEntSkillTechnicalKnowledge:	0.437
pEntSkillOpeness:	0.657
pEntSkillCommunicationAbility:	0.569
pEntSkillDrive:	0.833
pEntSkillNeedForAchievement:	0.213
pOpennessToWorld:	0.582
pEntSkillRiskBearing:	0.334
pEntSkillSourceOfFormalAuthority:	0.98
pEntSkillInitiative:	0.137
pIP:	0.026
pInvestmentInRandD:	0.016
pBusinessIncubators:	0.389
pTrust:	0.69
pKnowledge:	0.406
pInnovativeCulture:	0.362
pTechIndustryPlatforms:	0.230
pEntSkillNetworkWithResourceProviders:	0.270
pBusinessPartnerships:	0.161
pTargetedPublicPolicies:	
pInvestmentsInICT:	0.839
pUniversity:	0.449

Table 62: China’s 43 Parameters

China - Country

Name: China

☑ Show name ☐ Ignore

◉ Single agent ○ Population of agents

Parameter	Value
pCultureofJoy:	0.2
pCultureofAchievement:	0.45
pInfrastructure:	0.675
pICTuse:	
pInvestmentsInKBC:	0.711
pReallocationOfResources:	0.254
pCultureofHonor:	0.55
pNewProductionMethod:	0.863
pTechPlatformLeaders:	0.891
pGovFundedNfpVCFirms:	0.89
pEntSkillAgreeableness:	0.08
pGovFunding:	0.35
pProofOfConceptCenters:	
pUniversityResearchParks:	0.81
pScientificResearch:	0.665
pICTaccess:	0.545
pValueDiversity:	0.445
pCultureOfIndividualism:	0.402
pYoungFirms:	0.606
pEntSkillNotDelegatingTasks:	0.388
pEntSkillSoloPerformance:	0.277

China - Country

Parameter	Value
pEntSkillRecognizeAndSeizeOpportunities:	0.131
pEntSkillTechnicalKnowledge:	0.001
pEntSkillOpeness:	0.179
pEntSkillCommunicationAbility:	0.078
pEntSkillDrive:	0.952
pEntSkillNeedForAchievement:	0.271
pOpennessToWorld:	0.821
pEntSkillRiskBearing:	0.525
pEntSkillSourceOfFormalAuthority:	0.180
pEntSkillInitiative:	0.152
pIP:	0.492
pInvestmentInRandD:	0.021
pBusinessIncubators:	0.261
pTrust:	0.06
pKnowledge:	0.66
pInnovativeCulture:	0.643
pTechIndustryPlatforms:	0.213
pEntSkillNetworkWithResourceProviders:	0.491
pBusinessPartnerships:	0.255
pTargetedPublicPolicies:	
pInvestmentsInICT:	0.646
pUniversity:	0.696

Table 63: Denmark's 43 Parameters

Denmark - Country

Name: Denmark

☑ Show name ☐ Ignore

◉ Single agent ○ Population of agents

Parameter	Value
pCultureofJoy:	0.31
pCultureofAchievement:	0.98
pInfrastructure:	0.431
pICTuse:	
pInvestmentsInKBC:	0.538
pReallocationOfResources:	0.514
pCultureofHonor:	0.02
pNewProductionMethod:	1
pTechPlatformLeaders:	0.723
pGovFundedNfpVCFirms:	1
pEntSkillAgreeableness:	0.79
pGovFunding:	0.714
pProofOfConceptCenters:	
pUniversityResearchParks:	0.941
pScientificResearch:	0.727
pICTaccess:	0.852
pValueDiversity:	1
pCultureOfIndividualism:	0.98
pYoungFirms:	0.544
pEntSkillNotDelegatingTasks:	0.471
pEntSkillSoloPerformance:	0.833

Denmark - Country

Parameter	Value
pEntSkillRecognizeAndSeizeOpportunities:	1
pEntSkillTechnicalKnowledge:	0.451
pEntSkillOpeness:	0.672
pEntSkillCommunicationAbility:	0.665
pEntSkillDrive:	0.726
pEntSkillNeedForAchievement:	0.923
pOpennessToWorld:	1
pEntSkillRiskBearing:	0.736
pEntSkillSourceOfFormalAuthority:	0.98
pEntSkillInitiative:	0.634
pIP:	0.131
pInvestmentInRandD:	0.03
pBusinessIncubators:	1
pTrust:	0.90
pKnowledge:	0.503
pInnovativeCulture:	0.398
pTechIndustryPlatforms:	1
pEntSkillNetworkWithResourceProviders:	0.674
pBusinessPartnerships:	0.394
pTargetedPublicPolicies:	
pInvestmentsInICT:	0.833
pUniversity:	0.741

Table 64: El Salvador's 43 Parameters

El_Salvador - Country

Name: El_Salvador

☑ Show name ☐ Ignore

◉ Single agent ○ Population of agents

Parameter	Value	Parameter	Value
pCultureofJoy:	0.38	**pEntSkillRecognizeAndSeizeOpportunities:**	0.269
pCultureofAchievement:	0.15	**pEntSkillTechnicalKnowledge:**	0.121
pInfrastructure:	0.207	**pEntSkillOpeness:**	0.836
pICTuse:		**pEntSkillCommunicationAbility:**	0.136
pInvestmentsInKBC:	0.391	**pEntSkillDrive:**	0.786
pReallocationOfResources:	0.356	**pEntSkillNeedForAchievement:**	0.303
pCultureofHonor:	0.85	**pOpennessToWorld:**	0.224
pNewProductionMethod:	0.199	**pEntSkillRiskBearing:**	0.192
pTechPlatformLeaders:	0.001	**pEntSkillSourceOfFormalAuthority:**	0.77
pGovFundedNfpVCFirms:	0.188	**pEntSkillInitiative:**	0.240
pEntSkillAgreeableness:	0.19	**pIP:**	0.001
pGovFunding:	0.32	**pInvestmentInRandD:**	0.001
pProofOfConceptCenters:		**pBusinessIncubators:**	0.162
pUniversityResearchParks:	0.807	**pTrust:**	0.84
pScientificResearch:	0.035	**pKnowledge:**	0.014
pICTaccess:	0.495	**pInnovativeCulture:**	0.045
pValueDiversity:	0.244	**pTechIndustryPlatforms:**	0.094
pCultureOfIndividualism:	0.471	**pEntSkillNetworkWithResourceProviders:**	0.397
pYoungFirms:	0.279	**pBusinessPartnerships:**	0.099
pEntSkillNotDelegatingTasks:	0.22	pTargetedPublicPolicies:	
pEntSkillSoloPerformance:	0.133	**pInvestmentsInICT:**	0.432
		pUniversity:	0.32

Table 65: Finland’s 43 Parameters

Finland - Country

Name: Finland

☑ Show name ☐ Ignore

◉ Single agent ○ Population of agents

Parameter	Value
pCultureofJoy:	0.74
pCultureofAchievement:	0.94
pInfrastructure:	0.531
pICTuse:	
pInvestmentsInKBC:	0.577
pReallocationOfResources:	0.745
pCultureofHonor:	0.06
pNewProductionMethod:	0.792
pTechPlatformLeaders:	0.735
pGovFundedNfpVCFirms:	0.591
pEntSkillAgreeableness:	0.71
pGovFunding:	0.678
pProofOfConceptCenters:	
pUniversityResearchParks:	0.931
pScientificResearch:	0.867
pICTaccess:	0.769
pValueDiversity:	0.457
pCultureOfIndividualism:	0.958
pYoungFirms:	0.648
pEntSkillNotDelegatingTasks:	0.449
pEntSkillSoloPerformance:	0.683

Finland - Country

Parameter	Value
pEntSkillRecognizeAndSeizeOpportunities:	0.914
pEntSkillTechnicalKnowledge:	0.46
pEntSkillOpeness:	0.358
pEntSkillCommunicationAbility:	0.467
pEntSkillDrive:	0.702
pEntSkillNeedForAchievement:	0.905
pOpennessToWorld:	0.866
pEntSkillRiskBearing:	0.75
pEntSkillSourceOfFormalAuthority:	1
pEntSkillInitiative:	0.943
pIP:	0.146
pInvestmentInRandD:	0.029
pBusinessIncubators:	1
pTrust:	0.88
pKnowledge:	0.612
pInnovativeCulture:	0.403
pTechIndustryPlatforms:	0.601
pEntSkillNetworkWithResourceProviders:	0.986
pBusinessPartnerships:	0.683
pTargetedPublicPolicies:	
pInvestmentsInICT:	0.861
pUniversity:	0.73

Table 66: Germany's 43 Parameters

Germany - Country

Name: Germany

☑ Show name ☐ Ignore

◉ Single agent ○ Population of agents

Parameter	Value
pCultureofJoy:	0.65
pCultureofAchievement:	0.92
pInfrastructure:	0.501
pICTuse:	
pInvestmentsInKBC:	0.657
pReallocationOfResources:	0.923
pCultureofHonor:	0.08
pNewProductionMethod:	0.757
pTechPlatformLeaders:	0.971
pGovFundedNfpVCFirms:	0.758
pEntSkillAgreeableness:	0.81
pGovFunding:	0.449
pProofOfConceptCenters:	
pUniversityResearchParks:	0.834
pScientificResearch:	0.841
pICTaccess:	0.909
pValueDiversity:	0.452
pCultureOfIndividualism:	0.948
pYoungFirms:	0.607
pEntSkillNotDelegatingTasks:	0.427
pEntSkillSoloPerformance:	0.671

