Charles University

Faculty of Social Sciences
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MASTER'S THESIS

Alternative approach to measuring development progress of countries.

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Declaration of Authorship

The author hereby declares that he compiled this thesis independently; using only the listed resources and literature, and the thesis has not been used to obtain a different or the same degree.

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Prague, July 31, 2017

Signature

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Abstract

This thesis studies the relationship between GDP and Social Progress Index, components of social progress model and their dimensions. Using the dataset of 49 countries and Bayesian Model Averaging (BMA) and clustering analysis we found that there is not straight relationship between GDP and SPI. By testing 15 different models for each of 3 dimension (Basic Human Needs, Foundations of Wellbeing and Opportunity) of SPI we have found that the best variation of components would be to include all of them for each dimension. By uasing BMA approach we have found that the best model of SPI out of 12 components includes only intercept, tolerance and inclusion variabels. The rest of components show quite low probability of inclusion, however, none of them showed 0 posterior probability.

JEL Classification	A13, C11, E01, I30,
Keywords	kuznets, progress, SPI, GDP, BMA

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Acronyms

SPI Social Progress Index

GDP Gross Domestic Product

BHW Basic Human Needs

FoW Foundations of Wellbeing

BMA Bayesian Model Averaging

BIC Bayesian information criterion

AIC Akaike's information criterion

RSS Sum of squares of residuals

SSE Sum of squared error

Master's Thesis Proposal

Author:	Bc. Valeria Efimenko
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Defense Planned:	September 2017

Proposed Topic:

Alternative approach to measuring development progress of countries

Motivtion:

It is obvious that GDP is defective. It does not take into account the environment. It considers prisons and bombs as development but it has nothing in common with justice, happiness, fairness and community. Not surprisingly, that our world concentrating on how to produce more and more GDP, forgot that it is waving on the edge of ecological problems and overload with conflicts and anger.

A better approach should be considered to measure society, which would judge real things that matter to real population. Am I able to write and read? Do I have enough food? Do I have shelter? Am I safe? Can my society discriminate me? Is the future of my children protected? There no answers GDP could provide for all of those questions, because it simply cannot. Social Progress Index might be a better measure of the wellbeing of population and it does not depend on GDP. It is a new method by how we can look at the world.

Hypotheses:

1. Hypothesis #1: Countries with higher Social Progress Index do not need to have high GDP rate.
2. Hypothesis #2:Each of 3 dimensions of SPI consist of 4 different components.
3. Hypothesis #3: The best model for describing social progress depends on 12 components.

Methodology:

I will use K-means clustering analysis to make to group countries. This approach assumes a big variety of data models in order to identify the most likely number of clusters and the model using Bayes criteria and maximum likelihood estimation. The optimal model is selected according to Bayesian's information criterion.

Akaike's information criterion is a measure of the goodness of fit of an estimated statistical model The AIC is an operational way of trading off the complexity of an estimated model against how well the model fits the data.

Bayesian Model averaging can provide a very big help in a field of economic growth, which developed a big number of competing theories. Fernandez, Ley and Steel in their work "Model uncertainty in cross-country growth regressions" (Fernandez, Ley and Steel (2001)) considered an extremely large set of possible models with 41 regressors. They had 2^{41}models to deal with.

The dataset of Social Price Index will be used. Instead of accentuating regular estimations of progress like income and investment, there are 50 indicators of ecological and social outcomes, which design a clearer picture of what life is truly like for ordinary people.

I will use 49 countries for investigation. All of the countries account for all continents, excluding Antarctica. There are 30 European countries, 3 African, 2 Oceanian countries, 3 South American, 3 North American and 8 Asian. This dataset present all types of countries – developed, developing and economies is transition.

Expected Contribution:

With an empirical results I will make a conclusion about goodness of fit of the Social Progress model. I will run some analysis regarding comparison of countries with similar GDPs per capita and will make a conclusion about GDP and SPI index.

Outline:

1. Motivation: Economic growth alone is not sufficient for measuring social progress. A community, which neglects to meet basic human needs, to protect nature and environment, to provide opportunities to get basic knowledge, discriminate people and forget about existence of personal rights is not succeeding. Development and growth must involve not only economic progress but also must include social progress.
2. Studies on social progress: I will briefly describe determinants of social progress and will compare it to GDP.
3. Data:I will use data from social progress index for 49 different countries.
4. Methods: I will explain Bayesian model averaging,will include K-means clustering and BIC analysis.
5. Results: I will discuss my main results and findings
6. Concluding remarks: I will summarize my findings and their implications for policy and future research.

Core Bibliography:

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Author **Supervisor**

1 Introduction

Economic growth over the last 50 years have improved lives of millions of people and dragged them out of poverty. However, there is still a lot of evidence about model of development constructed exclusively on economic progress being incomplete and some parts are missing. Economic growth alone is not sufficient. A community, which neglects to meet basic human needs, to protect nature and environment, to provide opportunities to get basic knowledge, discriminate people and forget about existence of personal rights is not succeeding. We must broaden our comprehension about being successful society beyond economic outcomes. Development and growth must involve not only economic progress but also must include social progress.

A wider framework is required to make the model of development more inclusive. We should proceed further in order to build social and environmental integral for measuring national performance and move away from simple Gross Domestic Product measurement. Measuring social performance more precisely will empower better policies, better decisions and better investments. Measuring social progress will lead us into converting economic gains to social progress. Social performance will be advanced in ways that will lead to greater economic performance. Social Progress Index is inclusive way to measure social progress and it is not a substitute of GDP, but it is a complement. With SPI a performance of any country can be measured and those measures are not relative and abstract.

Social Progress is a task that must be pursued but different countries move in their own way, at different rates in order to achieve this result and the outcome of result is different. Some countries have been adble to advance more, other less, while others even degrade having conflits and wars.

How to evaluate the state of society in terms of cosial progress, how to measure it? Last century, in the early 30's, American economist Simon Kuznets proposed using gross domestic product (GDP) as a solution for monitoring the state of the economy. This indicator has been recognized and has been used as an instrument for measuiring

national accounts around the world. It was eventually seen as an indicator for measuring welfare of society, although Simon Kuznets stated that GDP measures only economic activity but not welfare. Therefore, researchers seek to go beyond the GDP indicator and try to measure social progress as such. Richard Estes made one of the first attempts in the 1970s. Social Progress Index (SPI) developed under his leadership included, in addition to the GDP index, several more indicators (education, health, demography, political stability, etc.).

Financial and economic crisis of 2008-2009 actualized the discussion about necessity to change the dominant model of social and economic development in the world. At that time analytical research "The Social Progress Imperative" was of special interes. Within this project, a new Social Progress Index was developed, the first version was published in 2014 and the second in 2015. The authors set themselves an ambitious task: to create such a measurement tool that would allow to give an adequate idea of social progress for individual countries and in the world as a whole, and not distorted by any circumstances.

The initial message of the research was the understanding that a development model based only on data on economic growth is at least incomplete. The specificity of this research was to evaluate social development without any indicator of economic development. This approach makes it possible not only to present social progress in a "pure" form but also to reveal the correlation between the parameters of social progress and GDP, which allows us to understand the role of social progress as a driver of economic growth and helps to determine the optimal development strategy.

There are three hypothsesis will be tested in this work. The first hypothesis (H1) states that countries with higher Social Progress Index do not need to have high GDP rate. Comparison of countries with similar GDPs per capita level might show that they could have different level of social progres. A rich and developed country might preform very well on social progress but shows a lower level in comparison to other countries with similar income. On the other hand, a poor and developing country might perform very poor on social progress but shows very high level in comparison to countries with the same resource constraints. Even at high level of GDP there is significant variety of social progress among different countries.

There are a lot of striking examples where countries with considerably low GDP ranked very high with Social Progress Index. Take Costa Rica with low GDP ($ 14,232) and Russia with considerably high GDP ($ 23,293). Costa Rica ranked 28th in the rating of SPI and Russia ranked only 71st. Another striking example is the United States. The richest world power, whose leaders consider it a "model" for the peoples of other countries, took only 16th place in the rating of the SPI in 2015. According to Social Progress Index the United States ranks 30th on life expectancy, child survival on 38 place and 55 on maternal survival. There is high level of murders, USA rate for road fatality is above 37 other countries, and the suicide rate is higher than in 80 other countries. The US is 38th on the exponent of equality in the educational system and on 87th place for using cell phones. Higher GDP level not always means high Social Progress Index.

For the second hypothesis all of three dimensions of Social Progress Index will be tested saperately. (H2) 1.Basic Human Needs dimension of Social Progress Index depends on 4 components: nutrition and basic medical care, water and sanitation, shelter, personal safety. 2. Foundations of Wellbeing dimension of Social Progress Index depends on 4 components: access to basic knowledge, access to information and communications, health and wellness, environmental quality. 3.Opportunity dimension of Social Progress Index consists of 4 components: personal rights, personal freedom and choice, tolerance and inclusion, access to advanced education. There will be 15 models tested for each dimension.

The first dimension, Basic Human needs, measures how well country provides essential needs for its population. It assesses basic medical care, access to nutrition, availability of safe drinking water, accessibility of adequate housing with basic utilities, and if society is safe and secure. The second dimension, Foundation of Wellbeing, measures an access to basic education for citizens, information and knowledge from inside and outside of a country, if there are conditions for living healthy life. Environmental quality evaluates a country's protection of land, air, and water. The third dimension, Opportunity, measures whether people have personal rights and freedoms, whether they are allowed to make their own decisions, and access to advanced education to those who want to wide their knowledge and skills.

The necessity of inclusion each component for each dimension will be tested for three dimensions.

The third hypothesis will test full model of Social Progress Index with 12 variables. (H3) The best model for describing social progress depends on 12 components: nutrition and basic medical care, water and sanitation, shelter, personal safety, access to basic knowledge, access to information and communications, health and wellness, environmental quality, personal rights, personal freedom and choice, tolerance and inclusion, access to advanced education. What are the most significant variables and what are the varibles that can be excluded from the model – all of these questions will be solved with Bayesian model averaging approach.

This thesis has following structure. Chapter 1 introduces the thesis. Chapter 2 presents the literature review of Social Progress Index. First part of Chapter 3 includes the description of the data used in the empirical analysis. In the second part there is explanation of methodology. In Chapter 4 the results of empirical analysis are included and interpreted. In Chapter 5 all the main ideas are summarized and discussed.

2 Literature review

The report, named "National Income, 1929 – 1932" was submitted on the 4th of January, 1934 to the Congress of United States by a very young man. The name of this man was Simon Kuznets. He was not a politician, he was not a financial expert, and he was not a businessman. His major was economics and his report influences the lives of everybody on this planet until nowadays. This report provides a basic principle of judging any countries' success – Gross Domestic Product. GDP has defined as monetary value of final goods and services of a country over given period of time and it navigates our lives during last 80 years.

There was the time of Great Depression and time of crisis when Kuznets submitted his report. Policymakers did not leave any comments and didn't know how to react and what to say about this report. The reason was that they did not know what was happening and there was no statistics or data on which they could rely on. The report contained the data about production of United States yearly. With the help of this information, policymakers discovered a way to exit from the collapse. Nowadays, every country collects information about goods and secrecies in order to produce GDP statistics. Kuznet's report was very useful back in 30th and spread around the globe, even until now.

However, in that initial report, Kuznets left a warning message himself. According to author: "The welfare of a nation can, therefore, scarcely be inferred from a measurement of national income as defined above" *(Kuznets (1934), p 7)*. It is not the best sentences an economist can pronouns but his message was understandable: GDP is a way of measuring economic performance but not the measure of our prosperity and it should not be an instruction to all decision making.

Our nations have ignored Kuznet's message. We live on the planet where GDP is the most important variable in order to determine success in a worldwide economy. Our governments boast when GDP grows. Billions of dollars of capital move around the world with markets move. Based on that, countries go down and up and everything is measured in GDP. Our population has become machines to produce more GDP.

It is obvious that GDP is defective. It does not take into account the environment. It considers prisons and bombs as development but it has nothing in common with justice, happiness, fairness and community. Not surprisingly, that our world concentrating on how to produce more and more GDP, forgot that it is waving on the edge of ecological problems and overload with conflicts and anger.

A better approach should be considered to measure society, which would judge real things that matter to real population. (*Porter M.E., Stern S., Green M.,2015)* Am I able to write and read? Do I have enough food? Do I have shelter? Am I safe? Can my society discriminate me? Is the future of my children protected? There no answers GDP could provide for all of those questions, because it simply cannot. Today there is enough information for analyzing the data, which would have been impossible for Kuznets.

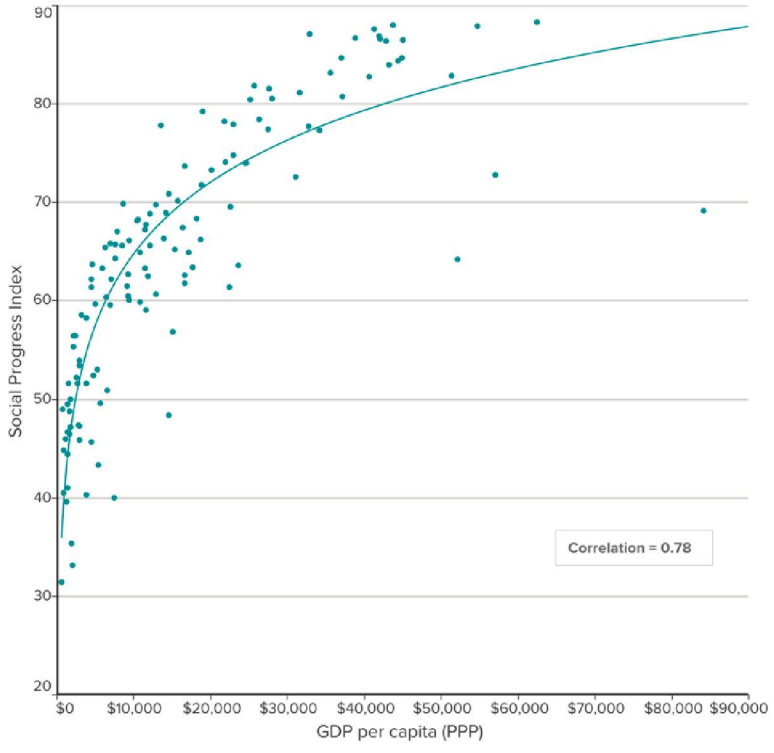
Social Progress Index might be a better measure of the wellbeing of population and it does not depend on GDP. It is a new method by how we can look at the world. SPI starts by identifying what does it mean to be a good society based on 3 dimensions. The first dimension answers the question about having simple needs for survival: shelter, food, safety and water. The second dimension provides information about environment, education and health. The third dimension collects information about each individual having opportunity to achieve his or her goals, about having freedom from discrimination, freedom of choice and freedom to get new knowledge. All in all, there are 12 indicators to measure Social Progress Index and each of the indicators reflects the real level of achievement, not an effort. Expenditure on healthcare and passing law against discrimination are out of interest for SPI, rather, it would consider the quality and length of people's lives and if people feel discriminated.

