

DOI: 10.18559/SOEP.2016.5.6

Burak Erkut

Dresden University of Technology, Germany
Burak.Erkut@tu-dresden.de

STRUCTURAL SIMILARITIES OF ECONOMIES FOR INNOVATION AND COMPETITIVENESS – A DECISION TREE BASED APPROACH¹

Abstract: The purpose of this article is to classify countries according to their stage of competitive advantage (factor-driven, efficiency-driven, innovation-driven) by using an expert survey on entrepreneurship and innovation. For this purpose, machine learning tools were used. The algorithm used to create a decision tree is the exhaustive CHAID algorithm. This classification not only identifies how countries of similar competitive advantages are structurally similar, but also shows the experts survey in a reduced-dimensional space for further analyses. Even though there is heterogeneity amongst countries belonging to the same category, the structural similarities are associated with infrastructure, legislature and financing and support possibilities for entrepreneurs. This analysis provides additional information to data on the ease of doing business relevant for FDI decisions as well as for macroeconomic policymaking. This paper is unique in combining a powerful method to derive decision rules, with a new perspective on competitive advantages and innovativeness of economies. The results help to understand the competitive advantages of economies.

Keywords: entrepreneurship; competition; innovation; decision tree analysis.

JEL codes: O38, O10, C44.

¹ I should like to thank Prof. Roland Schuhr from the University of Leipzig for his support and supervision during my master thesis, which motivated me to write this paper. Furthermore I should like to thank two anonymous referees for their comments.

Introduction

Country classifications according to the competitiveness of economies are very common in the literature. Since Porter's [1990a, 1990b] theoretical contribution, the World Economic Forum issues the Global Competitiveness Report, which is a sound indicator of the competitive stage of a country. Furthermore other analyses and data sources build up upon this report to observe different aspects of economic activities of nations in comparison.

A classification scheme can be useful for developing economic policies based on the economic strengths of a particular country, as well as for decisions regarding FDI. Considering economic activities of different countries it could be asked how a certain classification observes structural similarities of countries within the same classification category. What aspects of their economic activities, impediments, possibilities and so on make different countries belong to the same classification category?

By making use of machine learning tools, the National Experts Survey (NES) of the Global Entrepreneurship Monitor (GEM) will be analyzed for the structural similarities of economies belonging to the classification categories of competitive advantages. GEM NES is a subjective opinion survey conducted by an international consortium on a yearly basis which focuses on the early phases of entrepreneurship, where experts from different countries describe the possibilities and frontiers for entrepreneurial activities in their own country.

Uncertainty plays a key role in economies, their presence is associated with individual market actors adjusting and re-adjusting their plans according to the information they receive from the markets [Hayek 1968, p. 13]. In an uncertain economic environment it is still not possible to say that everything related to the economy is unknown. We still can make pattern predictions [Hayek 1968, p. 12] and observe empirical regularities, which, according to Hayek, do not always need to be true.

Lehmann-Waffenschmidt states that a system transformation process is a "self-organised economic evolution, which is at least partially open-loop and consequently cannot be predicted and designed perfectly" [2008, p. 105]. The stages of competitiveness, as described by Porter [1990a, 1990b], build the strengths of a country's economy based on its competitive advantages. These competitive advantages, based on a 12-pillar model, vary across the countries [Eriksson 2013, p. 2].

The transformation of the economy from one stage of competitiveness to the other can be interpreted within the context of a self-organised eco-

nomie evolution. Even within the uncertainty, which justifies the existence of the markets, economies can share similarities [Lehmann-Waffenschmidt 2008, p. 108], even though they may not be identical in case of innovation and competitiveness.

The research hypothesis of this paper is that the selected properties of economies based on GEM NES data can give an idea as to how similar economies are in terms of their structures which build their competitive advantages and their strengths in innovativeness. Understanding these structural similarities can be relevant for both investment decisions and policy recommendations to provide ground for well-functioning markets driven by innovation and technological progress.

Using the machine learning tools a dimension reduction with fewer variables giving a meaningful explanation to the classification of countries according to their competitiveness and innovativeness may be used for further analysis purposes as well. In a complementary paper written by the author it will be shown that GEM NES as a subjective data and the Index of Economic Freedom by the Heritage Foundation as an objective data show the same tendencies regarding innovation, economic freedom and entrepreneurship.