Germany - Country

Parameter	Value
pEntSkillRecognizeAndSeizeOpportunities:	0.761
pEntSkillTechnicalKnowledge:	0.442
pEntSkillOpeness:	0.299
pEntSkillCommunicationAbility:	0.604
pEntSkillDrive:	0.786
pEntSkillNeedForAchievement:	0.832
pOpennessToWorld:	0.522
pEntSkillRiskBearing:	0.624
pEntSkillSourceOfFormalAuthority:	0.96
pEntSkillInitiative:	0.569
pIP:	0.187
pInvestmentInRandD:	0.029
pBusinessIncubators:	0.763
pTrust:	0.77
pKnowledge:	0.673
pInnovativeCulture:	0.431
pTechIndustryPlatforms:	0.789
pEntSkillNetworkWithResourceProviders:	0.381
pBusinessPartnerships:	0.779
pTargetedPublicPolicies:	
pInvestmentsInICT:	0.815
pUniversity:	0.585

Table 67: Iceland's 43 Parameters

Iceland - Country

Name: Iceland

☑ Show name ☐ Ignore

◉ Single agent ○ Population of agents

Parameter	Value	Parameter	Value
pCultureofJoy:	0.68	**pEntSkillRecognizeAndSeizeOpportunities:**	0.948
pCultureofAchievement:	0.93	**pEntSkillTechnicalKnowledge:**	0.478
pInfrastructure:	0.592	**pEntSkillOpeness:**	0.701
pICTuse:		**pEntSkillCommunicationAbility:**	0.814
pInvestmentsInKBC:	0.583	**pEntSkillDrive:**	1
pReallocationOfResources:	0.476	**pEntSkillNeedForAchievement:**	0.64
pCultureofHonor:	0.07	**pOpennessToWorld:**	0.612
pNewProductionMethod:	0.684	**pEntSkillRiskBearing:**	0.903
pTechPlatformLeaders:	0.442	**pEntSkillSourceOfFormalAuthority:**	1
pGovFundedNfpVCFirms:	0.604	**pEntSkillInitiative:**	1
pEntSkillAgreeableness:	0.88	**pIP:**	0.056
pGovFunding:	0.663	**pInvestmentInRandD:**	0.022
pProofOfConceptCenters:		**pBusinessIncubators:**	1
pUniversityResearchParks:	0.926	**pTrust:**	0.96
pScientificResearch:	0.869	**pKnowledge:**	0.485
pICTaccess:	0.942	**pInnovativeCulture:**	0.311
pValueDiversity:	0.495	**pTechIndustryPlatforms:**	1
pCultureOfIndividualism:	0.95	**pEntSkillNetworkWithResourceProviders:**	1
pYoungFirms:	0.625	**pBusinessPartnerships:**	0.952
pEntSkillNotDelegatingTasks:	0.401	pTargetedPublicPolicies:	
pEntSkillSoloPerformance:	0.682	**pInvestmentsInICT:**	0.768
		pUniversity:	0.647

Table 68: Indonesia's 43 Parameters

Indonesia - Country

Name: Indonesia

☑ Show name ☐ Ignore

◉ Single agent ○ Population of agents

Parameter	Value
pCultureofJoy:	0.51
pCultureofAchievement:	0.3
pInfrastructure:	0.467
pICTuse:	
pInvestmentsInKBC:	0.375
pReallocationOfResources:	0.241
pCultureofHonor:	0.7
pNewProductionMethod:	0.49
pTechPlatformLeaders:	0.001
pGovFundedNfpVCFirms:	0.166
pEntSkillAgreeableness:	0.05
pGovFunding:	0.332
pProofOfConceptCenters:	
pUniversityResearchParks:	0.764
pScientificResearch:	0.198
pICTaccess:	0.471
pValueDiversity:	0.187
pCultureOfIndividualism:	0.494
pYoungFirms:	0.088
pEntSkillNotDelegatingTasks:	0.199
pEntSkillSoloPerformance:	0.22

Indonesia - Country

Parameter	Value
pEntSkillRecognizeAndSeizeOpportunities:	0.24
pEntSkillTechnicalKnowledge:	0.098
pEntSkillOpeness:	0.313
pEntSkillCommunicationAbility:	0.152
pEntSkillDrive:	0.655
pEntSkillNeedForAchievement:	0.296
pOpennessToWorld:	0.761
pEntSkillRiskBearing:	0.251
pEntSkillSourceOfFormalAuthority:	0.65
pEntSkillInitiative:	0.39
pIP:	0.004
pInvestmentInRandD:	0.001
pBusinessIncubators:	0.285
pTrust:	1
pKnowledge:	0.029
pInnovativeCulture:	0.398
pTechIndustryPlatforms:	0.026
pEntSkillNetworkWithResourceProviders:	0.53
pBusinessPartnerships:	0.045
pTargetedPublicPolicies:	
pInvestmentsInICT:	0.356
pUniversity:	0.335

Table 69: Iran's 43 Parameters

Iran - Country

Name: Iran

☑ Show name ☐ Ignore

◉ Single agent ○ Population of agents

pCultureofJoy:	0.36
pCultureofAchievement:	0.18
pInfrastructure:	0.381
pICTuse:	
pInvestmentsInKBC:	0.478
pReallocationOfResources:	0.198
pCultureofHonor:	0.82
pNewProductionMethod:	0.126
pTechPlatformLeaders:	0.001
pGovFundedNfpVCFirms:	0.317
pEntSkillAgreeableness:	0.06
pGovFunding:	0.204
pProofOfConceptCenters:	
pUniversityResearchParks:	0.851
pScientificResearch:	0.187
pICTaccess:	0.626
pValueDiversity:	0.392
pCultureOfIndividualism:	0.365
pYoungFirms:	0.313
pEntSkillNotDelegatingTasks:	0.127
pEntSkillSoloPerformance:	0.168

Iran - Country

pEntSkillRecognizeAndSeizeOpportunities:	0.086
pEntSkillTechnicalKnowledge:	0.177
pEntSkillOpeness:	0.373
pEntSkillCommunicationAbility:	0.187
pEntSkillDrive:	0.774
pEntSkillNeedForAchievement:	0.148
pOpennessToWorld:	0.97
pEntSkillRiskBearing:	0.016
pEntSkillSourceOfFormalAuthority:	0.160
pEntSkillInitiative:	0.623
pIP:	0.101
pInvestmentInRandD:	0.003
pBusinessIncubators:	0.269
pTrust:	0.99
pKnowledge:	0.25
pInnovativeCulture:	0.425
pTechIndustryPlatforms:	0.303
pEntSkillNetworkWithResourceProviders:	0.430
pBusinessPartnerships:	0.147
pTargetedPublicPolicies:	
pInvestmentsInICT:	0.359
pUniversity:	0.386

Table 70: Ireland's 43 Parameters

Ireland - Country

Name: Ireland

☑ Show name ☐ Ignore

◉ Single agent ○ Population of agents

Parameter	Value
pCultureofJoy:	0.75
pCultureofAchievement:	0.69
pInfrastructure:	0.471
pICTuse:	
pInvestmentsInKBC:	0.625
pReallocationOfResources:	0.654
pCultureofHonor:	0.27
pNewProductionMethod:	0.84
pTechPlatformLeaders:	0.811
pGovFundedNfpVCFirms:	0.63
pEntSkillAgreeableness:	0.63
pGovFunding:	0.505
pProofOfConceptCenters:	
pUniversityResearchParks:	0.959
pScientificResearch:	0.756
pICTaccess:	0.819
pValueDiversity:	0.926
pCultureOfIndividualism:	0.885
pYoungFirms:	0.833
pEntSkillNotDelegatingTasks:	0.811
pEntSkillSoloPerformance:	0.397

Ireland - Country

Parameter	Value
pEntSkillRecognizeAndSeizeOpportunities:	0.664
pEntSkillTechnicalKnowledge:	0.406
pEntSkillOpeness:	0.627
pEntSkillCommunicationAbility:	0.505
pEntSkillDrive:	0.774
pEntSkillNeedForAchievement:	0.743
pOpennessToWorld:	0.522
pEntSkillRiskBearing:	0.664
pEntSkillSourceOfFormalAuthority:	0.97
pEntSkillInitiative:	0.904
pIP:	0.027
pInvestmentInRandD:	0.015
pBusinessIncubators:	0.907
pTrust:	0.91
pKnowledge:	0.241
pInnovativeCulture:	0.625
pTechIndustryPlatforms:	0.801
pEntSkillNetworkWithResourceProviders:	0.391
pBusinessPartnerships:	0.827
pTargetedPublicPolicies:	
pInvestmentsInICT:	0.748
pUniversity:	0.603