2.1 Social Progress Index and Gini coefficient

There is a positive correlation between GDP per capita and Social Progress Index *(Veneta Andonova,Mauricio Losaro-Otalora, 2017)* and there is a tendency of getting wider as GDP increases. This trend could be seen from the picture, where change in Social Progress is higher when GDP crosses the level of $10,000 per capita. There is no longer linear relationship between GDP and SPI and it is obvious that this

relationship is complex. The data clearly show that the economic development cannot fully explain social progress alone.(*Porter M.E., Stern S., Green M.,2015)*

In low-income countries, small differences in GDP levels are associated with significant differences in social development. As countries reach higher levels of income, the opportunities of further social progress end, while economic growth brings new social and environmental problems. Countries can have similar level of social development but the level of GDP per capita will vary significantly.



Source: Porter M.E., Stern S., Green M. Social progress index 2015.

2.2 Social Progress Index and Gini Coefficient and political importance

The problem of inequality in terms of social progress is investigated by authors of the study (*Porter M.E., Stern S., Green M,2015*), but somehow casually and formally. A comparison of SPI and the Gini coefficient leads them to the following conclusions. Countries with the highest SPI have the lowest Gini coefficient, that is, they are the countries with the lowest income inequality. The same comparison for all countries reveals a generally negative correlation between SPI and Gini coefficient, but a very

weak one. There is a weakly expressed trend of reducing social progress as inequality grows.

If we take the US benchmark with their rather high level of inequality, we can name countries where the inequality is less and the lag of social progress relative to the GDP is more; and developing countries, where inequality is greater but they outstrip their GDP but the indicator of social progress. This suggests that the relationship between social progress and income inequality depends on the level of development of the country: the higher the level of development - the relationship is weaker, the lower – the relationship is stronger. (*Porter M.E., Stern S., Green M,2015*) According to researches, if the indicator of GDP is removed, then a statistically significant relationship between inequality and social progress is not recognized.

We have to keep in mind that Gini coefficients has its own disadvantages such as the source of income is not taken into account and all the assets are not always included (e.g. real estate). *(Verber A.,2013. No.1.)* Its direct comparison with SPI leaves aside the influence of super-richness, the probability of greater social progress with greater equality. Super-wealth is the possibility of influencing privileged groups of society on the decisions of the power institutions concerning the allocation of budgetary funds; this is counteracting the increase in social spending in the interests of the majority. Therefore, we could see the relationship and an extreme inequality is negatively correlated with indicators of social progress.

This circumstance becomes especially obvious if we turn to the phenomenon of poverty. Social progress takes into account the alleviation and overcoming of poverty, but it also limits its possibilities. The authors acknowledge the impact of poverty as a brake on social progress. When moving to countries with a large SPI, the percentage of people living in extreme poverty decreases. Poverty is negatively and significantly correlated with social progress - comparison gives a statistically significant result that is valid for all three basic measurements of the Index.

Why is the low level of social progress associated with extreme poverty? In many cases this is due to a fatal lack of resources. But the extremely low SPI indicators are explained not only by poverty. Countries with low per capita income show a wide range of differences in the level of social progress and poverty. The point, therefore,

is how much the citizens of this or that country are able to participate actively in economic life (what is called inclusion, involvement). And this depends on the availability and accessibility of basic social opportunities - elementary medical services, at least primary education, protection of property rights, personal safety, etc.

Social progress index has a great political importance politically. The problems of social development, although depends on a history and objective state of things, largely rely on politics, especially in the choice of development strategies and priorities.

Why Costa Rica with its low GDP ($ 14,232) ranked 28th in the rating of SPI? (*Social Progress imperative 2016)* Likely because in Costa Rica in the XIX century there was introduced primary education in schools. The new Constitution, adopted in 1949, banned the creation and maintenance of a regular army in peacetime. The freed resources were used for the development of education.

Why did Russia with a much larger per capita GDP of $ 23,293 took only 71st place, losing not only to Costa Rica, but many other countries with much lower GDP? For this there are, of course, weighty objective reasons, which are mentioned above. But there are also reasons for the institutional and subjective order: a high degree of centralization of power and the setting of priorities that sometimes run counter to the aspirations of the majority of the population. *(Levinson, 2015)*

Another striking example is the United States. The richest world power, whose leaders consider it a "model" for the peoples of other countries, took only 16th place in the rating of the SPI in 2015. Nicholas Kristof wrote: "A newly released global index finds that America falls short, along with other powerful countries, on what matters most: assuring a high quality of life for ordinary citizens. <…> We may thump our chests and boast that we're No. 1, and in some ways we are. But, in important ways, we lag." *(Kristof 2015)*

In confirmation of what has been a said Kristof pointed out that according to Social Progress Index the United States ranks 30th on life expectancy, child survival on 38 place and 55 on maternal survival. He pointed out about high level of murders, but USA rate for road fatality is above 37 other countries, and the suicide rate is higher

than in 80 other countries. The US is 38th on the exponent of equality in the educational system and on 87th place for using cell phones.

(Kristof, 2015) directly connects this situation with inequality and especially with poverty. Financial support programs for poor individuals requires increasing taxes for rich, but they prefer to create private alternatives to public goods - private schools, private security agencies. This lead to underfunding of social services that are vital for those in need. "We obsess on the wrong measures, so we often have the wrong priorities."

In general, we can state that the Social Progress Index will not change anything by itself, but it raises questions and poses problems that should make many people to think.

2.3 Wellbeing of population by different indeces.

There are various methods for accessing the well being of population. Ecept of Social Progress Index there are Wrold Happiness Index, The Legatum Prosperity Index, The Quality of Life Index, OESD Better Life Index, etc.

World Happinness Index includes epxrets for national statistics, economics, survey analysis and psychology. This index can show how measurements of wellbeing could be used to reach nation progress.[1] Top 5 countres rated with the highest result are: Norway, Denmark, Iceland, Switzerland and FInland

The Legatum Prosperity Index evaluates economics, education, management, health, security, personal freedom and social capital. 2017 rankings[2] include Norway, New Zeland, Finland, Switzerland and Sweden as top 5 countries with the highest scores.

The Quality of Life Index uses 9 factors to determine the score of a country[3]. Such factors are:

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[1] World Happiness report, John Helliwell, Richard Layard, Jeffery Sachs, 2016

[2] The Legatum Prospority Index, Legatum institute, 2017

3 The Economist Intelligence Unit's Quality-of-Life Index

1. Health: life expectancy (in years)
2. Family life: divorce rates
3. Social life
4. Material well being: GDP per capita
5. Political stability and safety
6. Climate
7. Job safety: unemployment rate
8. Political freedom
9. Gender equality:share of seats in parlametn taken by women

Top 5 countries by ranking of 2013: Switzerland, Australia, Norway, Sweden, Denmark.

OESD Better Life Index[4] includes 11 dimensions of wellbeing: housing conditons, household income, communit, education and what you get out of it, job security and unemployment, quality of environment, health, level of happiness, involvement in democracy, work-life balance and safety. Top 5 countries with the highest ranks are: Norway, Australia, Denmark, Switzerland, and Canada.

To conclude based on 4 indeces, all the lieaders are nearly the same. Countries with good, developed social system and high GDP occupy the first places. Two countries- Norway and Switzerland are the most successful countries based on 5 indeces, including SPI.

[4] OECD Better Life Index

3 Data and Methodology

3.1 Data

In this work the dataset of Social Price Index is used. Instead of accentuating regular estimations of progress like income and investment, there are 50 indicators of ecological and social outcomes, which design a clearer picture of what life is truly like for ordinary people. The indicators are separated over three dimensions: Basic human needs, foundations of wellbeing and opportunity. An average of these 3 dimensions has been taken for computing the Social Price Index. Each dimension consists of 4 components, which are scored form 0 to 100. Lover scores reflect low social progress and high scores reflect high social progress. The Social Progress Index can show the worst and the best global performance on each indicator by any out of 49 countries since 2004.

Inside of each dimension, there are four variables that further split the indicators into thematic classes. The different selection of indicators gives the ability for granular analysis of the specific basis of social progress in each country, while the large categories of Social Progress Index help to better understanding international and regional trends.

3.1.1 Countries

My dataset consist of data, which are scored from 0 to 100 and a collected since 2004 for 49 countries. The list of all 49 countries is stated in the table 3.1

Table 3.1: Countries

Angola	Denmark	Lebanon	Slovenia
Argentina	Estonia	Lithuania	South Korea
Australia	Finland	Malaysia	Spain
Austria	France	Mexico	Sweden
Azerbaijan	Georgia	Moldova	Switzerland
Belgium	Germany	Netherlands	Tanzania
Bosnia,Her	Greece	New Zealand	Thailand
Canada	Hungary	Nigeria	Turkey
Chile	India	Norway	UK
China	Ireland	Poland	USA
Colombia	Israel	Portugal	
Croatia	Italy	Romania	
Czech Rep	Japan	Russia	

All of this countries account for all continents, excluding Antarctica. There are 30 European countries, 3 African, 2 Oceanian countries, 3 South American, 3 North American and 8 Asian. This dataset present all types of countries – developed, developing and economies is transition.

3.1.2. Describing dimensions

Basic Human Needs

The first dimension, Basic Human needs, measures how well country provides essential needs for its population. It assesses basic medical care, access to nutrition, availability of safe drinking water, accessibility of adequate housing with basic utilities, and if society is safe and secure.

This dimension consists of four components, which are:

Nutrition and basic medical care

Social progress originates early in life, with possible access to medicine, and sufficient nutrition.

The two elements are requirements for survival, as well as prevent early-life harm that may prompt permanent retrogression. The consequences of not having access to medical care or not getting enough food extend from dying as a child, in early years, or as an adult, suffering from serious infections.

Water and sanitation

Clean water and sanitation are recognized as an essential to survival and can dramatically improve life expectance. Water must be free of pathogens because it is necessary for drinking, cooking and washing. Moreover, sanitation not only prevents the spread of infection, it is a part of human dignity that can influence multiple areas of life.

Shelter

Sufficient living conditions are essential for security and health. Housing goes to the further side of having four walls and a rooftop. It must be sheltered, contain basic facilities and provide safety protection.

Safety

Safety is basic element for being healthy, in peace and justice. Security is basic for the achievement of wellbeing, peace, equity, and prosperity. It decreases human's fear to leave their homes and walk alone.

Foundations of Wellbeing

The second dimension, Foundation of Wellbeing, measures an access to basic education for citizens, information and knowledge from inside and outside of a country, if there are conditions for living healthy life. Environmental quality evaluates a country's protection of land, air, and water. The dimension consists of four components:

Access to basic knowledge

Education and knowledge is fundamental to empowerment. With elementary knowledge in math, writhing and reading, any person can improve his financial, economic or social position, as well as be more active participant of society.

Access to information and communication

An opportunity to get and exchange information is necessary part for open, responsible and efficient society. Possibility of one person to connect with others through Internet or phone helps forward exchanging ideas and learning, and exposure to differentiate cultures and views. Freedom of social media and press make sure that the government does not restrain access to information. People can educate themselves about their country, their community and the whole world.

Health and wellness

The health and wellness variable measures the degree to which a country's population have healthy, long lives. Conversely with nutrition and basic medical care, this variable includes the ability to limit deaths from non-communicable diseases that normally affect people later on and can be prevented or managed for a long time. Mental health is measure using suicide rate as a proxy. It is integral to the ability of individuals to live fulfilled and happy lives.

Environmental quality

A sheltered and secured natural environment is a precondition for living satisfying and healthy life. It is affecting both survival and health: any kind of pollution can affect a man's ability to breath freely, while greenhouse effect and gas emissions affect the world's collective climate, control of disease and food chain. Moreover, dangerous waste in water and somewhere else prevents the realization of other human needs, for example, sanitation, clean water and shelter.

Opportunity

The third dimension, Opportunity, measures whether people have personal rights and freedoms, whether they are allowed to make their own decisions, and access to advanced education to those who want to wide their knowledge and skills.

Personal rights

Personal rights empower a person to take part freely in society without the intrusion of, social organization and government. The variable personal rights include rights of association and expression, political rights and the right to own a property. Individuals encourage the participation in building democratic and free society, where individual's voices are valued in determining state and community affairs.

Personal freedom and choice

Personal freedom and choice concentrates on individual freedom over decisions of life, rather than the rights of society as a whole. An individual ought to choose the religion to follow, whom to marry and when to have a wedding, when to start a family. This variable also includes corruption, which controls people's decisions.

Tolerance and inclusion

A tolerant society is a comprehensive society, where each individual can follow his human right to a life of dignity and worth. Discrimination in light of ethnicity, sex, nation, religion or sexual orientation stop people fully participate in society makes conflict ad violence. A strong community can cooperate together for the advancement of a better society and all people.