The rest of the paper is structured as follows: After a literature review of GEM the decision tree algorithm will be presented, which will be used for the analysis. The results will be presented and discussed. A conclusion follows with implications for future research.

1. Literature Review

Literature on Global Entrepreneurship Monitor consists of three main categories [Bosma 2012, p. 17]: Publications based on country-level information, publications of a special issue of the Small Business Management journal with different thematic focuses and publications focusing on policy effects and economic development.

An interesting aspect is Anokhin and Schulze's research using data from GEM, where the focus is on innovation and corruption. According to the authors domestic innovative activity is associated with the relation of corruption and foreign direct investments [Anokhin and Schulze 2009, p. 5]. Corruption can be controlled if innovation and entrepreneurship can grow, where the uncertainty and outcomes of corruption are working as discouraging factors on potential entrepreneurs to take initiatives [Anokhin and Schulze 2009, p. 2].

Koellinger [2008] asks why some entrepreneurs are more innovative than others in his empirical research with GEM data and finds out that innovativeness of entrepreneurs cannot be explained by individual factors alone. Furthermore the creation of new knowledge should be done by the members of society other than the entrepreneur himself [Koellinger 2008, p. 35]; the innovative and imitative entrepreneur types are seen as complementary figures and their importance for the economy is stressed.

Bjórnskov and Foss [2007] analyze how economic policies and institutions can be linked to entrepreneurial activities and economic freedom on a cross-country based empirical research. Their findings suggest that government size, monetary policy and financial environment are the key factors for the entrepreneurial activity [Bjórnskov and Foss 2007, p. 324]. The authors differentiate between necessity entrepreneurship (which is, in their findings, positively influenced by government spending) and opportunity entrepreneurship (based on their findings is negatively affected by government transfers) [Bjórnskov and Foss 2007, p. 324–325].

Using data from GEM, Wennekers and co-authors [Wennekers et al., 2005] test the hypothesis of a U-shaped relationship between entrepreneurial tendencies and economic development. They find that incentives for start-ups and the effective use of intellectual property legislation shall be the relevant policy implications to boost innovativeness [Wennekers et al., 2005, p. 21].

Lundström and Stevenson [2007] focus on entrepreneurial policies and identify that education, reducing entry and exit barriers as well as start-up support are important policy measures to promote entrepreneurship.

Coduras and Autio [2013] implement an empirical methodology using discriminant and regression analyses; their focus is on the comparison of the Global Entrepreneurship Monitor with the Global Competitiveness Index (GCI). The authors find that the GEM data can be seen as a complementary data source to the GCI [Coduras and Autio 2013, p. 71].

The literature review on GEM data shows that the research on GEM data is mainly empirical in nature; however, according to the author, machine learning tools were not used as a method to discover structural similarities of economies from the point of view of the experts interviewed. The identified findings on entrepreneurship and innovation are based on policy implications to improve entrepreneurial activities, decrease corruption and boost economic growth through these measures.

2. Methods

Machine learning as a discipline of artificial intelligence has different purposes such as the modelling of human processes, theories of adaptive algorithms and solving decision making and classification problems.

In this paper the following definition of a decision tree will be used: “A decision tree is a flowchart-like tree structure, where each internal node (non-leaf node) denotes a test of an attribute, each branch represents an outcome of the test and each leaf node (or terminal node) holds a class label” [Han and Kamber 2001, p. 330–331].

Generating a decision tree usually consists of two phases; tree construction and tree pruning; the latter can take place either by means of pre-pruning or post-pruning. Pre-pruning cuts the tree prior to the classification whereas post-pruning allows the classification of the data and prunes the tree afterwards. The general algorithm can be stated as follows:

Tree construction is based on a top-down recursive partitioning approach, i.e. the starting point is the top of the tree, which will grow by “splitting attributes one by one” [Rudin 2012, p. 1]; the splitting attribute will be determined based on the maximization of the homogeneity in groups. Leaf nodes will be assigned; the graphical representation of the tree will consist of a root node and terminal nodes. The top-down approach leads to an end, where the tree will be pruned in order to avoid overfitting [Rudin 2012, p. 1]. Generating a decision tree is based on the decisions of selecting a splitting criterion, selecting a stopping criterion and finding the best tree [Castillo 2012, p. 128].