Table 71: Japan's 43 Parameters

Japan - Country

Name: Japan

☑ Show name ☐ Ignore

◉ Single agent ○ Population of agents

Parameter	Value
pCultureofJoy:	0.13
pCultureofAchievement:	0.78
pInfrastructure:	0.497
pICTuse:	
pInvestmentsInKBC:	0.52
pReallocationOfResources:	0.580
pCultureofHonor:	0.22
pNewProductionMethod:	1.0
pTechPlatformLeaders:	0.932
pGovFundedNfpVCFirms:	0.554
pEntSkillAgreeableness:	0.7
pGovFunding:	0.437
pProofOfConceptCenters:	
pUniversityResearchParks:	0.861
pScientificResearch:	1.0
pICTaccess:	0.88
pValueDiversity:	1.0
pCultureOfIndividualism:	0.827
pYoungFirms:	1.0
pEntSkillNotDelegatingTasks:	0.516
pEntSkillSoloPerformance:	0.538

Japan - Country

Parameter	Value
pEntSkillRecognizeAndSeizeOpportunities:	0.183
pEntSkillTechnicalKnowledge:	0.248
pEntSkillOpeness:	0.433
pEntSkillCommunicationAbility:	0.251
pEntSkillDrive:	0.667
pEntSkillNeedForAchievement:	0.592
pOpennessToWorld:	0.642
pEntSkillRiskBearing:	0.639
pEntSkillSourceOfFormalAuthority:	0.88
pEntSkillInitiative:	0.152
pIP:	0.534
pInvestmentInRandD:	0.035
pBusinessIncubators:	0.592
pTrust:	0.41
pKnowledge:	0.567
pInnovativeCulture:	0.332
pTechIndustryPlatforms:	0.969
pEntSkillNetworkWithResourceProviders:	0.327
pBusinessPartnerships:	0.600
pTargetedPublicPolicies:	
pInvestmentsInICT:	0.888
pUniversity:	0.538

Table 72: Mexico's 43 Parameters

Mexico - Country

Name: Mexico

☑ Show name ☐ Ignore

◉ Single agent ○ Population of agents

Parameter	Value
pCultureofJoy:	0.61
pCultureofAchievement:	0.47
pInfrastructure:	0.367
pICTuse:	
pInvestmentsInKBC:	0.417
pReallocationOfResources:	0.262
pCultureofHonor:	0.53
pNewProductionMethod:	0.293
pTechPlatformLeaders:	0.425
pGovFundedNfpVCFirms:	0.160
pEntSkillAgreeableness:	0.47
pGovFunding:	0.345
pProofOfConceptCenters:	
pUniversityResearchParks:	0.857
pScientificResearch:	0.220
pICTaccess:	0.508
pValueDiversity:	0.154
pCultureOfIndividualism:	0.505
pYoungFirms:	0.183
pEntSkillNotDelegatingTasks:	0.259
pEntSkillSoloPerformance:	0.281

Mexico - Country

Parameter	Value
pEntSkillRecognizeAndSeizeOpportunities:	0.477
pEntSkillTechnicalKnowledge:	0.188
pEntSkillOpeness:	0.851
pEntSkillCommunicationAbility:	0.171
pEntSkillDrive:	0.714
pEntSkillNeedForAchievement:	0.148
pOpennessToWorld:	0.313
pEntSkillRiskBearing:	0.406
pEntSkillSourceOfFormalAuthority:	0.65
pEntSkillInitiative:	0.179
pIP:	0.006
pInvestmentInRandD:	0.006
pBusinessIncubators:	0.331
pTrust:	0.81
pKnowledge:	0.083
pInnovativeCulture:	0.303
pTechIndustryPlatforms:	0.2
pEntSkillNetworkWithResourceProviders:	0.612
pBusinessPartnerships:	0.208
pTargetedPublicPolicies:	
pInvestmentsInICT:	0.665
pUniversity:	0.431

Table 73: Netherlands' 43 Parameters

Netherlands - Country

Name: Netherlands

☑ Show name ☐ Ignore

◉ Single agent ○ Population of agents

Parameter	Value
pCultureofJoy:	0.67
pCultureofAchievement:	0.95
pInfrastructure:	0.486
pICTuse:	
pInvestmentsInKBC:	0.577
pReallocationOfResources:	0.464
pCultureofHonor:	0.05
pNewProductionMethod:	0.666
pTechPlatformLeaders:	0.83
pGovFundedNfpVCFirms:	0.656
pEntSkillAgreeableness:	0.93
pGovFunding:	0.528
pProofOfConceptCenters:	
pUniversityResearchParks:	0.942
pScientificResearch:	0.787
pICTaccess:	0.902
pValueDiversity:	0.38
pCultureOfIndividualism:	0.952
pYoungFirms:	0.506
pEntSkillNotDelegatingTasks:	0.793
pEntSkillSoloPerformance:	0.703

Netherlands - Country

Parameter	Value
pEntSkillRecognizeAndSeizeOpportunities:	0.87
pEntSkillTechnicalKnowledge:	0.466
pEntSkillOpeness:	0.687
pEntSkillCommunicationAbility:	0.778
pEntSkillDrive:	0.595
pEntSkillNeedForAchievement:	1
pOpennessToWorld:	0.896
pEntSkillRiskBearing:	0.817
pEntSkillSourceOfFormalAuthority:	0.99
pEntSkillInitiative:	0.902
pIP:	0.111
pInvestmentInRandD:	0.02
pBusinessIncubators:	0.965
pTrust:	0.45
pKnowledge:	0.648
pInnovativeCulture:	0.446
pTechIndustryPlatforms:	0.765
pEntSkillNetworkWithResourceProviders:	0.765
pBusinessPartnerships:	0.612
pTargetedPublicPolicies:	
pInvestmentsInICT:	0.889
pUniversity:	0.611

Table 74: Nigeria's 43 Parameters

Nigeria - Country

Name: Nigeria

☑ Show name ☐ Ignore

◉ Single agent ○ Population of agents

Parameter	Value
pCultureofJoy:	0.53
pCultureofAchievement:	0.23
pInfrastructure:	0.185
pICTuse:	
pInvestmentsInKBC:	0.328
pReallocationOfResources:	0.222
pCultureofHonor:	0.77
pNewProductionMethod:	0.174
pTechPlatformLeaders:	0.001
pGovFundedNfpVCFirms:	0.168
pEntSkillAgreeableness:	0.22
pGovFunding:	0.339
pProofOfConceptCenters:	
pUniversityResearchParks:	0.786
pScientificResearch:	0.164
pICTaccess:	0.296
pValueDiversity:	0.424
pCultureOfIndividualism:	0.198
pYoungFirms:	0.232
pEntSkillNotDelegatingTasks:	0.164
pEntSkillSoloPerformance:	0.204

Nigeria - Country

Parameter	Value
pEntSkillRecognizeAndSeizeOpportunities:	0.368
pEntSkillTechnicalKnowledge:	0.001
pEntSkillOpeness:	1
pEntSkillCommunicationAbility:	0.034
pEntSkillDrive:	0.893
pEntSkillNeedForAchievement:	0.169
pOpennessToWorld:	0.388
pEntSkillRiskBearing:	0.204
pEntSkillSourceOfFormalAuthority:	0.46
pEntSkillInitiative:	0.099
pIP:	0.001
pInvestmentInRandD:	0.002
pBusinessIncubators:	0.077
pTrust:	0.99
pKnowledge:	0.031
pInnovativeCulture:	0.103
pTechIndustryPlatforms:	0.145
pEntSkillNetworkWithResourceProviders:	0.316
pBusinessPartnerships:	0.188
pTargetedPublicPolicies:	
pInvestmentsInICT:	0.323
pUniversity:	0.357

Table 75: Peru's 43 Parameters

Peru - Country

Name: Peru

☑ Show name ☐ Ignore

◉ Single agent ○ Population of agents

Parameter	Value
pCultureofJoy:	0.46
pCultureofAchievement:	0.24
pInfrastructure:	0.349
pICTuse:	
pInvestmentsInKBC:	0.381
pReallocationOfResources:	0.248
pCultureofHonor:	0.75
pNewProductionMethod:	0.162
pTechPlatformLeaders:	0.001
pGovFundedNfpVCFirms:	0.233
pEntSkillAgreeableness:	0.43
pGovFunding:	0.341
pProofOfConceptCenters:	
pUniversityResearchParks:	0.85
pScientificResearch:	0.122
pICTaccess:	0.48
pValueDiversity:	0.33
pCultureOfIndividualism:	0.506
pYoungFirms:	0.278
pEntSkillNotDelegatingTasks:	0.134
pEntSkillSoloPerformance:	0.206

Peru - Country

Parameter	Value
pEntSkillRecognizeAndSeizeOpportunities:	0.446
pEntSkillTechnicalKnowledge:	0.146
pEntSkillOpeness:	0.463
pEntSkillCommunicationAbility:	0.171
pEntSkillDrive:	0.798
pEntSkillNeedForAchievement:	0.295
pOpennessToWorld:	0.164
pEntSkillRiskBearing:	0.445
pEntSkillSourceOfFormalAuthority:	0.71
pEntSkillInitiative:	0.309
pIP:	0.002
pInvestmentInRandD:	0.001
pBusinessIncubators:	0.374
pTrust:	0.95
pKnowledge:	0.063
pInnovativeCulture:	0.276
pTechIndustryPlatforms:	0.122
pEntSkillNetworkWithResourceProviders:	0.468
pBusinessPartnerships:	0.186
pTargetedPublicPolicies:	
pInvestmentsInICT:	0.487
pUniversity:	0.382