Access to advanced education

Despite the fact that not every individual will choose advanced education, the choice itself is crucial to advancing individual opportunity and society. World-class research and educational institutes provide benefits beyond simply educating people. They solve local and global problems with the help of innovation and act as a conduct for cutting edge knowledge. In additional, it is important to value higher education with

equity – guaranteeing that access is available to all individuals of all socioeconomic levels.

3.1.3. Calculating Social Progress Index scores

Principal component analysis was used for building the social progress index. The analysis helped to select the most significant indicators and shape the weights of the indicators making up each component. It points out indicators that may not fit well within a component. It also corrects for overlapping measurement between two or more indicators. The weights of principal component analysis indicators are very near to equal. This predicts a successful selection of indicators to measure the concept of components.

The social progress index scores on a 0-100 scale at the level of dimension and component level. The scale used the best and the worst absolute global performance on each component for any country since 2004 in order to determine the number for each indicator, and using the actual performance level from (0) the worst to (100) the best. Social Progress Index rescales the absolute performance of a country from good to bad. It is possible to track performance of any country on each component of the model.

For a more detailed analysis, all countries[5] are devided according to the achieved level of social progress into six groups with a certain similarity of aggregated indicators, although with significant differences in individual components. Norway, Sweden, New Zealand, Canada, Finland, Denmark, the Netherlands and Australia are among the top 10 (the "very high level"), in the lowest group ("very low") - several of the poorest countries in Africa and Asia.

[5] Meaning 133 countries from the Social Progress imperative, 2015

Group of countries according to social progress	Basic Human Needs	Foundations of Wellbeing	Opportunity
Very high	97,77	83,85	83,07
High	90,86	77,83	73,82
Upper middle	70,9	68,78	47,65
Lower middle	72,34	66,9	47,14
Low	50,05	58,01	38,35
Very low	38,46	48,55	26,05

Source: Social Progress Index..., 2015: 45–50

This table shows a wide range of differences in the levels of social progress in different countries based on its main dimensions. There are differences in the individual components, within each category. Even the "first echelon" countries have many unresolved problems and open opportunities for improvements in various directions. In particular, almost all of them received a low assessment of the sustainability of environmental quality. This situation is noted in all other groups. The middle groups are characterized by a sharply reduced assessment of the third dimension - the possibilities of progress. In the last two groups the basic needs of a person are particularly bad - estimates are even lower than estimates of the foundations of wellbeing. And, of course, the indicator of the possibilities of progress is extremely low.

A detailed analysis again confirms that economic results can not fully explain the differences in the levels of social progress. The degree of satisfaction of basic human needs correlates with GDP to the greatest extent. The foundations of wellbeing corelate less with GDP, and even less - the possibilities of human development (opportunities). The last case is understandable: for having high opportunities not only so much investment needed, but personal rights, tolerance and inclusion must be more important.

If we consider the world as one country, then the global index of social progress would be 61.00 points. At the same time, the average world estimate of satisfaction of basic human needs exceeds the overall global index for the sections "Nutrition" and "Basic medical care" - 87.47 points and under the heading "Water and sanitation" - 68.87 points. The worst in this section is the assessment of "Personal Security" - 56.27 points.

As for the "Foundations of Welfare", the world's average access to basic knowledge (85.98) is also above the others. Significantly lower indicators of health and conditions for wellness (64.67), as well as access to information and communication (63.56). The worst global average in this dimension is the stability of ecosystems, that is, the state of the environment (51,60).

The third dimension - "Opportunities" - on average received the lowest estimate at the global level. The best world average in this dimension is "Personal Freedom and Choice" (61.23). Indicators of other components are much lower: "Access to advanced education" - 46.24, "Personal rights" - 43.10, "Tolerance and inclusion" - 42.36. At the same time, the assessment of the observance of personal rights varies in a very wide range, dropping in some countries to a paltry 2.32 points, while in some other countries it reaches 98.84[6] points; the same applies to the assessment of tolerance and inclusion.

Additionally, we must take into account that the legal (institutional) opportunities for social progress are interpreted by the authors of social progree imperative from the standpoint of values adopted in the West, which often ignore the cultural and civilizational features of the countries like Asia, Africa, and Latin America.

3.2 Methodology

3.2.1 Hypothesis

There are three hypothesis tested. (H1) Countries with higher Social Progress Index do not need to have high GDP rate. This hypothesis will be tested by K-means

[6] Taking into account 133 countries of Social Progress Imperative,2015

clustering analysis and comparative analysis on 49 countries of different continents. (H2) 1.Basic Human Needs dimension of Social Progress Index depends on 4 components: nutrition and basic medical care, water and sanitation, shelter, personal safety. 2. Foundations of Wellbeing dimension of Social Progress Index depends on 4 components: access to basic knowledge, access to information and communications, health and wellness, environmental quality. 3.Opportunity dimension of Social Progress Index consists of 4 components: personal rights, personal freedom and choice, tolerance and inclusion, access to advanced education. (H3) The best model for describing social progress depends on 12 components: nutrition and basic medical care, water and sanitation, shelter, personal safety, access to basic knowledge, access to information and communications, health and wellness, environmental quality, personal rights, personal freedom and choice, tolerance and inclusion, access to advanced education. The last 2 hypotheses will be tested by Bayesian model averaging approach.

3.2.2. Models

There are three models. The dependent variables are basic human needs, foundations of wellbeing and opportunity respectively. The independent variables are nutrition and basic medical care, water and sanitation, shelter, personal safety for the first model; access to basic knowledge, access to information and communications, health and wellness, environmental quality for the second model; personal rights, personal freedom and choice, tolerance and inclusion, access to advanced education are independent variables for the third model.

Model 1:

$$BHN = Nutrition\_and\_Basic\_Medical\_Care + Water\_and\_Sanitation + Shelter + Personal\_Safety \tag{3.1}$$

Model 2:

$$FoW = Access\_to\_Basic\_Knowledge + Access\_to\_Information\_and\_Communications + Health\_and\_Wellness + Environmental\_Quality$$

(3.2)

Model 3:

$$Opportunity = Personal\_Rights + Personal\_Freedom\_and\_Choice + Tolerance\_and\_Inclusion + Access\_to\_Advanced\_Education$$

(3.3)

There is one more model, which would be tested with the dependent variable Social Price Index.

Full Model:

$$\begin{aligned} Social\_Progress\_Index &= Nutrition\_and\_Basic\_Medical\_Care + Water\_and\_Sanitation + Shelter \\ &+ Personal\_Safety + Access\_to\_Basic\_Knowledge \\ &+ Access\_to\_Information\_and\_Communications + Health \\ &+ Environmental\_Quality + Personal\_Rights \\ &+ Personal\_Freedom\_and\_Choice + Tolerance\_and\_Inclusion \\ &+ Access\_to\_Advanced\_Education \end{aligned}$$

(3.4)

3.2.3 Model selection with Bayesian information criterion and Akaike's information criterion

The BIC is an asymptotic result derived under the assumptions that the data distribution is in the exponential family.

Let:

- n = the number of observation, or equivalently, the sample size;
- k = the number of free parameters to be estimated. If the estimated model is a linear regression, k is the number of repressors, including the constant.
- L = the maximized value of the likelihood function for the estimated model

$$BIC = -2 * \ln(L) + kln(n)$$

(3.5)

Under the assumption that the model errors or disturbances are normally distributes, this becomes:

$$BIC = nln\left(\frac{RSS}{n}\right) + kln(n)$$

(3.6)

- RSS = residual sum of squares from the estimated model

Given any two estimated models. The model with the lower value of BIC is the one to be preferred. The BIC is an increasing function of RSS and an increasing function of k. That is, unexplained variation in the dependent variable and the number of explanatory variables increase the value of BIC. The BIC penalizes free parameters more strongly than does the Akaike information criterion.

It is important to keep in mind that the BIC can be used to compare estimated models only when the numerical values of the dependent variable are identical for all estimates being compared. The models being compared need not be nested, unlike the case when models are being compares using F or likelihood ratio test.

Akaike's information criterion developed by Hirotsugu Akaike under the name of "an information criterion" (AIC) in 1971 and proposed in Akaike (1974), is a measure of the goodness of fit of an estimated statistical model. It is grounded in the concept of entropy. The AIC is an operational way of trading off the complexity of an estimated model against how well the model fits the data.

The formula for AIC is:

$$AIC = 2k - 2\ln(L)$$

(3.7)

Where:

- k = the number of parameters in the statistical model
- L = the likelihood function

Over the remainder of this entry, it will be assumed that the model errors are normally and independently distributed. Let n be the number of observations and RSS be $RSS = \sum_{i=1}^{n} \varepsilon_i^2$ is the residual sum of squares. Then AIC becomes:

$$AIC = 2k + n[\ln\left(\frac{2\rho RSS}{n}\right) + 1$$

(3.8)

Increasing the number of free parameters to be estimated improves the goodness of fit, regardless of the number of free parameter in the data generating process. Hence, AIC not only rewards goodness of fit, but also includes a penalty that is an increasing function of the number of estimated parameters. The preferred model is the on with the lowest AIC value. The AIC methodology attempts to find the model that the best explains the data with a minimum of free parameters. It also penalizes free parameters less strongly than does the Schwarz criterion.

3.2.4 Residual sum of squares

In statistics, the residual sum of squares (RSS) is the sum of squares of residuals. It is the discrepancy between the data and the estimation model. As small this discrepancy is, better our estimation will be.

$$RSS = \sum_{i=1}^{n} (y_i - f(x_i))^2$$

(3.9)

In a standard regression model $y_i = a + bx_i + \varepsilon_i$, where a and b are coefficients, y and x are the regressand and the regressor, respectively, and ε is the "error term". The sum of squares of residuals is the sum of squares of estimates of ε_i, that is

$$RSS = \sum_{i=1}^{n} (y_i - (a + bx_i))^2$$

(3.10)

3.2.5 Bayesian Model Averaging

The popularity of Bayesian model averaging has increased over the last two decades due to computational advances. It is a commonly used approach to deal with a problem of model uncertainty. Model averaging can provide a very big help in a field of economic growth, which developed a big number of competing theories.

Fernandez, Ley and Steel in their work "Model uncertainty in cross-country growth regressions" (Fernandez, Ley and Steel (2001)) considered an extremely large set of possible models with 41 regressors. They had 2^{41} models to deal with.

There are few rules of probability on which Bayesian econometrics is built. Let's assume having two random variables: X and Y. From the two equations: $p(X,Y) = p(X|Y)p(Y)$ and $p(Y,X) = p(Y,X)p(X)$ we arrive to Bayes' rule:

$$p(Y|X) = \frac{p(X|Y)p(Y)}{p(X)} \tag{3.11}$$

Let M_l account for l different models. Each model depends on a vector of parameters θ_l. Using Bayes' rule:

$$p(\theta_l|y, M_l) = \frac{p(y|\theta_l, M_l)p(\theta_l|M_l)}{p(y|M_l)} \tag{3.12}$$

where $p(y|\theta_l, M_l)$ stands for likelihood function which is called "data generating process" and is the density of the data. $p(\theta_l|M_l)$ is prior density and $p(\theta_l|y, M_l)$ is posterior density, which tells us how much we know about θ_l, given the data. Prior density is not dependent on the data. It sums up what the researcher knows about θ prior. In econometrics, there are no any information of believes which are common or shared among researches, and there is a reason why non-informative priors are used in most cases. Popular practice is to assign the prior to a low importance, so it plays not significant role in posterior formula.

Posterior model probability:

$$p(M_l|y) = \frac{p(y|M_l)p(M_l)}{p(y)}$$

(3.13)

which allows for model comparison and model ranking.

Lets consider a dataset with n observations, dependent variable Y and independent variables: $X_1 \ldots . X_k$. The aim is to identify which variables are robust determinants for dependent variable. A usual approach would be to specify a set of the core variables and after to assess robustness by adding additional variables. Unfortunately, the procedure faces problems from a decision-theoretic perspective and it is non-transparent. With the help of BMA many more variables could be included into the model, model uncertainty can be reduced and omitted variable bias. In BMA number of explanatory variables is limited only by number of observations.

Imagine that we are interested in the effect of daily activity level on % of body fat. A lot of empirical researches suggest that there are many potential determinants of a body fat, and as a consequence, numerous models (for k independent variables will be $2^k = l$ different models) might be problematic. With the help of BMA framework it will be very easy task. Let's denote ω a vector of parameters with the common interpretation across all models. In the case of our problem, we are interested in daily activity level coefficient, so ω will be such coefficient in every regression.

All the information about ω is included into posterior $p(\omega|y)$- this is what Bayesian econometrics says. Using rules of probability:

$$p(\omega|y) = \sum_{l=1}^{L} p(\omega|y, M_l)p(M_l|y)$$

(3.14)

It says that in order to attain the data about ω, we evaluate each model $(p(\omega|y, M_l))$ and average them, and the weights are the posterior model probabilities $p(M_l|y)$. Using this technique, the posterior inclusion probability can be obtained. It will show the probability of each variable being included to the "true" model. $M_1, \ldots ., M_l$ means

the set of different models which is required to consider. The formula for posterior probability for model M_l:

$$p(M_l|y) = \frac{p(y|M_l)p(M_l)}{\sum_{l=1}^{L} p(y|M_l)p(M_l)} \tag{3.15}$$

where the following formula is the marginal likelihood of the model M_l.

$$p(y|M_l) = \int p(y|\theta_l M_l)p(\theta_l|M_l)d\theta_l \tag{3.16}$$

θ_l stands for the vector of parameters; $p(\theta_l|M_l)$ stands for the prior density of θ_l; $p(y|\theta_l M_l)$ stands for likelihood; $p(M_l)$ stands for the probability of M_l being the true model.[7]

3.2.6 K-means clustering

K-means clustering technique defines a prototype in terms of a centroid. The centroid is usually the mean of a group and related to objects in continuous n-dimensional space. K-means is one of the oldest and widely used clustering methods.