In this paper the exhaustive chi-squared automatic interaction detection (CHAID) algorithm will be used [Biggs, De Ville and Suen 1991]. It is based on a chi-squared test for splitting. The predictor with the smallest adjusted p-value will be selected and compared to an α_{split} which needs to be specified at the beginning of the analysis: $p\text{-value} \leq \alpha_{\text{split}}$ would imply that the node will be split using that specific predictor; otherwise the node cannot be split and remains as a terminal node [Clementine 2006, p. 51].

The target variable was described as the GCI categorization of each economy based on the competitive advantages, for which the values 1 (“factor driven economy”), 2 (“efficiency driven economy”) and 3 (“innovation driven economy”) are assigned by the author. The exhaustive CHAID algorithm was used to predict the competitive advantages of countries according to the opinions of experts. All the 88 ordinal scaled variables of the GEM national experts’ survey were used as independent variables. The

decision tree is a result of iteratively building compound categories for each predictor variable.

This algorithm was chosen for the following reasons:

1. The exhaustive CHAID algorithm allows for ordinal categorical independent variables [Castillo 2012, p. 139]. This applies to the case here since all of the predictor variables are measured on Likert scales which are widely accepted as ordinal. The country classification can be accepted as a nominal categorical dependent since the categorization according to factor-driven, efficiency-driven and innovation-driven economies reflect the different strengths of countries and the aim is to find the variables that describe the corresponding stage of development, since “the impact of each pillar on competitiveness varies across countries, in the function of their stages of economic development” [Eriksson 2013, p. 2].
2. The exhaustive CHAID algorithm makes use of multiple splits and is better for an analysis of the three-categories dependent variable than, for example, the classification and regression trees algorithm which has binary splits.
3. Furthermore it searches for the split point which has the smallest adjusted p-value, which is an important feature with respect to the statistical significance of the results [Nisbet, Elder and Miner 2009, p. 247]. The exhaustive CHAID is an improvement upon the CHAID algorithm. It is an exhaustive search mechanism which tries to merge similar pairs until one single pair remains.

The maximum tree depth is set equal to 3 – this is a precaution to make sure that the tree does not go very deep. The significance level for the splitting nodes, (α_{split}) is given as 0,05; the maximum number of iterations is 100 with the minimum change in expected cell frequencies being equal to 0,001. The Bonferroni method will be used for the adjustment and the likelihood ratio test will be chosen as the chi-square statistic, which gives more robust results in comparison to the Pearson test [IBM SPSS Decision trees, 2011, p. 10].

3. Results and Discussion

3.1 Results

53 nations participated in the GEM NES 2010 survey, which are also present in IEF simultaneously. Since the analysis will provide grounds for a complementary paper focusing on IEF, only these 53 nations will be considered.

The target is to find out those variables which can classify the 53 economies correctly according to the Global Competitiveness Index classification. Table 1 gives the names of these nations and their classification according to the GCI.

Table 1. Countries of the dataset and their corresponding GCI classifications

Factor-driven	Efficiency-driven	Innovation-driven
Angola	South Africa	Israel
Ghana	Tunisia	Slovenia
Uganda	Argentina	Japan
Zambia	Brazil	South Korea
Egypt	Chile	Finland
Iran	Columbia	France
Pakistan	Costa Rica	Germany
Saudi Arabia	Ecuador	Greece
Jamaica	Mexico	Iceland
Guatemala	Peru	Ireland
Bolivia	Trinidad and Tobago	Italy
Vanuatu	Uruguay	Norway
	Bosnia and Herzegovina	Portugal
	Croatia	Spain
	Hungary	Sweden
	Latvia	Switzerland
	Macedonia	United Kingdom
	Montenegro	United States of America
	Russia	
	Turkey	
	China	
	Malaysia	
	Taiwan	

Source: Modified from [Kelley, Bosma and Amorós 2011, p. 8].

The distribution of 1972 interviewees across nations is usually made according to the principle of having 4 experts for nine different categories [Bosma et al. 2012, pp. 40–41]; however there are some exceptions. Some countries have less than 36 experts in the dataset, whereas others have more than 36 experts interviewed. 26,6% of 1946 experts were female, 73,4% were male. The interviews are usually conducted online, especially due to problems noticed during face-to-face interviews.