Table 76: Philippines’ 43 Parameters

Phillippines - Country

Name: Phillippines

☑ Show name ☐ Ignore

◉ Single agent ○ Population of agents

Parameter	Value
pCultureofJoy:	0.48
pCultureofAchievement:	0.29
pInfrastructure:	0.329
pICTuse:	
pInvestmentsInKBC:	0.376
pReallocationOfResources:	0.302
pCultureofHonor:	0.71
pNewProductionMethod:	0.579
pTechPlatformLeaders:	0.001
pGovFundedNfpVCFirms:	0.116
pEntSkillAgreeableness:	0.71
pGovFunding:	0.302
pProofOfConceptCenters:	
pUniversityResearchParks:	0.689
pScientificResearch:	0.197
pICTaccess:	0.47
pValueDiversity:	0.450
pCultureOfIndividualism:	0.466
pYoungFirms:	0.208
pEntSkillNotDelegatingTasks:	0.34
pEntSkillSoloPerformance:	0.213

Phillippines - Country

Parameter	Value
pEntSkillRecognizeAndSeizeOpportunities:	0.272
pEntSkillTechnicalKnowledge:	0.24
pEntSkillOpeness:	0.567
pEntSkillCommunicationAbility:	0.124
pEntSkillDrive:	0.655
pEntSkillNeedForAchievement:	0.289
pOpennessToWorld:	0.119
pEntSkillRiskBearing:	0.335
pEntSkillSourceOfFormalAuthority:	0.63
pEntSkillInitiative:	0.513
pIP:	0.005
pInvestmentInRandD:	0.001
pBusinessIncubators:	0.342
pTrust:	0.9
pKnowledge:	0.106
pInnovativeCulture:	0.403
pTechIndustryPlatforms:	0.014
pEntSkillNetworkWithResourceProviders:	0.188
pBusinessPartnerships:	0.153
pTargetedPublicPolicies:	
pInvestmentsInICT:	0.506
pUniversity:	0.269

Table 77: Poland's 43 Parameters

Poland - Country

Name: Poland

☑ Show name ☐ Ignore

◉ Single agent ○ Population of agents

Parameter	Value
pCultureofJoy:	0.69
pCultureofAchievement:	0.44
pInfrastructure:	0.387
pICTuse:	
pInvestmentsInKBC:	0.459
pReallocationOfResources:	0.373
pCultureofHonor:	0.56
pNewProductionMethod:	0.605
pTechPlatformLeaders:	0.001
pGovFundedNfpVCFirms:	0.580
pEntSkillAgreeableness:	0.40
pGovFunding:	0.366
pProofOfConceptCenters:	
pUniversityResearchParks:	0.842
pScientificResearch:	0.375
pICTaccess:	0.709
pValueDiversity:	0.512
pCultureOfIndividualism:	0.822
pYoungFirms:	0.477
pEntSkillNotDelegatingTasks:	0.238
pEntSkillSoloPerformance:	0.276

Poland - Country

Parameter	Value
pEntSkillRecognizeAndSeizeOpportunities:	0.389
pEntSkillTechnicalKnowledge:	0.376
pEntSkillOpeness:	0.269
pEntSkillCommunicationAbility:	0.327
pEntSkillDrive:	0.702
pEntSkillNeedForAchievement:	0.468
pOpennessToWorld:	0.284
pEntSkillRiskBearing:	0.391
pEntSkillSourceOfFormalAuthority:	0.93
pEntSkillInitiative:	0.688
pIP:	0.052
pInvestmentInRandD:	0.01
pBusinessIncubators:	0.425
pTrust:	0.96
pKnowledge:	0.242
pInnovativeCulture:	0.357
pTechIndustryPlatforms:	0.381
pEntSkillNetworkWithResourceProviders:	0.369
pBusinessPartnerships:	0.705
pTargetedPublicPolicies:	
pInvestmentsInICT:	0.707
pUniversity:	0.571

Table 78: Singapore's 43 Parameters

Singapore - Country

Name: Singapore

☑ Show name ☐ Ignore

◉ Single agent ○ Population of agents

Parameter	Value
pCultureofJoy:	0.73
pCultureofAchievement:	0.48
pInfrastructure:	0.577
pICTuse:	
pInvestmentsInKBC:	0.49
pReallocationOfResources:	0.798
pCultureofHonor:	0.52
pNewProductionMethod:	0.659
pTechPlatformLeaders:	0.64
pGovFundedNfpVCFirms:	0.807
pEntSkillAgreeableness:	0.45
pGovFunding:	0.75
pProofOfConceptCenters:	
pUniversityResearchParks:	0.965
pScientificResearch:	1
pICTaccess:	0.87
pValueDiversity:	1
pCultureOfIndividualism:	0.65
pYoungFirms:	1
pEntSkillNotDelegatingTasks:	0.671
pEntSkillSoloPerformance:	0.290

Singapore - Country

Parameter	Value
pEntSkillRecognizeAndSeizeOpportunities:	0.482
pEntSkillTechnicalKnowledge:	0.543
pEntSkillOpeness:	0.433
pEntSkillCommunicationAbility:	0.378
pEntSkillDrive:	0.893
pEntSkillNeedForAchievement:	0.724
pOpennessToWorld:	0.254
pEntSkillRiskBearing:	0.798
pEntSkillSourceOfFormalAuthority:	0.52
pEntSkillInitiative:	0.033
pIP:	0.031
pInvestmentInRandD:	0.022
pBusinessIncubators:	1
pTrust:	0.80
pKnowledge:	0.277
pInnovativeCulture:	0.472
pTechIndustryPlatforms:	0.741
pEntSkillNetworkWithResourceProviders:	0.439
pBusinessPartnerships:	1
pTargetedPublicPolicies:	
pInvestmentsInICT:	0.878
pUniversity:	0.44

Table 79: Spain's 43 Parameters

Spain - Country

Name: Spain

☑ Show name ☐ Ignore

◉ Single agent ○ Population of agents

Parameter	Value
pCultureofJoy:	0.98
pCultureofAchievement:	0.76
pInfrastructure:	0.445
pICTuse:	
pInvestmentsInKBC:	0.565
pReallocationOfResources:	0.408
pCultureofHonor:	0.24
pNewProductionMethod:	0.317
pTechPlatformLeaders:	0.749
pGovFundedNfpVCFirms:	0.557
pEntSkillAgreeableness:	0.83
pGovFunding:	0.439
pProofOfConceptCenters:	
pUniversityResearchParks:	0.866
pScientificResearch:	0.551
pICTaccess:	0.792
pValueDiversity:	0.395
pCultureOfIndividualism:	0.872
pYoungFirms:	0.269
pEntSkillNotDelegatingTasks:	0.362
pEntSkillSoloPerformance:	0.497

Spain - Country

Parameter	Value
pEntSkillRecognizeAndSeizeOpportunities:	0.394
pEntSkillTechnicalKnowledge:	0.329
pEntSkillOpeness:	0.299
pEntSkillCommunicationAbility:	0.408
pEntSkillDrive:	0.619
pEntSkillNeedForAchievement:	0.333
pOpennessToWorld:	0.537
pEntSkillRiskBearing:	0.663
pEntSkillSourceOfFormalAuthority:	0.96
pEntSkillInitiative:	0.682
pIP:	0.027
pInvestmentInRandD:	0.012
pBusinessIncubators:	0.544
pTrust:	0.83
pKnowledge:	0.316
pInnovativeCulture:	0.41
pTechIndustryPlatforms:	0.750
pEntSkillNetworkWithResourceProviders:	0.624
pBusinessPartnerships:	0.264
pTargetedPublicPolicies:	
pInvestmentsInICT:	0.833
pUniversity:	0.562

Table 80: Sweden's 43 Parameters

Sweden - Country

Name: Sweden

☑ Show name ☐ Ignore

◉ Single agent ○ Population of agents

Parameter	Value
pCultureofJoy:	0.01
pCultureofAchievement:	1
pInfrastructure:	0.647
pICTuse:	
pInvestmentsInKBC:	0.587
pReallocationOfResources:	0.788
pCultureofHonor:	0.01
pNewProductionMethod:	0.806
pTechPlatformLeaders:	0.82
pGovFundedNfpVCFirms:	0.622
pEntSkillAgreeableness:	0.91
pGovFunding:	0.684
pProofOfConceptCenters:	
pUniversityResearchParks:	0.946
pScientificResearch:	1
pICTaccess:	0.869
pValueDiversity:	0.627
pCultureOfIndividualism:	0.992
pYoungFirms:	0.611
pEntSkillNotDelegatingTasks:	0.621
pEntSkillSoloPerformance:	1