Algorithm of K-means

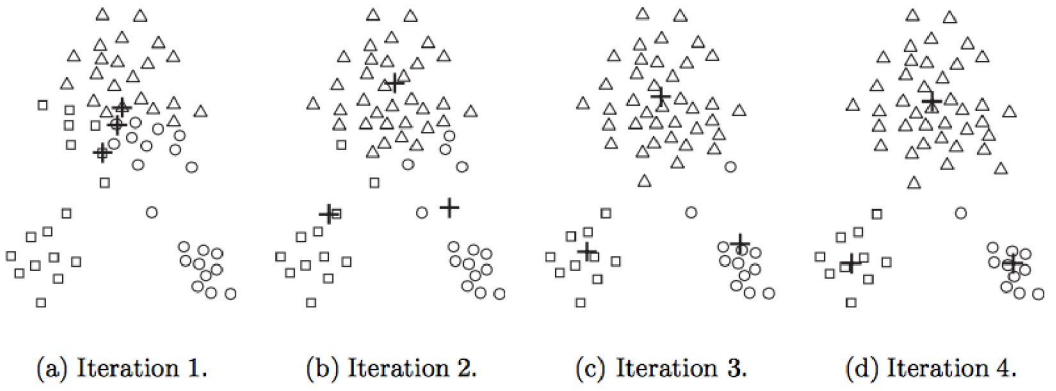
K-means clustering technique is easy. First of all, the K initial centroids are chosen, where K is the number of clusters or a user-specified parameter. Each point from data is assigned to the closest centroid. Each group of points is assigned to a centroid, which designs the cluster. Repeat the same algorithm until no point changes clusters or the centroids remain unchanged.

The procedure of K-means is illustrated in Figure 1. It demonstrates the final clusters can be found in 4 steps, starting from 3 centroids. In these figures representing K-means clustering, the centroids and the assignment of the points to those centroids are

[7] Assuming that one of considered model is true

displayed. The "+" symbol represents centroids and all the points connecting within the same cluster have the same figure shape.

Figure 1: Procedure of K-means



Source: Cluster Analysis: Basic Concepts and Algorithms

In the "Iteration 1" the points are assigned to the initial centroids. The centroids are concentrated in the larger group of points. For this case, the mean as the centroid is used. The centroid is updated after all the points are assigned to a centroid. In the next stage, points are assigned to the updated centroids and they are updated again. On the Figure 1 (b), (c), (d) 2 centroids have tendency to move to smaller groups of points, down to the bottom of the figures. On Figure 1 (d) no more changes occur and K-means algorithm stops. Now the natural groups of points are formed and the centroids are assigned to each of them. K-means reaches a stage where no points are moving from one cluster to another, and as the result, the centroids don't change. The algorithm of K-means has the following structure:

1. Select K points as initial centroids
2. Repeat
3. From K clusters by assigning each point to its closes centroid
4. Recompute the centroid of each cluster
5. Until centroids do not change

Choosing nearest centroids for points

To assign a point to the nearest centroid, we require a measure that evaluates the notion of "nearest" for the specific data under consideration. Euclidean distance is usually utilized for information focuses in Euclidean space. When the data is in low-dimensional Euclidean space, there is a possibility to avoid computing many of the similarities and as the result K-means algorithm is speeded up.

Data in Euclidean space

Scatter or sum of squared error (SSE) is used for our objective function, which identifies the quality of clustering. Simply said, we calculate the error of each data point, i.e., its Euclidean distance to the closest centroid. After that, we compute the total sum of squared errors. If the two different sets of clusters are given with the two different runs of K-means, it is better to choose the one with the smallest squared error. The explanation follows the principal that the means that are centroids of this clustering are a better representation of the points in their cluster. The SSE is defines as follows:

$$SSE = \sum_{i=1}^{K} \sum_{x \in C_i} dist(c_i, x)^2 \tag{3.17}$$

where $dist$ is Euclidean distance between 2 objectives in Euclidean space, x is an object, C_i is the ith cluster, c_i is centroid of cluster C_i, K is the number of clusters.

Given previous assumptions, it can be shown that the centroid that minimizes the SSE of the cluster is the mean. The centroid (mean) of the ith cluster is defined as following:

$$c_i = \frac{1}{m_i} \sum_{x \in C_i} x \tag{3.18}$$

where c_i is centroid of cluster C_i, m_i is the number of objects in the ith cluster, m is the number of objects in the dataset, x is an object, C_i is the ith cluster.

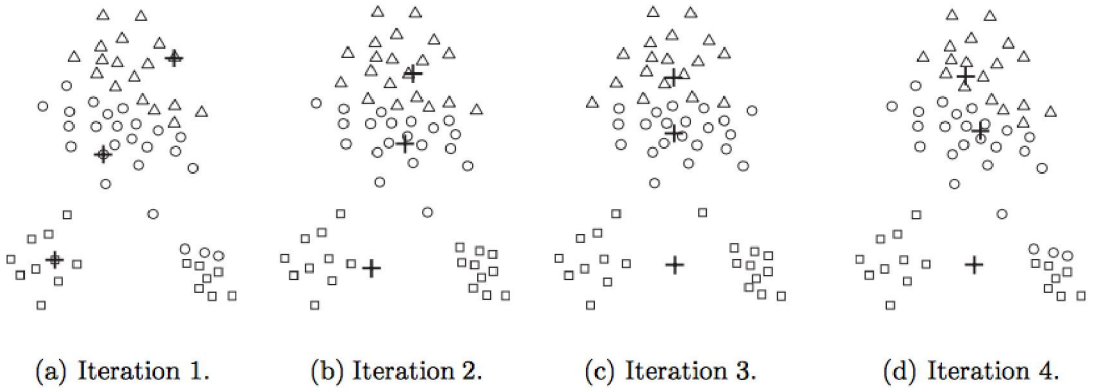
Stages 3 and 4 of the K-means algorithm aimed at minimizing the SSE. Stage 3 frames groups by assigning points to their nearest centroid, which limits the SSE for the given arrangement of centroids. Stage 4 recomputes centroids in order to additionally limit the SSE. Stages 3 and 4 are only guaranteed to find the local minimum with respect to SSE since they depend on optimizing SSE for particular choices of the centroids and clusters, rather than for all possible choices.

Choosing initial centroids

The main step of the basic K-means procedure is to choose the proper initial centroids. The easiest way is to choose the initial centroids randomly, but the outcome form resulting clusters are often poor. Different runs of K-means resulting in different total SSEs.

Figures 1 and 2 are the outcomes of the clusters that describe two particular choices of initial centroids. (Crosses indicate the position of the cluster centroids.) In Figure 1 all the initial centroids from one cluster, the minimum SSE clustering does still exist. In Figure 2 the initial centroids seem to be better organized but a suboptimal clustering is obtained with higher squared error.

Figure 2: Poor centroids for K-means

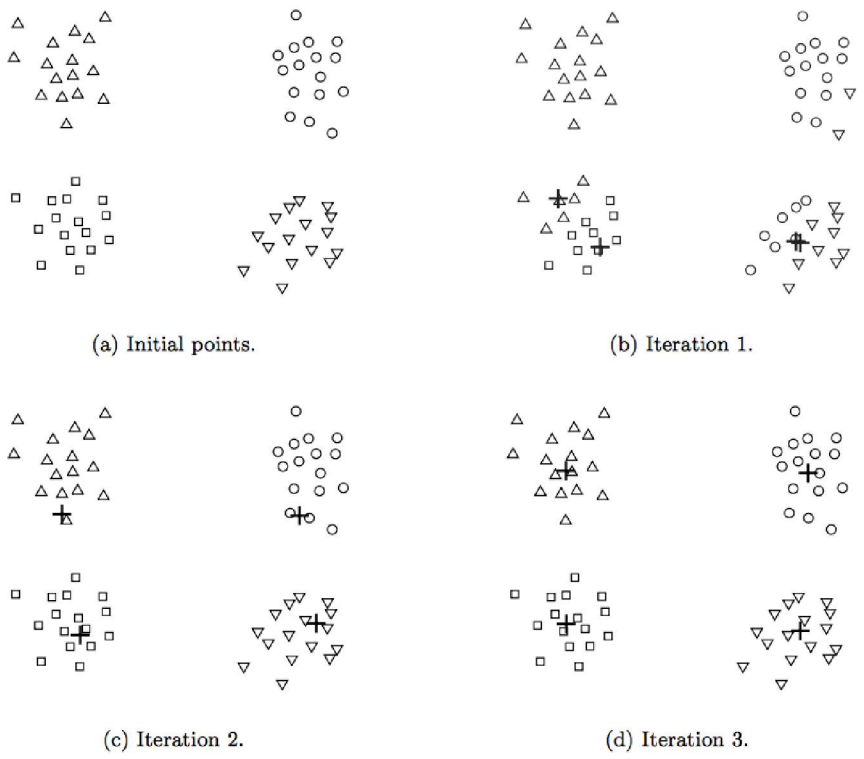


Source: Cluster Analysis: Basic Concepts and Algorithms

The most common technique, which helps to solve the problem of choosing centroids, is to perform multiple runs. Each run should contain a different set of randomly chosen initial centroids and choose the set of clusters with the minimum

SSE. However, this technique might not work very good, it depends on the number of clusters and the data.

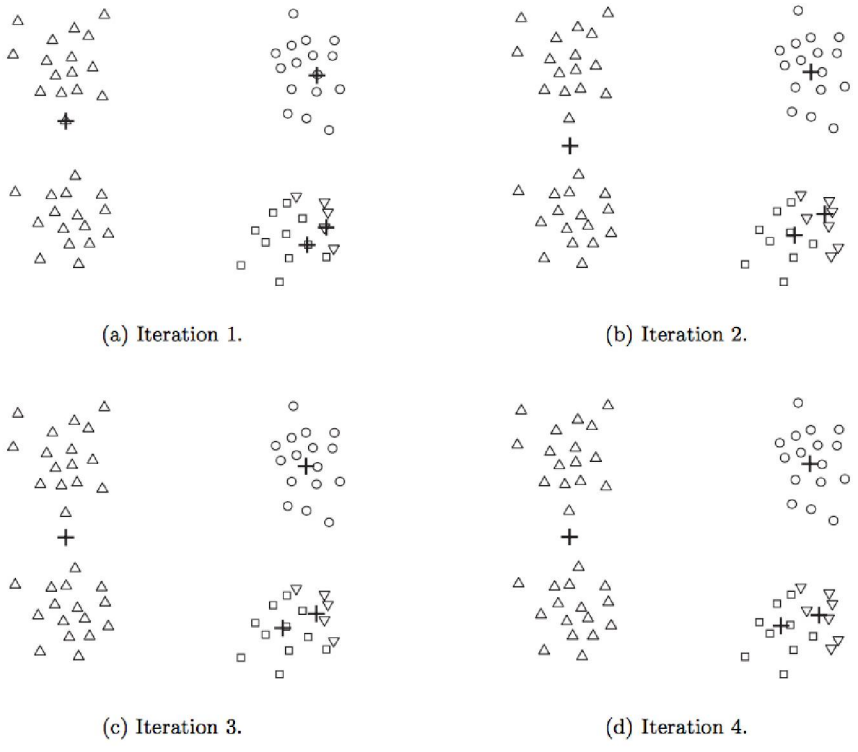
Figure 3: Two pairs of clusters with a pair of initial centroids within each pair of clusters.



Source: Cluster Analysis: Basic Concepts and Algorithms

On the Figure 3 the data includes two pairs of clusters, where the clusters in each top-bottom pair are closer to each other than to the clusters in the other pair. Figures 3 (b-d) shows that even starting with two initial centroids per pair of clusters, the centroids will redistribute themselves and the "true" clusters will be found, even if centroids were grouped in a single cluster. However, Figure 4 shows that if there is only one centroid between a pair of clusters and the other park has three, then two of the true clusters will be joined and one true cluster will be split.

Figure 4: Two pairs of clusters with more or fewer than two initial centroids with a pair of clusters.



Source: Cluster Analysis: Basic Concepts and Algorithms

As long as two initial centroids drop anywhere in a pair of clusters, the optimal clustering is obtained. The centroids will redistribute themselves belonging one to each cluster. However, with the increasing number of clusters it is more likely that at least one pair of clusters will have only one initial centroid. In such case, K-means procedure will not redistribute the centroids between pairs of clusters because the pairs of cluster are father apart than clusters within a pair. Only a local minimum will be achieved.

There are varieties of other techniques, which are used for initialization due to the problems with using randomly selected initial centroids. Moreover, repeated runs might not overcome the problem of randomly selected initial centroids. One effective procedure is to take a sample of points and cluster them using a hierarchical clustering technique. K clusters are extracted from the hierarchical clustering, and the centroids of those clusters are used as the initial centroids. This technique usually works well but it should satisfy two conditions: (1) the sample is relatively small and (2) K is relatively small compare to the sample size.

Issues with K-means

1.Empty clusters

There are number of problems that can appear with the basic K-means algorithm. One of them is an empty cluster. It can appear if no points are allocated to a cluster during the assignment step. In such case, a strategy is needed to choose a replacement centroid; otherwise, the SSE will be larger than necessary. One possibility is to choose the farthest point from any current centroid. If nothing else, this eliminates the point that currently contributes most to the total squared error. Another strategy is to choose the replacement centroid from the cluster that has the highest SSE. This procedure will decrease the overall SSE of clustering and split it. In case of several clusters, this procedure can be repeated several times.

2.Outliers

Outliers can influence the clusters when the SE criterion is used. When outliers are presented, the centroids may not be as representative as they would be without outliers, the SSE would be higher as well. Due to this fact, it is better to discover outliers and eliminate them beforehand. However, it might be the case that there are certain clustering applications for which outliers should not be eliminated. Such an example could be financial analysis, apparent outliers or profitable customers. Those outliers might present the most interesting points.

If approaches that remove outliners before clustering are used, we avoid clustering points that will not cluster well. Outliners can also be recognized in post processing step. We can keep track of contribution of each SSE for every point, and eliminate points with unusually high contributions. Moreover, small clusters might be eliminated since they frequently present groups of outliers.