The professions of the experts are summarized in five categories. These categories are listed as entrepreneur (570), business and support service provider (479), educator-researcher-teacher (345), policy maker (275) and investor-financier-banker (194). Not only are the national teams required to hand in a list of experts to the GEM data team before the start of survey, around 35% of the sample should consist of entrepreneurs as well [Bosma 2012, p. 15].

Considering the missing values it becomes obvious that the vast majority of missing values are either of the “do not know” or the “does not apply” type. All data are examined regularly by GEM data monitoring teams if the number of missing values is acceptable for each case. Sometimes the data team even requests more interviews to balance the sample.

The exhaustive CHAID algorithm makes use of missing values. It treats all missing values as a single category, which may or may not get merged with other categories of each predictor variable [IBM SPSS 20 Decision Trees 2011, p. 104]. The resulting decision tree is presented in Figure 1.

The result is a classification tree with 34 nodes (of which 21 are terminal). The degree of IPR legislation being efficiently enforced is the strongest independent variable on the categorization of a nation according to Porter’s classification. The exhaustive CHAID analysis recorded the participation of the interviewees on this question by means of four nodes reflecting four homogenous groups.

According to the exhaustive CHAID analysis entrepreneurship being a desirable career choice is more common for efficiency driven economies. Quick access to utilities (such as water, gas, sewer or electricity) is more common for innovation driven economies and less common for efficiency driven economies and factor driven economies, whereas sufficient debt funding for new and growing firms is more common for factor driven economies and efficiency driven economies.

From the analysis it is clear that there is a gap between opportunities and effective entrepreneurial support with respect to the factor driven economies: Science parks and business incubators are not present or they do not provide effective support for new and growing firms; however, there are more good opportunities to create new firms than there are people able to perceive and make use of these opportunities. For the latter the evidence was mixed for efficiency-driven economies; experts from innovation-driven economies rejected the latter argument.

The existence of many good opportunities to create truly high growth firms led to two groups; in the “accepting” group, there were mainly experts

from the factor driven and efficiency driven economies, whereas in the “rejecting” group, the tendency was more towards innovation driven economies. According to the experts of efficiency driven economies, good opportunities for new firms have increased in the past five years; at the same time the perceived gender equality is clearer in efficiency driven economies than in the other two groups.

Whether subcontractors, suppliers and consultants were used during the business creation process led to mixed evidence with an almost equal number of efficiency-driven and factor driven economies in the groups completely rejecting it and being either neutral or accepting it to be true respectively. There were many innovation-driven economies in the rejecting group.

One of the twelve pillars of competitiveness in GCI is the effectiveness of institutions, which is a key factor for factor-driven economies, the opinion of experts show the ineffectiveness of governmental assistance in this group. Whether government assistance for new and growing firms can be obtained through a single institution led to three groups, where the experts of factor driven economies mainly answered this question with “completely false”. Amongst those experts who answered this question with “completely false”, the question about the effectiveness of government programmes to support new and growing firms also led to a subdivision of experts from factor-driven economies completely rejecting this statement, whereas the experts from efficiency-driven economies could not completely reject it. With respect to the role of university education for start ups and growing new firms it could be observed that experts from innovation-driven countries mainly rejected this statement.

There is an estimate of 0,440 and a standard error of 0,011. If the countries were to classify using this exhaustive CHAID analysis, an overall correct classification rate of 56% would be reached which is widely acceptable. Based on the results described above, it can be seen that even though there are structural similarities there is also heterogeneity amongst members of the same classification category.

3.2. Discussion

The question in the survey which can give the most important explanation to the distinction of countries according to their competitiveness and development stage is on the efficient enforcement of the intellectual property rights legislation. This can be seen as a notion in line with Adam Smith's point of view whose argument was that a well functioning mechanism of

law and institutions can guarantee a good environment to be economically active as an individual, through which the prosperity of a nation will increase.

In the diagram programme

According to McCreadie's interpretation of Smith a business is highly profitable either because of the lack of competition or because there is a trade secret which gives the entrepreneur an advantage [McCreadie, 2009, p. 27]. It can be seen that factor-driven economies have competitive advantages in the production of simple products and the competition is based on price. Entrepreneurs use either cheap raw materials or cheap labour for their advantage [Porter 1990b, p. 79] where technology does not play a key role.