Sweden - Country

Parameter	Value
pEntSkillRecognizeAndSeizeOpportunities:	1
pEntSkillTechnicalKnowledge:	0.504
pEntSkillOpeness:	0.552
pEntSkillCommunicationAbility:	0.602
pEntSkillDrive:	0.881
pEntSkillNeedForAchievement:	0.896
pOpennessToWorld:	0.96
pEntSkillRiskBearing:	0.75
pEntSkillSourceOfFormalAuthority:	1
pEntSkillInitiative:	0.509
pIP:	0.124
pInvestmentInRandD:	0.033
pBusinessIncubators:	0.946
pTrust:	0.76
pKnowledge:	0.749
pInnovativeCulture:	0.505
pTechIndustryPlatforms:	1
pEntSkillNetworkWithResourceProviders:	0.738
pBusinessPartnerships:	0.868
pTargetedPublicPolicies:	
pInvestmentsInICT:	0.836
pUniversity:	0.677

Table 81: Switzerland's 43 Parameters

Switzerland - Country

Name: Switzerland

☑ Show name ☐ Ignore

◉ Single agent ○ Population of agents

Parameter	Value
pCultureofJoy:	0.4
pCultureofAchievement:	0.97
pInfrastructure:	0.517
pICTuse:	
pInvestmentsInKBC:	0.65
pReallocationOfResources:	1.0
pCultureofHonor:	0.03
pNewProductionMethod:	0.971
pTechPlatformLeaders:	0.943
pGovFundedNfpVCFirms:	1
pEntSkillAgreeableness:	0.83
pGovFunding:	0.635
pProofOfConceptCenters:	
pUniversityResearchParks:	0.884
pScientificResearch:	0.877
pICTaccess:	0.895
pValueDiversity:	0.775
pCultureOfIndividualism:	0.913
pYoungFirms:	0.611
pEntSkillNotDelegatingTasks:	0.723
pEntSkillSoloPerformance:	0.759

Switzerland - Country

Parameter	Value
pEntSkillRecognizeAndSeizeOpportunities:	0.759
pEntSkillTechnicalKnowledge:	0.53
pEntSkillOpeness:	0.597
pEntSkillCommunicationAbility:	0.686
pEntSkillDrive:	0.893
pEntSkillNeedForAchievement:	0.83
pOpennessToWorld:	0.612
pEntSkillRiskBearing:	0.893
pEntSkillSourceOfFormalAuthority:	0.95
pEntSkillInitiative:	0.723
pIP:	0.177
pInvestmentInRandD:	0.03
pBusinessIncubators:	0.918
pTrust:	1
pKnowledge:	0.858
pInnovativeCulture:	0.491
pTechIndustryPlatforms:	0.899
pEntSkillNetworkWithResourceProviders:	0.529
pBusinessPartnerships:	1
pTargetedPublicPolicies:	
pInvestmentsInICT:	0.735
pUniversity:	0.586

Table 82: Tanzania's 43 Parameters

Tanzania - Country

Name: Tanzania

☑ Show name ☐ Ignore

◉ Single agent ○ Population of agents

pCultureofJoy:	0.27
pCultureofAchievement:	0.11
pInfrastructure:	0.417
pICTuse:	
pInvestmentsInKBC:	0.483
pReallocationOfResources:	0.198
pCultureofHonor:	0.9
pNewProductionMethod:	0.102
pTechPlatformLeaders:	0.001
pGovFundedNfpVCFirms:	0.135
pEntSkillAgreeableness:	0.06
pGovFunding:	0.273
pProofOfConceptCenters:	
pUniversityResearchParks:	0.791
pScientificResearch:	0.235
pICTaccess:	0.265
pValueDiversity:	0.128
pCultureOfIndividualism:	0.372
pYoungFirms:	0.266
pEntSkillNotDelegatingTasks:	0.126
pEntSkillSoloPerformance:	0.105

Tanzania - Country

pEntSkillRecognizeAndSeizeOpportunities:	0.286
pEntSkillTechnicalKnowledge:	0.034
pEntSkillOpeness:	0.851
pEntSkillCommunicationAbility:	0.035
pEntSkillDrive:	0.893
pEntSkillNeedForAchievement:	0.193
pOpennessToWorld:	0.119
pEntSkillRiskBearing:	0.093
pEntSkillSourceOfFormalAuthority:	0.66
pEntSkillInitiative:	0.034
pIP:	0.001
pInvestmentInRandD:	0.005
pBusinessIncubators:	0.255
pTrust:	0.98
pKnowledge:	0.042
pInnovativeCulture:	0.331
pTechIndustryPlatforms:	0.15
pEntSkillNetworkWithResourceProviders:	0.197
pBusinessPartnerships:	0.077
pTargetedPublicPolicies:	
pInvestmentsInICT:	0.365
pUniversity:	0.229

Table 83: Turkey's 43 Parameters

Turkey - Country

Name: Turkey

☑ Show name ☐ Ignore

◉ Single agent ○ Population of agents

Parameter	Value
pCultureofJoy:	0.55
pCultureofAchievement:	0.37
pInfrastructure:	0.346
pICTuse:	
pInvestmentsInKBC:	0.647
pReallocationOfResources:	0.314
pCultureofHonor:	0.64
pNewProductionMethod:	0.716
pTechPlatformLeaders:	0.512
pGovFundedNfpVCFirms:	0.761
pEntSkillAgreeableness:	0.15
pGovFunding:	0.385
pProofOfConceptCenters:	
pUniversityResearchParks:	0.87
pScientificResearch:	0.383
pICTaccess:	0.62
pValueDiversity:	0.386
pCultureOfIndividualism:	0.543
pYoungFirms:	0.75
pEntSkillNotDelegatingTasks:	0.192
pEntSkillSoloPerformance:	0.233

Turkey - Country

Parameter	Value
pEntSkillRecognizeAndSeizeOpportunities:	0.336
pEntSkillTechnicalKnowledge:	0.205
pEntSkillOpeness:	0.463
pEntSkillCommunicationAbility:	0.235
pEntSkillDrive:	0.774
pEntSkillNeedForAchievement:	0.331
pOpennessToWorld:	0.239
pEntSkillRiskBearing:	0.249
pEntSkillSourceOfFormalAuthority:	0.6
pEntSkillInitiative:	0.645
pIP:	0.036
pInvestmentInRandD:	0.001
pBusinessIncubators:	0.337
pTrust:	0.98
pKnowledge:	0.288
pInnovativeCulture:	0.346
pTechIndustryPlatforms:	0.623
pEntSkillNetworkWithResourceProviders:	0.435
pBusinessPartnerships:	0.389
pTargetedPublicPolicies:	
pInvestmentsInICT:	0.567
pUniversity:	0.455

Table 84: Ukraine's 43 Parameters

Ukraine - Country

Name: Ukraine

☑ Show name ☐ Ignore

◉ Single agent ○ Population of agents

Parameter	Value
pCultureofJoy:	0.45
pCultureofAchievement:	0.52
pInfrastructure:	0.255
pICTuse:	
pInvestmentsInKBC:	0.537
pReallocationOfResources:	0.156
pCultureofHonor:	0.48
pNewProductionMethod:	0.259
pTechPlatformLeaders:	0.001
pGovFundedNfpVCFirms:	0.548
pEntSkillAgreeableness:	0.29
pGovFunding:	0.306
pProofOfConceptCenters:	
pUniversityResearchParks:	0.944
pScientificResearch:	0.378
pICTaccess:	0.648
pValueDiversity:	0.502
pCultureOfIndividualism:	0.646
pYoungFirms:	0.484
pEntSkillNotDelegatingTasks:	0.246
pEntSkillSoloPerformance:	0.299

Ukraine - Country

Parameter	Value
pEntSkillRecognizeAndSeizeOpportunities:	0.130
pEntSkillTechnicalKnowledge:	0.376
pEntSkillOpeness:	0.09
pEntSkillCommunicationAbility:	0.258
pEntSkillDrive:	0.738
pEntSkillNeedForAchievement:	0.162
pOpennessToWorld:	0.403
pEntSkillRiskBearing:	0.013
pEntSkillSourceOfFormalAuthority:	0.57
pEntSkillInitiative:	0.595
pIP:	0.067
pInvestmentInRandD:	0.006
pBusinessIncubators:	0.234
pTrust:	0.56
pKnowledge:	0.455
pInnovativeCulture:	0.281
pTechIndustryPlatforms:	0.348
pEntSkillNetworkWithResourceProviders:	0.331
pBusinessPartnerships:	0.381
pTargetedPublicPolicies:	
pInvestmentsInICT:	0.559
pUniversity:	0.583

Table 85: United Kingdom's 43 Parameters

UnitedKingdom - Country

Name: UnitedKingdom

☑ Show name ☐ Ignore

◉ Single agent ○ Population of agents

pCultureofJoy:	0.81
pCultureofAchievement:	0.86
pInfrastructure:	0.436
pICTuse:	
pInvestmentsInKBC:	0.639
pReallocationOfResources:	0.654
pCultureofHonor:	0.14
pNewProductionMethod:	0.646
pTechPlatformLeaders:	0.88
pGovFundedNfpVCFirms:	0.56
pEntSkillAgreeableness:	0.75
pGovFunding:	0.63
pProofOfConceptCenters:	
pUniversityResearchParks:	0.946
pScientificResearch:	0.712
pICTaccess:	0.924
pValueDiversity:	1
pCultureOfIndividualism:	0.817
pYoungFirms:	0.741
pEntSkillNotDelegatingTasks:	0.303
pEntSkillSoloPerformance:	0.615