3.Merging clusters

The clusters with closest centroids are grouped. However, another, perhaps better approach is to merge two or more clusters that result in the smallest increase in total SSE. These merging techniques are the analogy of the hierarchical clustering known as the centroid method and Ward's method.

4.Splitting a cluster

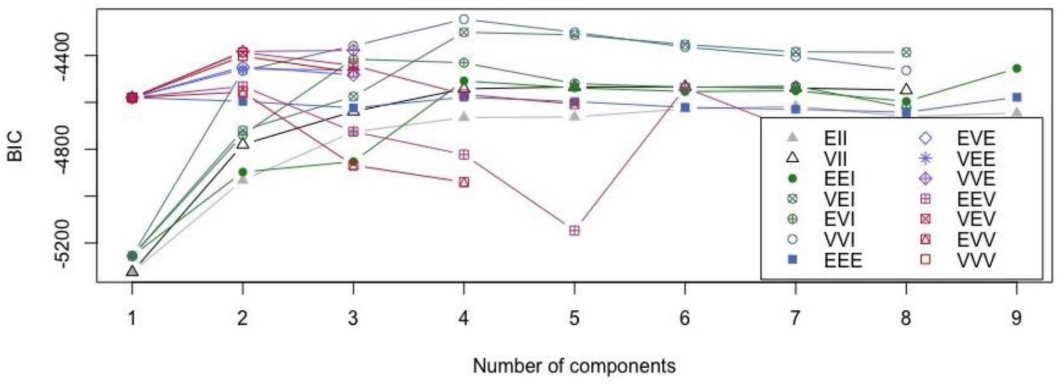
A common approach is usually to select a cluster with the largest SSE or with the largest size to split. This procedure gives priority to size-balanced clusters. This can be simplified in formula: $p = \arg\min_k (1/n_k)$, where p is a cluster. This is a reasonable approach, but natural clusters are not restricted to the situation where each cluster has the same size.

4 Results and discussions

4.1 Clustering analysis

My suggestion about splitting all the 49 countries into 4 different groups supported by the model based analysis. This approach assumes a big variety of data models in order to identify the most likely number of clusters and the model using Bayes criteria and maximum likelihood estimation. The optimal model is selected according to BIC and the number of clusters is chosen with the largest BIC. From the figure 5 we could see that the biggest BIC number belongs to the dataset with 4 clusters.

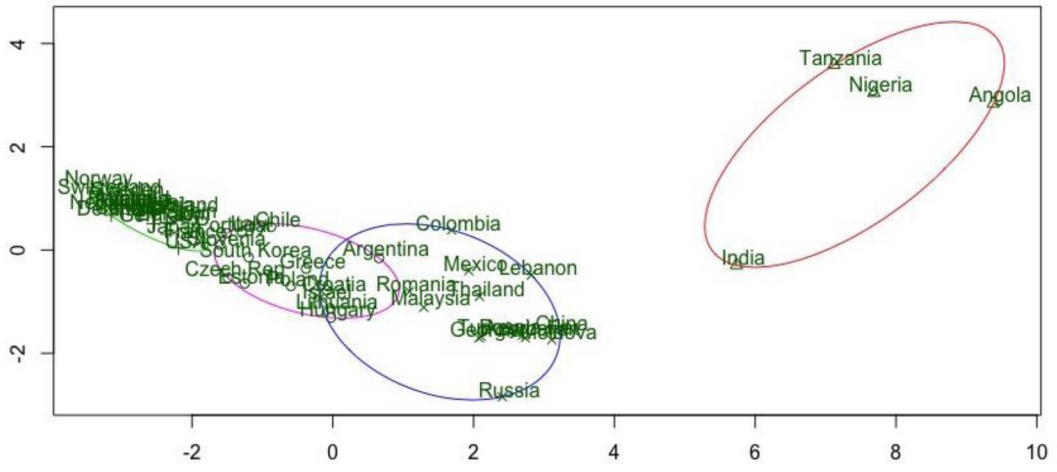
Figure 5: Clustering with BIC



Source: author's computations

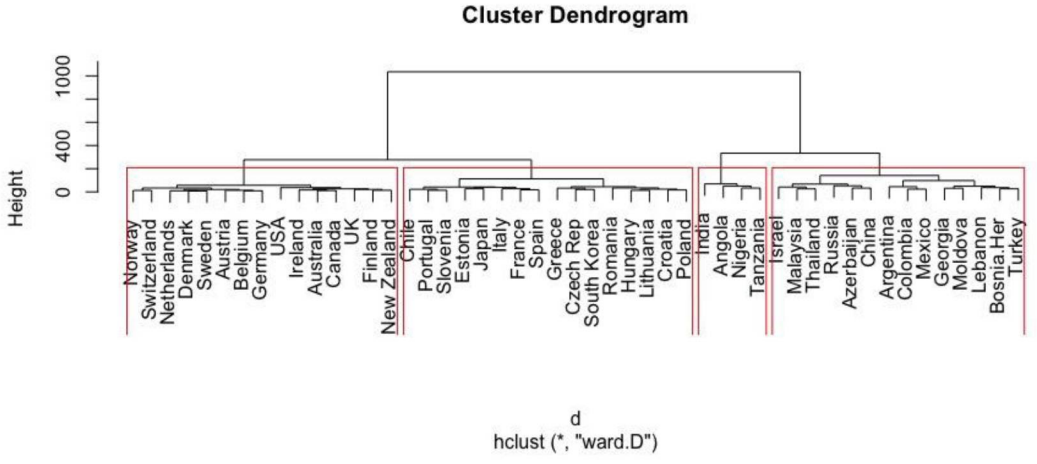
The next figure represents the clusters split by 4 groups based on all 12 variables, which are the components of the Social Price Index. Since the number of countries is quite big for one figure and there is no solution in statistical software R how to fix these names, it is possible to see the names of countries within each cluster on the Figure 6.

Figure 6: Clustering countries



Source: author's computations

Figure 7: Hierarchical clustering



Source: author's computations

The table "Clustering Vector" represents belonging of each country to each cluster. There are 13 countries in cluster 1, 18 countries in cluster 2, 4 countries in cluster 4 and 14 countries in cluster 4.

Table 4.1: Clustering vector

Country	Cluster	Country	Cluster
Angola	3	**Italy**	1
Argentina	1	**Japan**	2
Australia	2	**Lebanon**	4
Austria	2	**Lithuania**	1
Azerbaijan	4	**Malaysia**	4
Belgium	2	**Mexico**	4
Bosnia and Herz.	4	**Moldova**	4
Canada	2	**Netherlands**	2
Chile	1	**New Zealand**	2
China	4	**Nigeria**	3
Colombia	4	**Norway**	2
Croatia	1	**Poland**	1
Czech Rep	1	**Portugal**	1
Denmark	2	**Romania**	4
Estonia	1	**Russia**	4
Finland	2	**Slovenia**	1
France	2	**South Korea**	1
Georgia	4	**Spain**	2
Germany	2	**Sweden**	2
Greece	1	**Switzerland**	2
Hungary	1	**Tanzania**	3
India	3	**Thailand**	4
Ireland	2	**Turkey**	4
Israel	4	**UK**	2
		USA	2

This table represents the centers of each component within the cluster. Once clusters are grouped, there is still the task to evaluate the clusters. One very known and utilized measure is the centroid; that is, the normal estimation of the items contained in the group on each of the factors making up each object's profile. The average profile measures are computed for each cluster. In addition, each cluster can be portrayed by the group's model profile on each of the attributes.

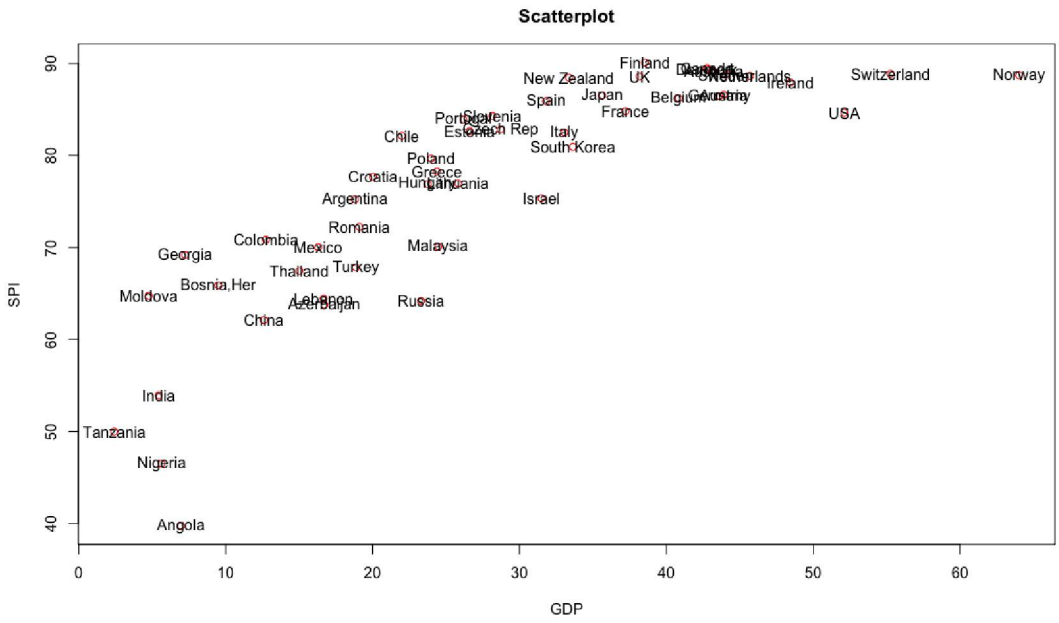
Cluster 3 represents the lowest centroids on every single component out of 12. In contrast, cluster 2 has the highest values for centroids in each variable. Clusters 1 and 4 show very similar values, but cluster 1 has their means few points higher. The description of each cluster can be found in the section 4.3.

Table 4.2: Cluster centers

Variable	Cluster 1	Cluster 2	Cluster 3	Cluster 4
Nutrition and Basic Medical Care	98.98923	99.27278	69.89	96.84857
Water and Sanitation	97.62462	99.40333	34.6525	86.685
Shelter	83.03462	89.50667	42.4	77.38286
Personal Safety	83.19	90.37	55.21	67.21143
Access to Basic Knowledge	97.28308	97.82667	62.12	92.74286
Access to Information and Communications	84.43308	91.04167	55.605	72.12786
Health and Wellness	64.58538	71.52667	57.8525	62.48286
Environmental Quality	78.76923	86.72556	54.165	61.31857
Personal Rights	78.96538	89.47722	36.265	43.07571
Personal Freedom and Choice	71.00769	86.20778	43.915	60.29786
Tolerance and Inclusion	60.12462	75.73222	34.8825	39.68714
Access to Advanced Education	65.53154	75.67278	23.37	52.65143

4.2 Comparing Social Price Index and Gross Domestic Product

Figure 8: SPI and GDP relationship



Source: author's computations

The Figure 8 reflects the relationship between GDP per capita (constant 2011 international $) and Social Progress Index for 49 countries. From the chart we could see that the highest SPI stands for Finland. Now, let's compare USA against New

Zealand or Japan. USA got higher GDP level (52.118) with comparison to New Zealand (33.36) and Japan (35.635) and USA is considerably richer than New Zealand and USA. However the social progress level for USA (84.62) is lover than for New Zealand (88.45) and Japan (86.54).

Table 4.3: SPI and GDP of New Zealand, Japan, USA

Country	SPI	GDP
New Zealand	88,45	99,08
Japan	86,54	99,27
USA	84,62	98,81

Lets compare Nigeria and India. Nigeria has one of the smallest social progresses among the rest of the countries (46.49) and India has (53.92). However, both of them have nearly the same GDP level: (5.639) for Nigeria and (5,439) for India.

Table 4.4: SPI and GDP of India and Nigeria

Country	SPI	GDP
India	53,92	83,38
Nigeria	46,49	66,93

The regression line shows the average relationship between GDP and SPI. There are three conclusions, which could be made looking at this picture:

1. The very big amount of noise around trend line suggests the fact that GDP is not the best way of measuring. For every point of GDP per capita there might be opportunities for higher or lower level of social progress.
2. For the rich countries the slow of the trend is nearly flat and for the poor countries the slope of the trend is very steep. This means if poor countries increase their GDP by a small amount and fund it into sanitation, education, doctors, they would get a very big increase in SPI and economic growth. History shows a lot of examples that over last twenty-thirty years many people escaped the poverty with the help of economic growth.
3. Every additional dollar of GDP is purchasing less and less SPI on the part where the curve smoothing out.

4.3 Description of clusters

Cluster 1 consist of 13 countries: Argentina, Chile, Croatia, Czech Republic, Estonia, Greece, Hungary, Italy, Lithuania, Poland, Portugal, Slovenia, South Korea. There are 10 countries from European Union area, 2 from South America and South Korea.

There are many European countries, which didn't achieve the level of the higher performing cluster with Nordic countries. They average score for tolerance and inclusion is lower in comparison with the score of nutrition and basic medical care. However, they underperform in health and wellness variable due to big number of deaths from suicides and diseases. Slovenia performs very well in personal safety among other countries within the cluster. Greece lies behind most of European countries in SPI and the rate for tolerance and inclusion, personal freedom is very low. It has low levels on tolerance for immigrants and religious tolerance. Portugal has high score in tolerance and inclusion compared to countries with similar GDP level. Also, it has high level in personal freedom and choice variable.

Argentina and Chile belongs to Latin America. Chile ha s better performance in tolerance and inclusion, personal rights, personal freedom and choice. It performs quite well an average compared to the rest of countries. Latin American's countries for the last few decades were trying to construct democratic institutions. Argentina outperforms Chile in nutrition and basic medical care, a little bit in water and sanitation, in tolerance and inclusion. It has lower level in the rest of independent variables, compared to Chile.

By looking at cluster 1 overall we could see that all of the countries, in general, have their strengths, but, in contrast, there some areas which have to be developed. Such dissimilarities mirror differences in choices of investment and policy; also it reflects cultural differences.