Technology's role changes when the country's competitive advantage is based on investments or efficiency – in that case, countries not only accumulate and imitate foreign technologies from more developed and innovative economies but they also try to improve upon these technologies. An innovation-driven economy has technology as one of its most important elements; new and differentiated products are invented, which increases competition. In order to secure the profitability of a differentiated product the entrepreneur needs a guarantee of the protection of his intellectual property.

The experts who believe that the intellectual property rights legislation is not effectively enforced in their countries also say that the availability of government assistance for new and growing firms through contact with a single agency is not possible. Furthermore the experts who believe that both factors are completely false for their country also reject the idea that government programmes targeting new and growing firms are effective.

Clearly this situation is the case of most factor-driven economies and some efficiency driven economies. The situation can be linked to the key factor "institutions" as one of the twelve pillars of competition and which is a basic requirement for factor-driven economies. An institutional framework is one of the important things the governmental structure has to establish and preserve in order for the economy to be successful. Of course being in the stage of a factor-driven economy may be "too early" for an effective enforcement of intellectual property rights legislation, even if there is one, since the technological structure of the economy in this early stage is either based on importing the technologies from more innovative countries or by imitating them. However even if there are some inventions both

corruption and bureaucracy can be factors which may endanger the enforcement process. Anokhin and Schulze [2009] demonstrate the result that through more innovation corruption can be taken under control.

In the literature there is an ongoing debate as to whether intellectual property rights have a positive effect on economic growth in developing countries; the empirical evidence is mixed [Adams 2004 p. 4–6]. This can also be seen for the cases of both government assistance through a single agency and government programmes targeting new and growing firms. The first case is more focused on the bureaucratic costs.

In some cases innovation-driven European economies have more bureaucratic processes than less innovative economies. For example, S. Djankov, R. La Porta, F. Lopez-de-Silanes and A. Shleifer [2002] focused on the regulation of entry for start up firms in an empirical research on 85 countries. They compare the time and costs of beginning to operate a firm legally in New Zealand and in France; whereas in New Zealand this process takes place in three days, in France it takes 53 days [Djankov et al. 2002, p. 12]. Furthermore their findings suggest that “heavier regulation of entry is generally associated with greater corruption and a larger unofficial economy, but not with a better quality of private or public goods.” [Djankov et al. 2002, p. 37].

In the second case the relevant question is not about the existence of the programmes but rather on their effectiveness. Both corruption and bureaucracy can be possible impediments where the distinction between factor-driven and efficiency-driven economies can be a distinguishing feature of a well-functioning institutional framework. Another possible impediment may be the ineffectiveness of the government programmes to reach new and growing firms, or to address their needs.

For the experts who say that the effective enforcement of the intellectual property rights legislation in their countries is somewhat false, the effective support of science parks and business incubators for new and growing firms was considered important. The experts who believe that both factors are either completely false or somewhat false for their country believe that the opportunities exist for creating high growth firms and there are more opportunities for new firms than people who can perceive these opportunities. Obviously the situation described is typical for factor-driven economies. Also for factor-driven economies the existence of opportunities to create high growth firms is “somewhat true”.

For efficiency-driven economies, the case of science parks and business incubators is “somewhat false”, hence, emphasizing the issue of the

transformation from being importers of new technologies to being both importers and developers of these. Although science parks, places where universities, industry and governments contribute to develop projects, are more common for innovation-driven economies, business incubators may be more typical for efficiency-driven economies. This can be explained with the two pillars “higher education and training” and “technological readiness” as two key factors for the efficiency-driven economies – at this stage, business incubators dedicated to the creation of new firms can have a coordination and support role.

Innovation-driven economies, on the other hand, are characterized by the fact that the opportunities are not more than the number of people who can perceive and take advantage of them; this may be interpreted as a reference to the key factors “business sophistication” and “innovation” of the innovation-driven economies. For innovation-driven economies the emphasis is more on business sophistication than on the creation of high growth firms; this stage is characterized by firms developing global strategies and replacing hierarchical structures through dividing the power amongst their sub-units.