UnitedKingdom - Country

pEntSkillRecognizeAndSeizeOpportunities:	0.835
pEntSkillTechnicalKnowledge:	0.476
pEntSkillOpeness:	0.627
pEntSkillCommunicationAbility:	0.687
pEntSkillDrive:	0.702
pEntSkillNeedForAchievement:	0.913
pOpennessToWorld:	0.448
pEntSkillRiskBearing:	0.844
pEntSkillSourceOfFormalAuthority:	0.97
pEntSkillInitiative:	0.583
pIP:	0.074
pInvestmentInRandD:	0.017
pBusinessIncubators:	0.892
pTrust:	0.83
pKnowledge:	0.56
pInnovativeCulture:	0.532
pTechIndustryPlatforms:	0.984
pEntSkillNetworkWithResourceProviders:	0.506
pBusinessPartnerships:	0.636
pTargetedPublicPolicies:	
pInvestmentsInICT:	0.933
pUniversity:	0.599

Table 86: USA's 43 Parameters

USA - Country

Name: USA

☑ Show name ☐ Ignore

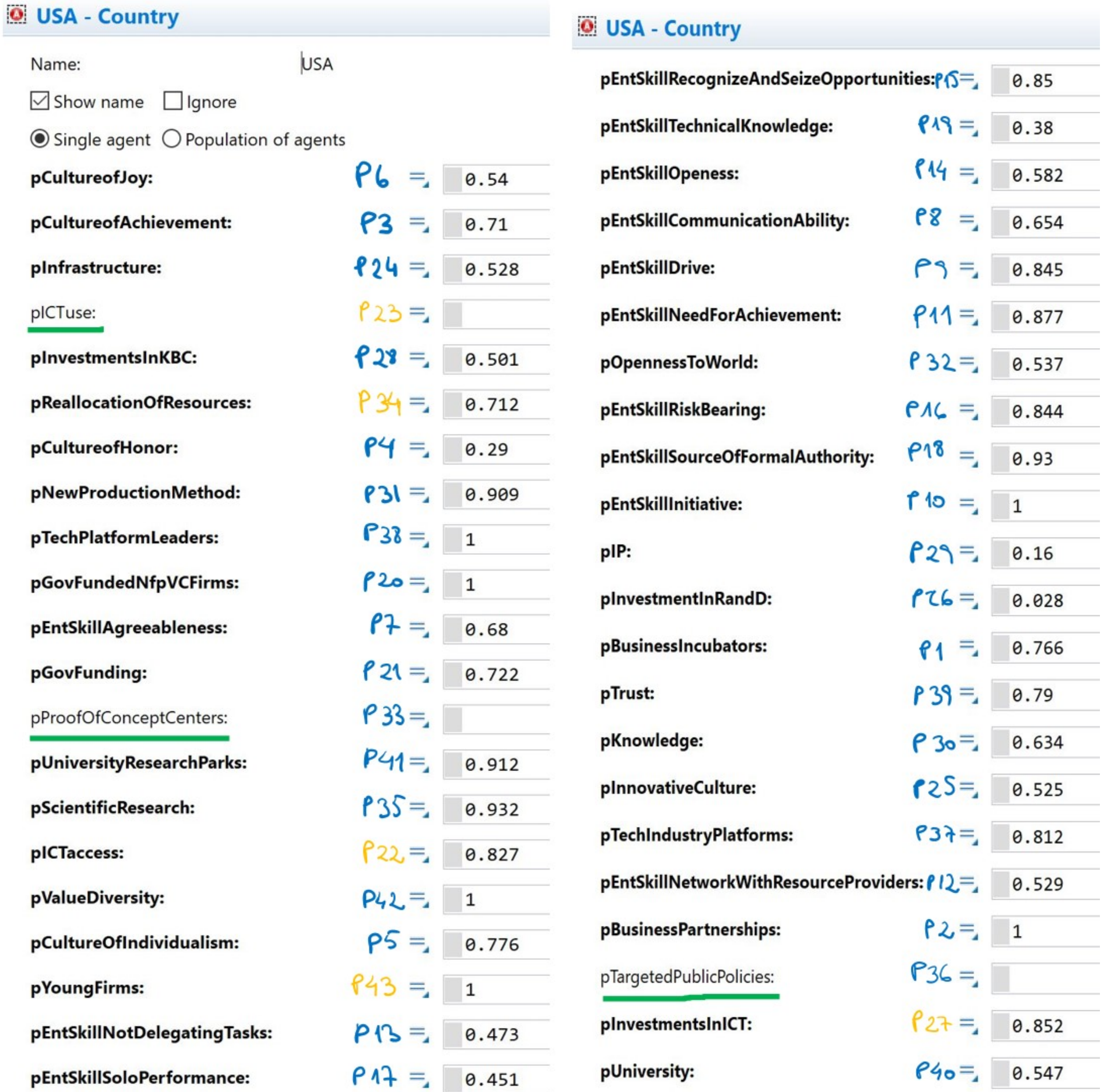
◉ Single agent ○ Population of agents

Parameter	Value
pCultureofJoy:	0.54
pCultureofAchievement:	0.71
pInfrastructure:	0.528
pICTuse:	
pInvestmentsInKBC:	0.501
pReallocationOfResources:	0.712
pCultureofHonor:	0.29
pNewProductionMethod:	0.909
pTechPlatformLeaders:	1
pGovFundedNfpVCFirms:	1
pEntSkillAgreeableness:	0.68
pGovFunding:	0.722
pProofOfConceptCenters:	
pUniversityResearchParks:	0.912
pScientificResearch:	0.932
pICTaccess:	0.827
pValueDiversity:	1
pCultureOfIndividualism:	0.776
pYoungFirms:	1
pEntSkillNotDelegatingTasks:	0.473
pEntSkillSoloPerformance:	0.451

USA - Country

Parameter	Value
pEntSkillRecognizeAndSeizeOpportunities:	0.85
pEntSkillTechnicalKnowledge:	0.38
pEntSkillOpeness:	0.582
pEntSkillCommunicationAbility:	0.654
pEntSkillDrive:	0.845
pEntSkillNeedForAchievement:	0.877
pOpennessToWorld:	0.537
pEntSkillRiskBearing:	0.844
pEntSkillSourceOfFormalAuthority:	0.93
pEntSkillInitiative:	1
pIP:	0.16
pInvestmentInRandD:	0.028
pBusinessIncubators:	0.766
pTrust:	0.79
pKnowledge:	0.634
pInnovativeCulture:	0.525
pTechIndustryPlatforms:	0.812
pEntSkillNetworkWithResourceProviders:	0.529
pBusinessPartnerships:	1
pTargetedPublicPolicies:	
pInvestmentsInICT:	0.852
pUniversity:	0.547

Table 87: Illustration of the Actual Parameter Numbering



USA - Country

Name: USA

☑ Show name ☐ Ignore

◉ Single agent ○ Population of agents

Parameter	Number	Value
pCultureofJoy:	P6 =	0.54
pCultureofAchievement:	P3 =	0.71
pInfrastructure:	P24 =	0.528
pICTuse:	P23 =	
pInvestmentsInKBC:	P28 =	0.501
pReallocationOfResources:	P34 =	0.712
pCultureofHonor:	P4 =	0.29
pNewProductionMethod:	P31 =	0.909
pTechPlatformLeaders:	P38 =	1
pGovFundedNfpVCFirms:	P20 =	1
pEntSkillAgreeableness:	P7 =	0.68
pGovFunding:	P21 =	0.722
pProofOfConceptCenters:	P33 =	
pUniversityResearchParks:	P41 =	0.912
pScientificResearch:	P35 =	0.932
pICTaccess:	P22 =	0.827
pValueDiversity:	P42 =	1
pCultureOfIndividualism:	P5 =	0.776
pYoungFirms:	P43 =	1
pEntSkillNotDelegatingTasks:	P13 =	0.473
pEntSkillSoloPerformance:	P17 =	0.451

USA - Country

Parameter	Number	Value
pEntSkillRecognizeAndSeizeOpportunities:	P15 =	0.85
pEntSkillTechnicalKnowledge:	P19 =	0.38
pEntSkillOpeness:	P14 =	0.582
pEntSkillCommunicationAbility:	P8 =	0.654
pEntSkillDrive:	P9 =	0.845
pEntSkillNeedForAchievement:	P11 =	0.877
pOpennessToWorld:	P32 =	0.537
pEntSkillRiskBearing:	P16 =	0.844
pEntSkillSourceOfFormalAuthority:	P18 =	0.93
pEntSkillInitiative:	P10 =	1
pIP:	P29 =	0.16
pInvestmentInRandD:	P26 =	0.028
pBusinessIncubators:	P1 =	0.766
pTrust:	P39 =	0.79
pKnowledge:	P30 =	0.634
pInnovativeCulture:	P25 =	0.525
pTechIndustryPlatforms:	P37 =	0.812
pEntSkillNetworkWithResourceProviders:	P12 =	0.529
pBusinessPartnerships:	P2 =	1
pTargetedPublicPolicies:	P36 =	
pInvestmentsInICT:	P27 =	0.852
pUniversity:	P40 =	0.547