Countries within the cluster have tendency to have broad social security, which can be an explanation about having good performance on some social progress outcomes. In contrast, these countries perform worth in the dimension Opportunity compare to Foundations of Wellbeing and Basic human dimensions. Even at high level of GDP there is significant variety of social progress among different countries.

Cluster 2 shows the highest means across all the variables and it combines 18 countries in it: Australia, Austria, Belgium, Canada, Denmark, Finland, France, Germany, Ireland, Japan, Netherlands, New Zealand, Norway, Spain, Sweden, Switzerland, UK, USA. It includes Nordic countries, which have much in common in their history, social structure and way of life. The Nordic countries showed a reasonable large increase in GDP and high income. "The Nordics cluster at the top of league tables of everything from economic competitiveness to social health to happiness."[8] This cluster includes also non-Nordic countries such as Australia, Germany, Canada, UK. Finland and Denmark are ranked as the countries with the highest social progress, and it is not surprisingly, because they are well know for their social welfare policies. Finland is the first in access to information and communication, nutrition and basic medical care, personal freedom and choice, tolerance and inclusion. Denmark takes the first place in rest of variables and it was also named as the happiest country in the world.

Australia, Candana, New Zealand, UK, Ireland have very high score on opportunity dimension. Canada has the highest SPI score and is the best performer form G7 counties. These countries provide very good opportunities for getting new knowledge and a lot of top-class universities are located among those countries.

Germany preforms quite well in environmental quality and Austria preforms well in personal rights and safety. There is not very high life expectancy in Germany (around 60), thus the variable "health and wellness" does not show high score as it is for other variables. Austria shows the low score in access to advances education due to fewer average years at tertiary school and there are not so many high-ranked universities in this country.

Countries such as USA and France have nearly the same score for personal safety. In USA there quite a lot of traffic deaths while in France there is high level of violent crime.

[8]www.economist.com/news/leaders/21571136-politicians-both-right-and-left-could-learn-nordic-countries-next-supermodel

There are only 4 countries forming the **cluster 3**, which are: Angola, India, Nigeria and Tanzania. Not surprisingly, the larger part of the countries came from Africa. GDP level is very low, ranging form (2.421) for Tanzania and to (5.439) for India. The very low GDP level, the high volatility of commodity prices and poor state of the global economic recovery are the key aspects of falling into the cluster with the lowest variables. Countries of this cluster have low level of basic human needs due to have not achieved the level of economics development in order to improve this dimension. There are problems with water and electricity consumption and underfeeding.

Nigeria and Tanzania score quite well in health and wellness due to lower level of premature deaths from suicide and non-communicable diseases. However, their life expectancy is still at a low rate of 60 and it is lower compared to more developing countries. Angola has the lowest Social Progress Index level among 49 countries. According to World Bank, Angola's economy slowing down due to decrease in international crude oil price, which had big impact on budget balances. This country is still struggling to move further and overcome the effects of 27-year civil war.

In the huge rush if deregulation and economics liberalization that has cleared the world, Africa and India emerge among those that are late and have fluctuated along the path of policy return. "The measures of integration used include ratios of trade to Gross Domestic Product (GDP) and Foreign Direct Investment (FDI) to GDP, as well as credit worthiness ratings, tariffs, the share of manufactures to exports. India and South Africa are classified, up until 1994, as slow integrators compared to East Asian countries."[9]

Another measurement of useful comparison is the level of inequality in India and Africa. Research at the World Bank indicates the connection between the level of disparity and prospects for growth. "Societies with more even distributions of income tend to grow faster, as those at the bottom end of the scale are more likely to have access to credit. The distribution of income in South Africa is more unequal than in India."

[9] https://www.idsa-india.org/an-may-11.html

To increase the level of social progress, this countries have to concentrate on meeting people's basic needs such as water, food, literacy and electricity.

Cluster 4 is formed of Azerbaijan, Bosnia and Herzegovina, China, Colombia, Georgia, Israel, Lebanon, Malaysia, Mexico, Moldova, Romania, Russia, Thailand, and Turkey. This cluster can be called a cluster of developing economies or developing countries. However, various terms are used to describe not developed countries. Such indicators as lower life expectancy, lower income, less education and higher fertility rate are the components of developing countries. There is another classification by the World Bank, which classifies countries into four groups depending on GNI pre capita coefficient:

- Low income countries had GNI per capita of US$1,025 or less.
- Lower middle income countries had GNI per capita between US$1,026 and US$4,035.
- Upper middle income countries had GNI per capita between US$4,036 and US$12,475.
- High income countries had GNI per capita above US$12,476.[10]

This cluster includes countries with different economic development levels: starting from Moldova (4.754) and ending with Israel (31.485). It reflects that the level of economic development alone is not the only determinant of social progress. The countries of this cluster perform well overall but they have a lot of arias for improvement. Nearly all of these countries meet problem with Opportunity dimension.

Mexico with the level of (70.02) in SPI preforms well in shelter, water and sanitation, nutrition and basic medical care but the area of personal safety has to be improved. This country has very high level of crime and homicide rate. Nearly the same level of SPI got Malaysia (70.08). It performs very well in Basic Human Needs and Foundation of Wellbeing dimensions and shows high performance in access to basic

[10] http://blogs.worldbank.org/opendata/2016-edition-world-development-indicators-out-three-features-you-won-t-want-miss

knowledge. However, the Opportunity dimension requires some improvements in tolerance and inclusion and personal rights. They have very strict rules for religion and tolerance for immigrants.

On average, this cluster of countries has sharply low scores in Opportunity dimension, especially in the area of personal rights compared to other areas in Basic Human Need and Foundation of Wellbeing. Russian is one of the countries, which underperforms in are of personal rights, tolerance and inclusion, personal freedom and choice but doing the best in access to advanced education among the rest of countries in this cluster. Most of the countries, except Russia, underperform in this area; they do not have high ranked universities. If countries of this cluster want to obtain higher level of Social Progress, they have to invest into institutions and policies, which will increase potential level of Opportunity dimension.

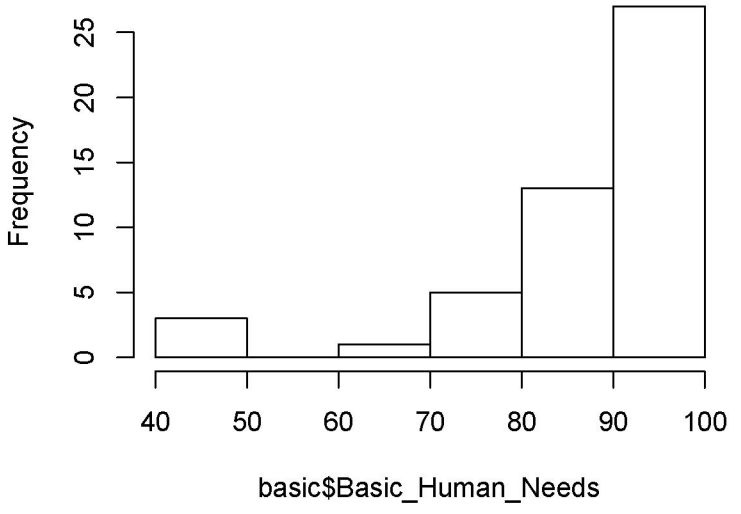
4.4 Model testing

Model 1 testing

There are fifteen sub-models, which will be tested for the first dimension "Basic Human Needs" of the Social Price Index. The number 15 comes from the fact that there are 4 independent variables and any combinations of those variables will be used, separately or non separately. All the variations of the model can be found in Appendix ,Table A1.

First of all, I will test my full model for normality and form the Figure 9 it is obvious that the data set is not normally distributed. A left-tailed skew, meaning that everything is clumped on the right side of the histogram and this is probably due to the outliers that are pushing everything to the right.

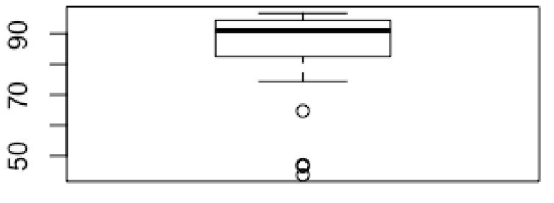
Figure 9: Histogram of Basic Human Needs



For the test of normal distribution I used Shapiro-Will test and p-value = 0.00000000207, which is less than 0.05 => it rejects the null hypothesis and this sample is not normally distributed.

Plotting a box plot, it is easily seen that few outliers do exist. Most of the countries have very high "Basic Human Needs" and it means they are doing very well (median stands for about 90) in case of basic medical care, nutrition, safety and security. Angola, Nigeria, Tanzania - all of these African countries are scheduled with very low basic human needs factor. They have BHN index lower than 50 on average and predict outliers. Poor living conditions, lack of water and shelter, unsafe - all of these conditions make BHN index very poor.

Figure 10: Boxplot of Basic Human Needs



BIC function is the general function, which calculates Bayesian information criterion. It is for one or several fitted model objectives for which a log likelihood value can be

obtained. This is all according to a formula: $BIC = -2\ln(L) + kln(n)$, where n represents the number of parameters that are in the model and k is the number of observations in the fitted model. The lower BIC value – the better the model.

In order to be fully sure that the BIC reflects the best model, AIC will be checked as well. AIC shows how well model fits the data. AIC and BIC should parallel each other and should reflect the same thing. Their only difference in practice is the size of the penalty; BIC penalizes model complexity more heavily. "The only way they should disagree is when AIC chooses a larger model than BIC."[11] Otherwise, AIC and BIC should be nearly the same, as they are in my case (see the table below). Both of them have the lowest value within the group: -403.48480 and -392.1339, and it proves that the model "doubt" is the best model, based on those criterions.

Table 4.5: AIC and BIC results for Basic Human Needs

model#	AIC	BIC
model11	-403.48480	-392.1339
model12	228.97611	238.4352
model13	267.43980	275.0071
model14	293.74421	299.4197
model15	266.71159	272.3871
model16	262.77916	268.4546
model17	336.40135	342.0768
model18	249.60104	257.1683
model19	211.01040	218.5777
model20	227.13029	234.6976
model21	190.10377	197.6710
model22	239.26802	246.8353
model23	162.09169	171.5508
model24	93.02131	102.4804
model25	168.53744	177.9965

The next Table 4.6 shows information about the top five models, where each model is represented as a variable inclusion indicator in that column. The column "model 1" is the best model; the ones mean that the model includes an intercept, nutrition and

[11] https://methodology.psu.edu/AIC-vs-BIC

basic medical care, water and sanction, shelter, personal safety. In this model there are no zero indicators, which would mean that such indicator is excluded. All model always include the intercept. The models in the table are ordered from the best to worst using their posterior probabilities. We could see that the first model definitely is the best version of all possible models. The logmarg row is -1/2*BIC and the raw for the Bayes factor uses the best BIC model as the base model. The top model has a base factor of 1.As the posterior probabilities are functions of ordinary R squared, but penalize model complexity through the dimension of the model. The model with intercept and forward predictors has the highest R squared and is the highest probability model. Under this prior model and possible models we believe that there is 100% chance that the model with all indicators and intercept is the true model. The second best model, according to output, would be the model, which excludes nutrition and basic medical care. R square is very high, however Bayes factor and posterior probabilities are 0.

Table 4.6: Top 5 models inclusion for Basic Human Needs

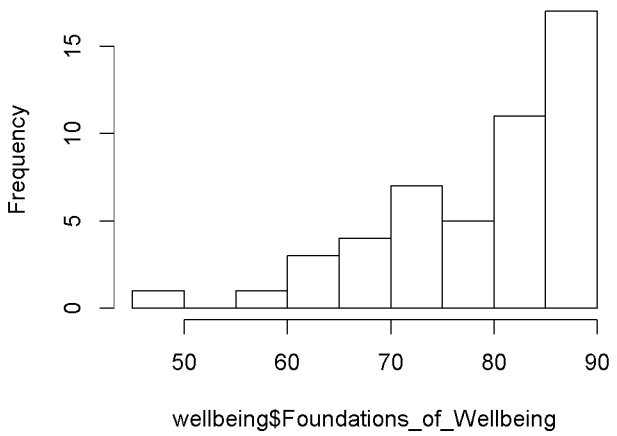
Name	P(B!=0|Y	model 1	model 2	model 3	model 4	model 5
Intercept	1	1.000	1.000	1.000	1.000	1.000
Nutrition and Basic Medical	1	1.000	0.000	1.000	1.000	0.000
Water and Sanitation	1	1.000	1.000	1.000	0.000	1.000
Shelter	1	1.000	1.000	0.000	1.000	0.000
Personal Safety	1	1.000	1.000	1.000	1.000	1.000
BF	NA	1.000	0.000	0.000	0.000	0.000
PostProb	NA	1.000	0.000	0.000	0.000	0.000
R squared	NA	1.000	0.998	0.992	0.990	0.984
dim	NA	5.000	4.000	4.000	4.000	3.000
logmarg	NA	172.191	-75.116	-	-112.874	-122.711

Model 2 testing

The second model stands for the "Foundations of Wellbeing" dimension and it consists of four different variables and all the variations of the model can be found in Appendix, Table 2A. The procedure for testing goodness of fit for this model is the same as for the model BHN. Fifteen sub-models will be tested in order to find the best fitted one.

The histogram (Figure 11) shows that the data set is not normally distributed. The heavier tail on the rights informs us that the out of 49 countries most of them have index for Wellbeing above 70 and doing quite well in case of access to basic education for citizens, information and knowledge from inside and outside of a country and conditions for living healthy life.

Figure 11: Histogram of Foundations of Wellbeing



Shapiro-Will test shows that and p-value = 0.0003332, which is less than 0.05 => it rejects the null hypothesis and this sample is not normally distributed.

According to Bayesian's information criterion and Akaike's information criterion the best-fitted model would be the model containing all for variables.