For the experts describing the effective enforcement of the intellectual property rights legislation in their countries as “somewhat false” and being neutral on the effective support of science parks and business incubators, costs for new and growing firms to use subcontractors, suppliers and consultants was determined as an important question. The experts who believe that the first factor is somewhat false and the second factor is indecisive for their country also believe that new and growing firms cannot afford the costs of using subcontractors, suppliers and consultants.

The question was clearly rejected by the vast majority of experts from innovation-driven economies. The reason may be the blocked entry to the market by new firms caused by larger firms with global strategies. Competition is bigger, structures to support firms are more established than other stages of economic growth and due to the key factor of business sophistication, the competition is based on differentiated products – in order to enter a market, a new or a growing firm first has to “invent” a good which really differs in its properties from the other goods of the same market. An example is the increasing number of smart phone apps which discover and exploit market gaps, such as Uber from the USA.

Of course this notion is more dependent on research and development costs than in the case of a new firm in a factor-driven economy, which focuses on the production of a “simple” good with “known” technology and

competes with the others on the basis of the price; intellectual property rights do not play a role and firms imitate each other's technologies (or the technologies of more innovative economies).

The situation may be "neutral" in the case of efficiency-driven and factor-driven economies due to a number of reasons. First of all, based on the survey, it is not clear whether business incubators or science parks exist in such economies. Second, even if they exist, new and growing firms cannot afford them, not because of the established structures as in the case of innovation-driven economies, but (most probably) due to lack of capital to invest. Hence efficiency-driven economies are characterized by foreign direct investments. In the initial Porter model this stage of development was described as investment-driven; therefore the establishment and success of firms depend on foreign capital inflows. Third, it may be unclear to the experts whether the support of these structures are effective due to other reasons, since in the factor-driven and efficiency-driven stages of economic development, key factors other than the effects of science parks may determine the success of a firm, e.g. macroeconomic instability or lack of qualified labour.

The experts who believe that the effective enforcement of the intellectual property rights legislation in their country is somewhat false and the support of science parks and business incubators is effective for new and growing firms. The issue of gender equality was determined as an important question. The experts who believe that the first factor is somewhat false and the second factor is somewhat true or true for their country believe that men and women get equal opportunities to start a new business. This was more typical of efficiency-driven economies. This can be related to "higher education and training" as a key factor to the efficiency-driven economies. It may be the case that potential women entrepreneurs get vocational education and support programmes through non-governmental organizations or public institutions in order to equalize their chances. Another example would be to give microcredit to women in order to encourage them to be entrepreneurs. Although this may be perceived as women having better chances than men to start a new business in an innovation driven economy it may be seen as the equalization of chances in an efficiency-driven economy, if the women usually do not work.

For the experts describing the effective enforcement of the intellectual property rights legislation in their countries as "neither true nor false", good opportunities for new firms in the past five years was considered as an important variable. For the experts from innovation-driven economies,

the existence of these opportunities could not be observed. In innovation-driven economies the focus is more on diversified, sophisticated products which need more effort and more knowledge than big competitors which act globally with the absence of hierarchical structures. For the experts from efficiency driven and some factor driven economies this statement was accepted. Those experts who evaluated the first statement as “neither true nor false” and the second statement as “somewhat true”, good and adequate preparation for starting and growing firms by universities and colleges was considered as an important variable; the tendency to be neutral was more common for efficiency driven and some factor driven economies also in this case.

Finally there are some experts, especially from innovation-driven economies, who accept the statement on the effectiveness of the legislation of intellectual property rights. Some experts from efficiency driven and factor driven economies seem to agree with this statement. This also reflects the subjective character of the survey and by extension, possibly, different perceptions of the issue of intellectual property rights.

For the case of the agreement on the statement, the question of entrepreneurship as a desirable career choice was considered important. The experts who agreed on the effectiveness of the intellectual property rights legislation and people’s consideration of entrepreneurship as a desirable career choice were mainly from efficiency-driven economies. Similar to the interpretations above the consideration can be based on the chances for new firms as well as for the “market openness”, which is a key factor to the efficiency-driven economies also for this case.

Market openness considers, amongst other things, also the readiness of consumers to buy new products, or to buy “usual” products from new firms. Clearly economists from efficiency-driven countries see bigger opportunities for potential entrepreneurs in these economies than in other stages of economic growth. It may be more common for innovation-driven economies to have entrepreneurs who are scientists or engineers, or entrepreneurs who can commercialize the ideas of scientists and engineers with their firms. For the experts from innovation-driven economies it may be more common to reject the statement that many people consider being an entrepreneur as a desirable career choice because of different entrepreneurial structures; it may even be the case that many people consider being a scientist and engineer working for industry as a desirable career choice. This consideration is not reflected in the survey.