APPENDIX J
- LIST OF SCHOLARLY PAPERS DESCRIBING DIFFERENT TYPES OF ECOSYSTEMS

Adapted from Ecosystem review list by Aarikka-Stenroos et al. (2016) for use here

Table 88: List of Different Types of Ecosystems in Research Literature Since 2003-2015

No.	Authors	Year	Title	Journal
1	Rong, Ke; Hu, Guangyu; Lin, Yong; Shi, Yongjiang; Guo, Liang	2015	Understanding **Business Ecosystem** Using A 6C Framework In Internet-Of-Things-Based Sectors	INTERNATIONAL JOURNAL OF PRODUCTION ECONOMICS
2	Richter, Carsten H.; Xu, Jianchu; Wilcox, Bruce A.	2015	Opportunities And Challenges Of The **Ecosystem Approach**	FUTURES
3	Vargo, Stephen L.; Wieland, Heiko;	2015	Innovation Through Institutionalization: A **Service Ecosystems** Perspective	INDUSTRIAL MARKETING
4	Vrolijk, Ademir; Szajnfarber, Zoe	2015	When Policy Structures Technology: Balancing Upfront Decomposition And In-Process Coordination In Europe S ’ Decentralized **Space Technology Ecosystem**	ACTA ASTRONAUTICA
5	Clarysse, Bart; Wright, Mike; Bruneel, Johan; Mahajan, Aarti	2014	Creating Value In Ecosystems: Crossing The Chasm Between, Knowledge And **Business Ecosystems**	RESEARCH POLICY
6	Lu, Chao; Rong, Ke; You, Jianxin; Shi, Yongjiang	2014	**Business Ecosystem** And Stakeholders' Role Transformation: Evidence From Chinese Emerging Electric Vehicle Industry	EXPERT SYSTEMS WITH APPLICATIONS
7	Chesbrough, Henry; Kim, Sohyeong; Agogino, Alice	2014	Chez Panisse: Building An **Open Innovation Ecosystem**	California Management
8	Gawer, Annabelle; Cusumano, Michael A.	2014	Industry Platforms And **Ecosystem Innovation**	JOURNAL OF PRODUCT INNOVATION MANAGEMENT
9	Mäkinen, Saku J.; Kanniainen, Juho; Peltola, Ilkka	2014	Investigating Adoption Of Free Beta Applications In A **Platform-Based Business Ecosystem**	JOURNAL OF PRODUCT INNOVATION MANAGEMENT
10	Gomez-Uranga, Mikel; Carlos Miguel, Juan; Mikel Zabala-Iturriagagoitia, Jon	2014	Epigenetic Economic Dynamics: The Evolution Of **Big Internet Business Ecosystems,** Evidence For Patents	TECHNOVATION
11	Li, Julia Fan; Garnsey, Elizabeth	2014	**Policy-Driven Ecosystems** For New Vaccine Development	TECHNOVA
12	Por, George	2014	Augmenting The Collective Intelligence Of The **Ecosystem Of Systems Communities**: Introduction To The Design Of The CI Enhancement Lab (CIEL)	SYSTEMS RESEARCH AND BEHAVIORAL SCIENCE
13	Akaka, Melissa Archpru; Vargo, Stephen L.	2014	Technology As An Operant Resource In **Service (Eco)Systems**	INFORMATION SYSTEMS AND E-BUSINESS MANAGEMENT
14	Wareham, Jonathan; Fox, Paul B.; Cano Giner,	2014	**Technology Ecosystem** Governance	Organization Science

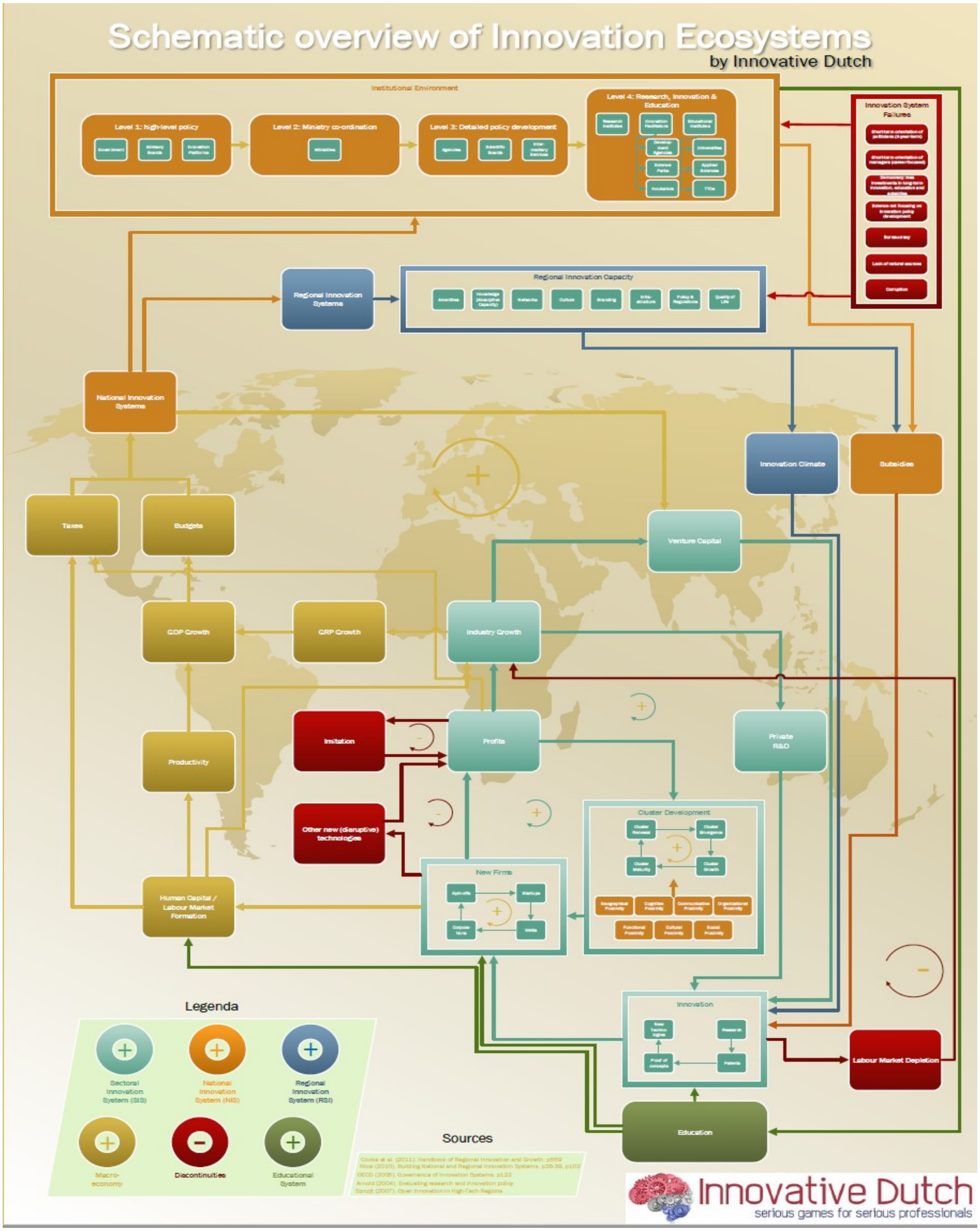
15	Hienerth, Christoph; Lettl, Christopher; Keinz, Peter	2014	Synergies Among Producer Firms, Lead Users, And User Communities: The Case Of The **LEGO Producer-User Ecosystem**	JOURNAL OF PRODUCT INNOVATION MANAGEMENT
16	Almirall, Esteve; Lee, Melissa; Majchrzak, Ann 2014	2014	Open Innovation Requires Integrated **Competition-Community Ecosystems**: Lessons Learned From Civic Open Innovation	BUSINESS HORIZONS
17	Still, Kaisa; Huhtamaki, Jukka; Russell, Martha G.; Rubens, Neil	2014	Insights For Orchestrating **Innovation Ecosystems**: The Case Of EIT ICT Labs And Data-Driven Network Visualizations	INTERNATIONAL JOURNAL OF TECHNOLOGY MANAGEMENT
18	Haines-Young, Roy; Potschin, Marion	2014	The **Ecosystem Approach** As A Framework For Understanding Knowledge Utilization	ENVIRONMENT AND PLANNING C-GOVERNMENT AND POLICY
19	Ben Letaifa, Soumaya	2014	The Uneasy Transition From Supply Chains To **Ecosystems** The Value-Creation/Value-Capture Dilemma	MANAGEMENT DECISION
20	Zhang, Wei; Karimi, Hamid Reza; Zhang, Qingpu; Wu, Shaobo	2014	Collaborative Development Planning Model Of Supporting Product In Platform **Innovation Ecosystem**	
21	Basole, Rahul C.; Clear, Trustin; Hu, Mengdie; Mehrotra, Harshit; Stasko, John	2013	Understanding Interfirm Relationships In **Business Ecosystems** With Interactive Visualization	IEEE TRANSACTIONS ON VISUALIZATION AND COMPUTER GRAPHICS
22	Battistella, Cinzia; Colucci, Katia; De Toni, Alberto F.; Nonino, Fabio	2013	Methodology Of **Business Ecosystems** Network Analysis: A Case Study In Telecom Italia Future Centre	TECHNOLOGICAL FORECASTING AND SOCIAL CHANGE
23	Sloane, A.; O'Reilly, S.	2013	The Emergence Of **Supply Network Ecosystems**: A Social Network Analysis Perspective	PRODUCTION PLANNING & CONTROL
24	Winn, Monika I.; Pogutz, Stefano	2013	Business, **Ecosystems**, And Biodiversity: New Horizons For Management Research	ORGANIZATION & ENVIRONMENT
25	Kapoor, Rahul; Lee, Joon Mahn	2013	Coordinating And Competing In **Ecosystems**: How Organizational Forms Shape New Technology Investments	STRATEGIC MANAGEMENT JOURNAL
26	Vaz, Luiz Felipe Hupsel; Nogueira, Antonio Roberto Ramos; Rodrigues, Marco Aurélio de Souza; Chimenti, Paula Castro Pires de Souza	2013	A New Conceptual Model For **Business Ecosystem** Visualization And Analysis	Revista De Administração Contemporânea
27	Rong, Ke; Shi, Yongjiang; Yu, Jiang	2013	Nurturing **Business Ecosystems** To Deal With Industry Uncertainties	INDUSTRIAL MANAGEMENT & DATA SYSTEMS
28	Selander, Lisen; Henfridsson, Ola; Svahn, Fredrik	2013	Capability Search And Redeem Across **Digital Ecosystems**	JOURNAL OF INFORMATION TECHNOLOGY