Table 4.7: AIC and BIC results for Foundations of Wellbeing

model#	AIC	BIC
model211	-411.2420	-399.8910
model212	209.3013	218.7604
model213	270.7150	278.2822
model214	318.8345	324.5099
model215	279.9792	285.6546
model216	334.8289	340.5044
model217	272.7049	278.3804
model218	198.1850	207.6441
model219	218.8791	226.4464
model220	188.5888	198.0479
model221	284.6609	292.2282
model222	208.9525	218.4116
model223	268.3831	275.9504
model224	238.9244	246.4916
model225	237.4571	245.0244

The next table shows information about the top five models for the "Foundation of Wellbeing" dependent variable. The column "model 1" is the best model meaning that the model includes an intercept, access to basic knowledge, access to information and communications, health vs. wellness and environmental quality. In this model there are no zero indicators, which would mean that such indicator is excluded. The model with intercept and forward predictors has the highest R squared and is the highest probability model. Under this prior model and possible models we believe that there is 100% chance that the model with all indicators and intercept is the true model. The second best model, according to output, would be the model, which excludes access to information and communications from the full model and the third best model excludes health vs. wellness from the fill mode. R square is very high for second and third models, however Bayes factor and posterior probabilities are 0.

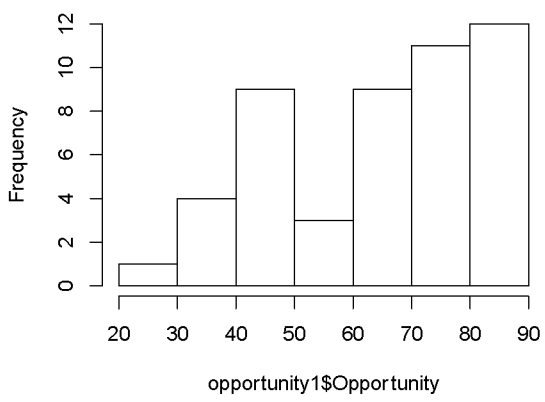
Table 4.8: Top 5 models inclusion for Foundation of Wellbenig

Name	P(B!=0|Y)	model 1	model 2	model 3	model 4	model 5
Intercept	1	1.000	1.000	1.000	1.000	1.000
Access to Basic Knowledge	1	1.000	1.000	1.000	0.000	1.000
Access to Inf. and Communicat.	1	1.000	0.000	1.000	1.000	1.000
Health and Wellness	1	1.000	1.000	0.000	1.000	1.000
Environmental Quality	1	1.000	1.000	1.000	1.000	0.000
BF	NA	1.000	0.000	0.000	0.000	0.000
PostProb	NA	1.000	0.000	0.000	0.000	0.000
R squared	NA	1.000	0.974	0.968	0.960	0.960
dim	NA	5.000	4.000	4.000	4.000	4.000
logmarg	NA	176.07	-122.990	-127.698	-133.082	-133.256

Model 3 testing

The last dimension is "Opportunity" and it is made of four independent variables. The number of sub-models depends on the number of independent variables, thus fifteen sub-models will be tested again. The combinations of them can be found in Appendix, Table 3A.

Figure 12: Histogram of Opportunity



Testing the data set for normality, it is obvious that the set is not normally distributed. A lot of data is concentrated on the right side of our distribution, meaning

that people in the most countries have personal rights and freedoms, they are allowed to make their own decisions, and they have an access to advanced education.

Shapiro-Will normality test shows that and p-value = 0.00852, which is less than 0.05 => it rejects the null hypothesis about normality and this sample is not normally distributed.

Bayesian's information criterion and Akaike's information criterion confirm goodness of fit of the model with all four independent variables.

Table 4.9: AIC and BIC results for Opportunity

model#	AIC	BIC
model311	-421.1281	-409.7772
model312	337.8340	343.5095
model313	329.6427	335.3181
model314	334.8164	340.4918
model315	358.3362	364.0116
model316	272.1774	279.7447
model317	293.7430	301.3103
model318	273.1877	280.7550
model319	292.8898	300.4570
model320	321.0057	328.5730
model321	300.5012	308.0685
model322	233.2210	242.6801
model323	233.5812	243.0403
model324	279.8668	289.3259
model325	202.1396	211.5987

The best version of a "true" model among fifteen sub-models is the "model 1" which includes an intercept, personal rights, personal freedom and choice, tolerance and inclusion, access to advanced education. R squared has the highest value and it is highest probability model. The second best model would be the model, which excludes the personal freedom and choice variable.

Table 4.10: Top 5 models inclusion for Opportunity

Name	P(B!=0|Y)	model 1	model 2	model 3	model 4	model 5
Intercept	1	1.000	1.000	1.000	1.000	1.000
Personal Rights	1	1.000	1.000	1.000	1.000	1.000
Personal Freedom and Choice	1	1.000	0.000	1.000	1.000	1.000
Tolerance and Inclusion	1	1.000	1.000	1.000	0.000	0.000
Access to Advanced Education	1	1.000	1.000	0.000	1.000	0.000
BF	NA	1.000	0.000	0.000	0.000	0.000
PostProb	NA	1.000	0.000	0.000	0.000	0.000
R squared	NA	1.000	0.990	0.980	0.980	0.955
dim	NA	5.000	4.000	4.000	4.000	3.000
logmarg	NA	181.013	-129.675	-145.216	-145.396	-163.748

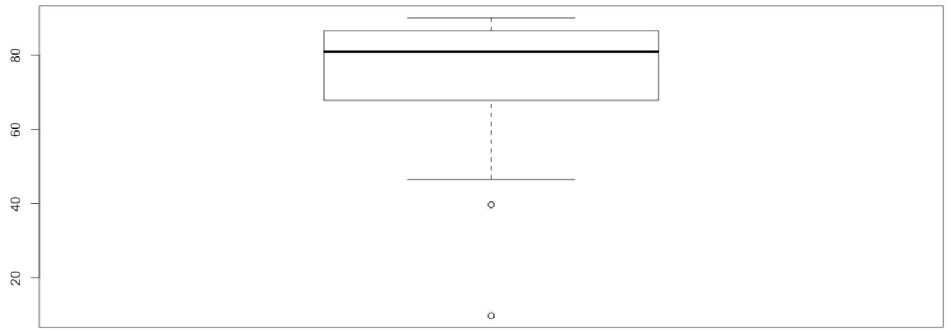
Social Progress model

At this stage the hypothesis about "true model" for Social Price Index will be tested. Full model consists of 12 independent variables and Social Price Index as dependent one.

$$
\begin{aligned}
Social\_Progress\_Index \\
&= Nutrition\_and\_Basic\_Medical\_Care + Water\_and\_Sanitation \\
&+ Shelter + Personal\_Safety + Access\_to\_Basic\_Knowledge \\
&+ Access\_to\_Information\_and\_Communications + Health \\
&+ Environmental\_Quality + Personal\_Rights \\
&+ Personal\_Freedom\_and\_Choice + Tolerance\_and\_Inclusion \\
&+ Access\_to\_Advanced\_Education
\end{aligned}
$$

The boxplot shows that the most countries have a very high Social Progress Index and the median is about 80. The minimum level would include countries with the measure around 50, which should be African countries. There are some outliers, which represent very low measure in Social Progress Index

Figure 13: Boxplot of SPI



With 12 regressors there are 2^{12} possible models, which is equal to 4096.

Table 4.11: Marginal Posterior Summaries of Coefficients using BMA

Name	post mean	post SD	post
Intercept	75.326531	1.468148	1.000000
Nutrition and Basic Medical Care	0.044139	0.268734	0.196080
Water and Sanitation	0.024858	0.119314	0.191940
Shelter	0.365996	0.320535	0.673620
Personal Safety	0.001908	0.072412	0.136348
Access to Basic Knowledge	0.020283	0.199346	0.182899
Access to Inf. and Communicat.	0.027218	0.144440	0.163463
Health and Wellness	0.104049	0.196231	0.322103
Environmental Quality	0.031530	0.116550	0.182800
Personal Rights	0.012494	0.052373	0.171604
Personal Freedom and Choice	0.077891	0.184741	0.261442
Tolerance and Inclusion	0.238599	0.184208	0.727846
Access to Advanced Education	0.017928	0.101416	0.161753

This table represents summaries of 12 coefficients using BMA based on the top 4096 models. The first column shows posterior means. These values could be used for prediction under BMA. The second column represents posterior standard deviations or, simply said, it shows how volatile each coefficient is. In the last column we could see the posterior probabilities, which replaces p-value and it gives the information about coefficient not being zero. The intercept gets the highest posterior probability because there is always an intercept in any model of our interest. “Tolerance and inclusion” should be included into the model with a probability approximately 0.73. We are also 67% sure that “Shelter” should be included as well; it gets the second

highest posterior probability[12]. "Health" and "Persona freedom and choice" have not very high probabilities but still they are stronger 2 or 3 times in comparison with rest of regressors, which have not been mentioned. The rest of regressors have very small posterior probabilities, ranging form 0.16-0.19. By using the low of total probability, this means that there are 0.81-0.84 probabilities that those coefficients are 0.

Table 4.12: Top 5 models inclusion for Social Progress Index

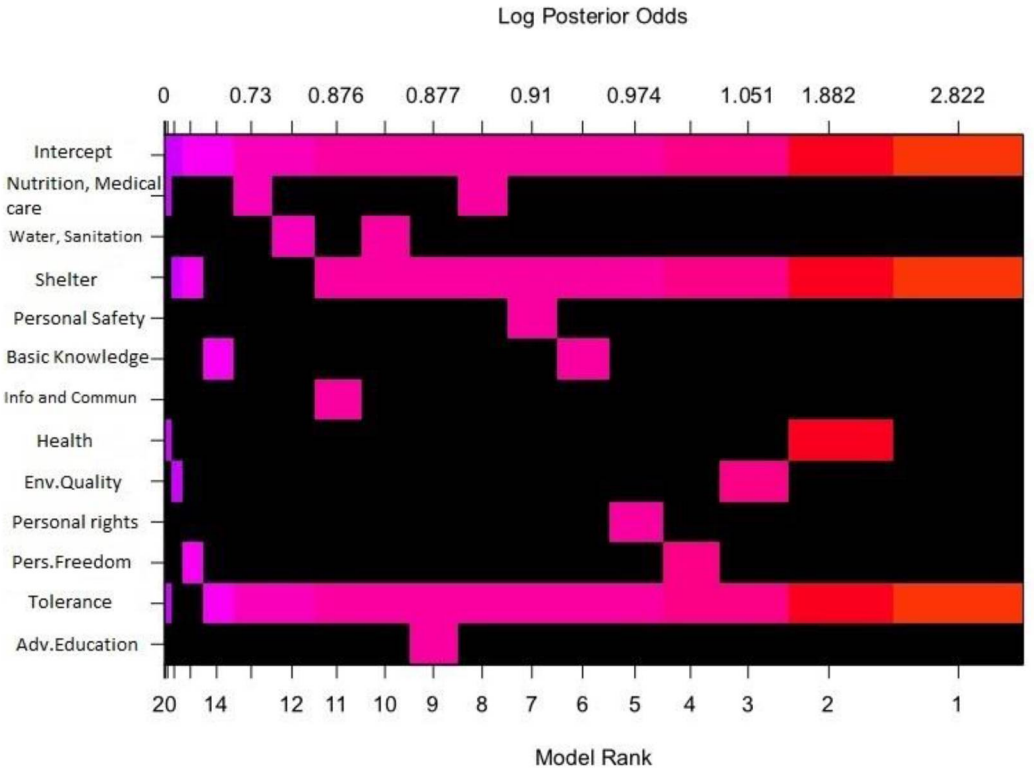
Name	P(B!=0|Y)	model 1	model 2	model 3	model 4	model 5
Intercept	1.000	1.000	1.000	1.000	1.000	1.000
Nutrition and Basic Medical Care	0.196	0.000	0.000	0.000	0.000	0.000
Water and Sanitation	0.192	0.000	0.000	0.000	0.000	0.000
Shelter	0.674	1.000	1.000	1.000	1.000	1.000
Personal Safety	0.136	0.000	0.000	0.000	0.000	0.000
Access to Basic Knowledge	0.183	0.000	0.000	0.000	0.0000	0.000
Access to Inf. and Communicat.	0.163	0.000	0.000	0.000	0.000	0.000
Health and Wellness	0.322	0.000	1.000	0.000	0.000	0.000
Environmental Quality	0.183	0.000	0.000	1.000	0.000	0.000
Personal Rights	0.172	0.000	0.000	0.000	0.000	1.000
Personal Freedom and Choice	0.261	0.000	0.000	0.000	1.000	0.000
Tolerance and Inclusion	0.728	1.000	1.000	1.000	1.000	1.000
Access to Advanced Education	0.162	0.000	0.000	0.000	0.000	0.000
BF	NA	1.000	0.391	0.170	0.168	0.158
PostProb	NA	0.105	0.041	0.018	0.018	0.016
R squared	NA	0.613	0.628	0.615	0.615	0.614
dim	NA	3.000	4.000	4.000	4.000	4.000
logmarg	NA	172.191	-75.116	-109.651	-112.874	-122.711

This table (4.12) shows best top 5 models out of 4096 possible. It confirms our observations based on the posteriors probabilities form the table (4.11). The best model includes the intercept, shelter and tolerance and inclusion variable. The second best model would contain an intercept, shelter, health, tolerance and inclusion. The third best model would contain the same as the second model but health variable will be swapped with environmental quality variable. We can see that the second model

[12] Not taking into account the intercept

with an intercept and forward predictors has the highest R squared but is not the highest probability model.

Figure 14: Log Posterior Odds



The last image represents model uncertainty, beyond the top 5 models, which have been mentioned earlier. This image has rows that correspond to each of the variables and intercept, with labels for the variables on the y-axis. The x-axis corresponds to the possible models. These are sorted by their posterior probability, from the worst at the left to the best at the right, with the rank on the top x-axis. The variables that are excluded in a model are shown in black for each column, while the variables that are included are colored, with the color related to the log posterior probability. We can use this plot to see that model 1 includes high Shelter and Tolerance and Inclusion, but not the rest of the variables. Shelter and Tolerance and Inclusion are in all of the models. The color of each column is proportional to the log of the posterior probabilities, the lower x-axis of the graph. Models that are the same color have similar log posterior probabilities. This allows us to view models that are clustered

together that have marginal likelihoods, where the differences are not worth a bare mention.