The experts who agreed on both statements also agreed on the fact that there is sufficient debt funding available for new and growing firms. Clearly the agreement on all three statements simultaneously reflects the situation on factor-driven and efficiency-driven economies. Debt funding generally involves a firm getting a loan from a bank or a financial institution without giving a part of the company to that institution [NFIB, 2009, p. 1]. This can be associated to the pillar of “financial market development” which is a key factor of efficiency-driven economies.

For the experts who agreed on the statement of the effectiveness of intellectual property rights legislation but rejected the statement that many people consider being an entrepreneur as a desirable career choice, the variable “In my country, new or growing firms can get good access to utilities (gas, water, electricity, sewer) in about a month” was considered. The experts who considered this statement as “completely true” were mainly from innovation-driven economies. Clearly the conditions of economic activity are different across nations. This may have different explanations; it may be because of bureaucratic processes, because of states/cities not having enough money to provide these services quickly, or because of corruption, or a combination of some of these factors.

Of course throughout these interpretations one aspect has to be clear: These are the subjective opinions of the experts. Although almost all nations fulfil the criterion on having at least four experts from nine different categories. These experts are only specified on small aspects which together constitute the bigger picture.

Conclusions

According to the decision tree analysis the most important structural similarity amongst innovation-driven economies is the role of intellectual property legislation, a very sound infrastructure and a well functioning bureaucracy – however, at the same time, the non-affordability of science parks and business incubators for newly founded firms is also important.

The most heterogeneous group of economies amongst the three categories appears to be the efficiency-driven economies; however structural similarities are entrepreneurship as a desirable career choice, perceived gender equality in business life, the ineffectiveness of intellectual property legislation and government assistance to newly established firms.

In factor-driven economies, it is expected that there are more opportunities to create a new business than people who perceive them. Sufficient

debt funding for new and growing firms is available. However governmental support lacks in factor-driven economies.

Based on the theoretical model it can be said that the stage of competitiveness can be associated with the effectiveness of governmental institutions, intellectual property legislation, gender equality, quick access to utilities and the discovery of opportunities by young entrepreneurs to establish new firms.

These structural similarities need to be analyzed in detail, especially according to the objective economic data, since the GEM NES survey has a subjective character. For future research the association of economic freedom and the stage of economic development need to be analyzed in detail. To fulfil this a complementary paper by the author focuses on the question as to whether the objective data from IEF and the subjective data from the GEM NES survey give the same tendencies in questions of entrepreneurship, economic freedom and innovation.

Through the given variables and the given decision tree, 56% of the cases could be classified correctly. The exhaustive CHAID analysis goes beyond Porter's model to classify countries according to their sources of competitiveness and innovativeness but also identifies their structural problems and opportunities for entrepreneurship.

References

- Adams, S., 2004, *Intellectual Property Rights, Innovation and Economic Growth in Sub-Saharan Africa*, ECPR Standing Group on Regulatory Governance, Third Biennial Conference, <http://regulation.upf.edu/dublin-10-papers/2G3.pdf> [access: 15.12.2015].
- Anokhin, S., Schulze, W.S., 2009, *Entrepreneurship, Innovation and Corruption*, Journal of Business Venturing, vol. 24 (5), pp. 465–476.
- Biggs, D., De Ville, B., Suen, E., 1991, *A Method of Choosing Multi-way Partitions for Classification and Decision Trees*, Journal of Applied Statistics, vol. 18(1), pp. 49–62.
- Bjórnskov, C., Foss, N.J., 2007, *Economic Freedom and Entrepreneurial Activity: Some Cross-country Evidence*, Journal of Public Choice 2008, vol. 134, pp. 307–328.
- Bosma, N., 2012, *The Global Entrepreneurship Monitor (GEM) and Its Impact on Entrepreneurship Research*, Global Entrepreneurship Monitor working paper series, vol. 12(1).