29	Kraemer-Mbula, Erika; Tang, Puay; Rush, Howard	2013	The **Cybercrime Ecosystem**: Online Innovation In The Shadows?	TECHNOLOGICAL FORECASTING AND SOCIAL CHANGE
30	Yang, Jiting; Weber, Charles M.; Gabella, Patricia	2013	Enabling Collaborative Solutions Across The **Semiconductor Manufacturing Ecosystem**	IEEE TRANSACTIONS ON SEMICONDUCTOR MANUFACTURING
31	Maia, Catarina; Claro, Joao	2013	The Role Of A Proof Of Concept Center In A **University Ecosystem**: An Exploratory Study	JOURNAL OF TECHNOLOGY TRANSFER
32	Nambisan, Satish; Baron, Robert A.	2013	Entrepreneurship In **Innovation Ecosystems**: Entrepreneurs' Self-Regulatory Processes And Their Implications For New Venture Success	ENTREPRENEURSHIP THEORY AND PRACTICE
33	Leten, Bart; Vanhaverbeke, Wim; Roijakkers, Nadine; Clerix, Andre; Van Helleputte, Johan	2013	IP Models To Orchestrate **Innovation Ecosystems**: IMEC, A PUBLIC RESEARCH INSTITUTE IN NANO-ELECTRONICS	CALIFORNIA MANAGEMENT REVIEW
34	Hung, Chih-Young; Lee, Wen-Yee; Wang, Ding-Shan	2013	Strategic Foresight Using A Modified Delphi With End-User Participation: A Case Study Of The Ipad's Impact On Taiwan's **PC Ecosystem**	TECHNOLOGICAL FORECASTING AND SOCIAL CHANGE
35	West, Joel; Wood, David	2013	Evolving An **Open Ecosystem**: The Rise And Fall Of The Symbian Platform	Collaboration And Competition In Business Ecosystems
36	Li, Julia Fan; Garnsey, Elizabeth	2013	Joint Value: **Ecosystem Support** For Global Health Innovations	Collaboration And Competition In Business Ecosystems
37	Brusoni, Stefano; Prencipe, Andrea	2013	The Organization Of Innovation In **Ecosystems**: Problem Framing, Problem Solving, And Patterns Of Coupling	Collaboration And Competition In Business Ecosystems
38	Ritala, Paavo; Agouridas, Vassilis; Assimakopoulos, Dimitris; Gies, Otto	2013	Value Creation And Capture Mechanisms In **Innovation Ecosystems**: A Comparative Case Study	INTERNATIONAL JOURNAL OF TECHNOLOGY MANAGEMENT
39	Zahra, Shaker A.; Nambisan, Satish	2012	Entrepreneurship And Strategic Thinking In Business Ecosystems	BUSINESS HORIZONS
40	Ceccagnoli, Marco; Forman, Chris; Huang, Peng; Wu, D. J.	2012	Cocreation Of Value In A **Platform Ecosystem**: The Case Of Enterprise Software	Mis Quarterly
41	Krucoff, Mitchell W.; Brindis, Ralph G.; Hodgson, Patricia K.; Mack, Michael J.; Holmes, David R., Jr.	2012	Medical Device Innovation: Prospective Solutions For An **Ecosystem** In Crisis Adding A Professional Society Perspective	JACC-CARDIOVASCULAR INTERVENTIONS
42	van der Borgh, Michel; Cloodt, Myriam; Romme, A. Georges L.	2012	Value Creation By **Knowledge-Based Ecosystems**: Evidence From A Field Study	R & D MANAGEMENT
43	Adner, Ron; Kapoor, Rahul	2010	Value Creation In **Innovation Ecosystems**: How The Structure Of	Strategic Management Journal

			Technological Interdependence Affects Firm Performance In New Technology Generations	
44	Weiss, Michael; Gangadharan, G. R.	2010	Modeling The **Mashup Ecosystem**: Structure And Growth	R & D MANAGEMENT
45	Isckia, Thierry	2009	Amazon's **Evolving Ecosystem**: A Cyber-Bookstore And Application Service Provider	CANADIAN JOURNAL OF ADMINISTRATIVE SCIENCES-REVUE CANADIENNE DES SCIENCES DE L ADMINISTRATION
46	Li, Yan-Ru	2009	The Technological Roadmap Of Cisco's **Business Ecosystem**	TECHNOVATION
47	Pierce, Lamar	2009	Big Losses In **Ecosystem Niches**: How Core Firm Decisions Drive Complementary Product Shakeouts	Strategic Management Journal
48	Raza, Muhammad; Hussain, Farookh Khadeer; Chang, Elizabeth	2009	Quality Measures For Digital **Business Ecosystems** Formation	IT REVOLUTIONS
49	Gueguen, Gael; Isckia, Thierry	2009	The Borders Of **Mobile Handset Ecosystems**: Is Coopetition Inevitable?	MOBILE WIRELESS MIDDLEWARE, OPERATING SYSTEMS, AND APPLICATIONS-WORKSHOPS
50	Rohrbeck, Rene; Hoelzle, Katharina; Gemuenden, Hans Georg	2009	Opening Up For Competitive Advantage - How Deutsche Telekom Creates An **Open Innovation Ecosystem**	R & D MANAGEMENT
51	Basole, Rahul C.	2009	Visualization Of Interfirm Relations In A **Converging Mobile Ecosystem**	JOURNAL OF INFORMATION TECHNOLOGY
52	Papaioannou, Theo; Wield, David; Chataway, Joanna	2009	Knowledge Ecologies And **Ecosystems**? An Empirically Grounded Reflection On Recent Developments In Innovation Systems Theory	ENVIRONMENT AND PLANNING C-GOVERNMENT AND POLICY
53	Carayannis, Elias G.; Campbell, David F. J.	2009	Mode 3' And 'Quadruple Helix': Toward A 21st Century Fractal **Innovation Ecosystem**	INTERNATIONAL JOURNAL OF TECHNOLOGY MANAGEMENT
54	Adamides, Emmanuel D.; Mouzakitis, Yannis	2009	**Industrial Ecosystems** As Technological Niches	JOURNAL OF CLEANER PRODUCTION
55	Wang Cheng	2009	Research On **Industry Ecosystem** Construction And Management	
56	Fragidis, Garyfallos; Koumpis, Adarrianticis; Tarabanis, Konstantinos	2007	The Impact Of Customer Participation On **Business Ecosystems**	Establishing The Foundation Of Collaborative Networks
57	Adomavicius, Gediminas; Bockstedt, Jesse C.; Gupta, Alok; Kauffman, Robert J.	2007	Technology Roles And Paths Of Influence In An **Ecosystem Model Of Technology Evolution**	INFORMATION TECHNOLOGY & MANAGEMENT
58	Adner, Ron	2006	Match Your Innovation Strategy To Your **Innovation Ecosystem**	HARVARD BUSINESS REVIEW

59	Huang, LC; Luo, YF	2003	Restrictive Factors In The **Regional Technological Innovation Ecosystem** And The Strategies For Adaptation	n.a.

APPENDIX K
- SCHEMATIC OVERVIEW OF INNOVATION ECOSYSTEMS



Source: Author created with the adaption of info from Shaver (2016)

Figure 48: Very complex schematic overview of innovation ecosystems by Innovative Dutch

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