- Bosma, N., Coduras, A., Litovsky, Y., Seaman, J., 2012, *GEM Manual: A Report on the Design, Data and Quality Control of the Global Entrepreneurship Monitor*, Babson College, Universidad del Desarrollo, Universiti Tun Abdul Razak.
- Castillo, M.d.L.G., 2012, *Modelling Patient Length of Stay in Public Hospitals in Mexico*, University of Southampton.
- Clementine, 2006, *SPSS Clementine Algorithms Guide*, Integral Solutions Limited.
- Coduras, A., Autio, E., 2013, *Comparing subjective and objective indicators to describe the national entrepreneurial context: the Global Entrepreneurship Monitor and the Global Competitiveness Index contributions*, Investigaciones Regionales, vol. 26, pp. 47–74.
- Djankov, S., La Porta, R., Lopez-de-Silanes, F., Shleifer, A., 2002, *The Regulation of Entry*, The Quarterly Journal of Economics, CXVII (1), pp. 1–37.
- Eriksson, J., 2013, *Global Competitiveness and Innovation*, <http://blog.bearing-consulting.com/2013/10/13/global-competitiveness-and-innovation/> [access: 15.12.2015].
- Global Entrepreneurship Research Association, 2010, National Experts Survey Global National Level Data, <http://www.gemconsortium.org/docs/3134/gem-2010-nes-global-national-level-data> [access: 10.12.2015].
- Global Entrepreneurship Research Association, 2010, National Experts Survey Global Individual Level Data, <http://www.gemconsortium.org/docs/3135/gem-2010-nes-global-individual-level-data> [access: 10.12.2015].
- Han, J., Kamber, M., 2001, *Data Mining: Concepts and Techniques*, Elsevier Ltd., Oxford.
- Hayek, F.A., 1968, *Competition as a Discovery Procedure*, English translation by Marcellus S. Snow, Quarterly Journal of Austrian Economics, vol. 5(3), Falls 2002, pp. 9–23.
- IBM, 2011, *IBM SPSS Decision Trees 20*.
- Kelley, D.J., Bosma, N.; Amorós, J.E., 2011, *Global Entrepreneurship Monitor. 2010 Executive Report*, Babson College, Universidad del Desarrollo.
- Koellinger, P., 2008, *Why are Some Entrepreneurs More Innovative than Others?* Small Business Economics, vol. 31(1), pp. 21–37.
- Lehmann-Waffenschmidt, M., 2008, *Strukturähnlichkeiten und- ungleichheiten evolvierender Ökonomien*, Wissenschaftliche Zeitschrift der Technischen Universität Dresden, Vol. 57(3–4), pp. 105–109.
- Lundström, A., Stevenson, L., 2007, *Dressing the Emperor: the Fabric of Entrepreneurship Policy*, in: Grilo, I.D., Thurik, A.R. (eds.), *Handbook of Research on Entrepreneurship Policy*, Cheltenham, UK and Northampton, MA, US, Edward Elgar Publishing Limited.
- McCreadie, K., 2009, *Adam Smith's the Wealth of Nations: A Modern Day Interpretation of an Economic Classic*, Infinite Ideas Limited.
- NFIB, National Federation of Independent Business, 2009, *Debt vs. Equity Financing: Which is the best way for your business to access capital?*, <http://www.nfib.com/article/ital-50036/> [access: 6.12.2015].

-
- Nisbet, R., Elder IV, J., Miner, G., 2009, *Handbook of Statistical Analysis and Data Mining Applications*, Academic Press.
- Porter, M.E., 1990a, *The Competitive Advantage of Nations*, Free Press, New York.
- Porter, M.E., 1990b, *The Competitive Advantage of Nations*, Harvard Business Review, vol. 68(2), pp. 73–93.
- Rudin, C., 2012, *Decision Trees MIT 15.097 Course Notes*, http://ocw.mit.edu/courses/sloan-school-of-management/15-097-prediction-machine-learning-and-statistics-spring-2012/lecture-notes/MIT15_097S12_lec08.pdf [access: 29.01.2016].
- Wennekers, S., Thurik, R., 1999, *Linking Entrepreneurship and Economic Growth*, Small Business Economics, vol. 13, pp. 27–55.
- Wennekers, S., van Stel, A., Thurik, R., Reynolds, P., 2005, *Nascent Entrepreneurship and the Level of Economic Development*, Small Business Economics, vol. 24(3).