5 Conslusion

The main goal of the Social Progress Index is to give a better understanding of how economic development and social progress are connected. It shows the relationship of social progress and measures of economic success, and how this relationship fluctuates by group of countries, dimension and component. Traditional way of measuring income, such as Gross Domestic Product (GDP), does not take into account the overall progress of society. SPI separates measurement of social performance of a country from economic performance. Using this technique, the relationship between economic development and social progress is better seen.

Social Progress Index shows how well a country performs on the things that really matter. Traditional measures of success, such as Gross Domestic Product, do not tell the whole story. The Social Progress Index complements GDP by looking at social and environmental indicators to create a clearer picture of how nation is doing. It chooses country's strengths and weaknesses. A success of nation can not be judged by wealth alone. A successful country provides social progress for all: conditions for survival, tools to build better life, and opportunity that everyone can reach his full potential.

The main importance of this work is triple. Firstly, comparison of country's Social Progress Index with the economic growth rate and deviding 49 countries by clusters. Secondly, each dimension of Social Progress Index (Basic Human Needs, Foundations of Wellbeing and Opportunity) was analyzed by its dependent variables. Lastly, Social Progress was tested by 12 different indicators using BMA approach and it brought new results.

Comparison of country's Social Progress Index with GDP showed very big amount of noice around trend line. It suggests the fact that GDP is not the best way of measuring. For every point of GDP there might be opportunities for higher or loer level of social progress. For reach coutries the trend which shows the relationship

between Social Progress Index and GDP is flat and for porr countries is steep. This means if poor countries increase their GDP by a small amount and fund it intosanitation, education, doctors, they will get a very big increase in SPI and, as a concequence, economic growth. For reach countries, where the trend is nearly flat, every additional dollar of GDP is purchasing less and less SPI.

With the help of Bayesian information criterion I have splitted all of 49 countries by 4 clusters. First cluster consist of 10 countries form European Union, 2 from South America and South Korea. (Argentina, Chile, Croatia, Czech Republic, Estonia, Greece, Hungary, Italy, Lithuania, Poland, Portugal, Slovenia, South Korea). There are many European countries, which didn't achieve the level of the higher performing cluster with Nordic countries. They average score for tolerance and inclusion is lower in comparison with the score of nutrition and basic medical care. However, they underperform in health and wellness variable due to big number of deaths from suicides and diseases. By looking at cluster 1 overall we could see that all of the countries, in general, have their strengths, but, in contrast, there some areas which have to be developed.

Cluster 2 consists of 18 courtiers, including Nordic countries - Australia, Austria, Belgium, Canada, Denmark, Finland, France, Germany, Ireland, Japan, Netherlands, New Zealand, Norway, Spain, Sweden, Switzerland, UK, USA. All of these countries have high GPD and high-income level. Many of them are famous for their welfare policies, medical care, personal freedom and choice, happiness and education.

The third cluster includes Angola, India, Nigeria and Tanzania. In contrast to the previous cluster, this cluster has very low GDP level, high volatility of commodity prices and poor state of the global economic recovery.

Cluster 4 is formed of Azerbaijan, Bosnia and Herzegovina, China, Colombia, Georgia, Israel, Lebanon, Malaysia, Mexico, Moldova, Romania, Russia, Thailand, and Turkey. This cluster can be called a cluster of developing economies or developing countries. It includes countries with different economic development levels: starting from Moldova (4.754) and ending with Israel (31.485). It reflects that the level of economic development alone is not the only determinant of social

progress. The countries of this cluster perform well overall but they have a lot of arias for improvement.

The first hypothesis (H1) where countries with higher Social Progress Index do not need to have high GDP rate has been supported by K-means clustering analysis. Comparison of countries with similar GDPs per capita level showed that they could have different level of social progress like in the case of India and Nigeria. A rich and developed country might preform very well on social progress but shows a lower level in comparison to other countries with similar income. On the other hand, a poor and developing country might perform very poor on social progress but shows very high level in comparison to countries with the same resource constraints. Even at high level of GDP there is significant variety of social progress among different countries.

The second hypothesis (H2) was supported by imperial results of Bayesian model averaging approach. I have tested 3 dimensions. (1) Basic Human Needs dimension of Social Progress Index depends on 4 components: nutrition and basic medical care, water and sanitation, shelter, personal safety. (2) Foundations of Wellbeing dimension of Social Progress Index depends on 4 components: access to basic knowledge, access to information and communications, health and wellness, environmental quality. (3) Opportunity dimension of Social Progress Index consists of 4 components: personal rights, personal freedom and choice, tolerance and inclusion, access to advanced education. It showed that the best variation of components would be to use all of them for Basic Human Needs, Foundations of Wellbeing and Opportunity dimensions. 15 different models were tested for each dimension.

The third hypothesis (H3) was not fully supported by imperial results. It showed that a lot of components must be excluded from the "true mode" for Social Progress Index. "True model" included 12 components: nutrition and basic medical care, water and sanitation, shelter, personal safety, access to basic knowledge, access to information and communications, health and wellness, environmental quality, personal rights, personal freedom and choice, tolerance and inclusion, access to advanced education. Using Bayesian model averaging approach, I councluded that the best model included only intercept, shelter, tolerance and inclusion. The rest of

components showed quite low probability of inclusion, however, none of them showed 0 posterior probability. The results from last hypothesis bring new challenges for current research and further investigation is required

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Appendix : A

Table A1: Variations of models for Basic Human Needs

model#	Basic Human Needs=
model11	Nutrition and Basic Medical Care+Water and Sanitation+Shelter+Personal Safety
model12	Nutrition and Basic Medical Care+Water and Sanitation+Shelter
model13	Nutrition and Basic Medical Care+Water and Sanitation
model14	Nutrition and Basic Medical Care
model15	Water and Sanitation
model16	Shelter
model17	Personal Safety
model18	Nutrition and Basic Medical Care+Shelter
model19	Nutrition and Basic Medical Care+Personal Safety
model20	Water and Sanitation+Shelter
model21	Water and Sanitation+Personal Safety
model22	Shelter+Personal Safety
model23	Nutrition and Basic Medical Care+Water and Sanitation+Personal Safety
model24	Water and Sanitation+Shelter+Personal Safety
model25	Nutrition and Basic Medical Care+Shelter+Personal Safety

Table A2: Variations of models for Foundations of Wellbeing

model#	Foundations of Wellbeing=
model211	Access to Basic Knowledge+Access to Information and Communications+HealthvsWellness+ +Environmental Quality
model212	Access to Basic Knowledge+Access to Information and Communications+HealthvsWellness
model213	Access to Basic Knowledge+Access to nformation and Communications
mode214	Access to Basic Knowledge
model215	Access to Information and Communications
model216	HealthvsWellness
model217	Environmental Quality
mode218	Access to Basic Knowledge+Access to Information and Communications+Environmental Quality

model219	Access to Basic Knowledge+Environmental Quality
model220	Access to Basic Knowledge+HealthvsWellness+Environmental Quality
model221	Access to Basic Knowledge+HealthvsWellness
model222	Access to Information and Communications+HealthvsWellness+Environmental Quality
model223	Health vs Wellness+Environmental Quality
model224	Access to Information and Communications HealthvsWellness
model225	Access to Information and Communications+Environmental Quality

Table A3: Variations of models for Opportunity

model#	**Opportunity=**
model311	Personal Rights+Personal Freedom and Choice+Tolerance and Inclusion+ +Access to Advanced Education
model312	Personal Rights
model131	Personal Freedom and Choice.
model314	Tolerance and Inclusion
model315	Access to Advanced Education.
model316	Personal Rights+Personal Freedom and Choice
model317	Personal Rights+Tolerance and Inclusion
model318	Personal Rights+Access to Advanced Education
model319	Personal Freedom and Choice+Tolerance and Inclusion
model320	Personal Freedom and Choice+Access to Advanced Education
model321	Tolerance and Inclusion+Access to Advanced Education
model322	Personal Rights+Personal Freedom and Choice+Tolerance and Inclusion.
model323	Personal Rights+Personal Freedom and Choice+Access to Advanced Education
model324	Personal Freedom and Choice+Tolerance and Inclusion+Access to Advanced Education
model325	Personal Rights+Tolerance and Inclusion+Access to Advanced Education

Table A4: List of countries and indexes

country	GDP PPP (constant 2011 international $)	Social Progress Index	Basic Human Needs	Foundations of Wellbeing	Opportunity	Nutrition and Basic Medical Care	Water and Sanitation	Shelter	Personal Safety	Access to Basic Knowledge	Access to Information and Communications	Health and Wellness	Environmental Quality	Personal Rights	Personal Freedom and Choice	Tolerance and Inclusion	Access to Advanced Education
Angola	6,955	39,7	43,74	49,73	25,65	62,41	27,69	31,12	53,73	52,19	52,23	51,58	42,91	21,36	23,77	43,13	14,32
Argentina	18,8	75,2	82,48	76,04	67,08	97,29	98,31	66,59	67,75	94,89	80,93	64,62	63,73	67,2	67,11	74,33	59,67
Australia	43,219	89,13	94,81	85,72	86,84	99,39	100	86,77	93,1	97,43	89,49	71,56	84,41	97,73	87,45	80,87	81,33
Austria	43,908	86,6	95,67	86,84	77,28	99,46	100	90,03	93,2	96,15	90,97	71,19	89,04	87,7	85,66	72,67	63,09
Azerbaijan	16,71	63,75	82,09	69,32	39,82	95,55	76,99	80,52	75,31	95,88	67,5	60,16	53,76	14,21	49,05	44,14	51,87
Belgium	40,823	86,19	94,34	85,46	78,79	99,18	99,83	89,76	88,57	95,41	91,55	67,28	87,58	85,43	85,21	74,16	70,36
Bosnia,Her	9,49	65,84	86,55	68,89	42,09	99,09	94,8	75,76	76,56	88,85	76,26	64,37	46,08	52,84	46,62	32,72	36,17
Canada	42,778	89,49	95,14	83,76	89,58	99,16	99,43	89,2	92,79	99,74	85,67	73,11	76,53	97,73	89,3	83,88	87,42
Chile	21,98	82,12	88,2	82,6	75,56	98,07	96,31	80,55	77,87	96,34	84,08	67,84	82,16	96,59	77,06	71,88	56,71
China	12,599	62,1	79,31	67,96	39,03	94,47	81,7	76,72	64,35	95,41	55,9	67,66	52,86	4,55	70,9	34,16	46,53
Colombia	12,743	70,84	74,31	77,34	60,86	93,89	78,4	76,31	48,62	90,85	72,83	73,63	72,06	63,12	66,17	59,96	54,2
Croatia	20,033	77,68	91,54	79,51	62	99,32	98,76	84,91	83,16	94,61	81,91	62,42	79,12	75,2	65,2	48,53	59,09
Czech Rep	28,715	82,8	96,17	82,57	69,66	99,29	99,71	90	95,68	97,92	90,35	63,9	78,11	75,7	77,48	57,42	68,03
Denmark	42,758	89,39	96,63	88,56	82,97	99,23	99,87	93,59	93,85	98,77	95,8	68,82	90,85	88,84	90,43	79,27	73,35
Estonia	26,612	82,62	92,03	82,63	73,19	99,38	97,75	87,89	83,09	98,79	91,67	59,94	80,14	97,73	77,75	48,33	68,96
Finland	38,535	90,09	96,11	87,61	86,56	99,63	99,23	92,44	93,13	96,97	95,16	68,14	90,19	97,73	91,76	84,2	72,57
France	37,214	84,79	92,57	87,03	74,78	99,22	99,56	86,93	84,55	99,34	87,69	71,5	89,58	80,6	82,56	62,4	73,57
Georgia	7,233	69,17	85,71	71,83	49,97	95,51	90,16	74,65	82,49	98,29	76,29	59,24	53,51	70,87	57,12	25,93	45,95
Germany	43,602	86,42	94,42	87,41	77,42	99,3	99,75	88,95	89,7	97,66	92,05	70,16	89,77	79,11	84,68	71,34	74,53

country	GDP PPP (constant 2011 international $)	Social Progress Index	Basic Human Needs	Foundations of Wellbeing	Opportunity	Nutrition and Basic Medical Care	Water and Sanitation	Shelter	Personal Safety	Access to Basic Knowledge	Access to Information and Communications	Health and Wellness	Environmental Quality	Personal Rights	Personal Freedom and Choice	Tolerance and Inclusion	Access to Advanced Education
Greece	24,372	78,27	90,62	83,18	60,99	99,22	99,67	82,43	81,17	97,47	78,66	75,36	81,23	64,29	58,39	53,62	67,67
Hungary	23,735	76,88	90,84	77,29	62,52	99	98,89	85,82	79,63	96,74	83,32	51,7	77,39	65,43	66,38	53,47	64,78
India	5,439	53,92	64,66	58,59	38,51	83,38	57,24	57,49	60,53	80,23	54,33	51,78	48,03	39,43	56,42	24,91	33,28
Ireland	48,431	87,94	93,41	85,42	84,99	99,29	95,31	89,39	89,65	97,62	90,5	71,21	82,33	87,7	85,23	84,9	82,12
Israel	31,485	75,32	88,85	83,33	53,78	99,17	100	82,11	74,1	98,18	80,33	74,96	79,86	37,76	70,19	34,02	73,15
Italy	33,039	82,49	89,19	86,11	72,18	99,42	99,84	85,38	72,1	98,38	79,52	78,19	88,33	88,63	63,52	63,34	73,23
Japan	35,635	86,54	96,17	87,1	76,36	99,27	99,58	92,25	93,56	99,86	87,19	79,69	81,66	95,45	78,89	56,75	74,35
Lebanon	16,659	64,42	76,03	73,23	43,99	97,9	86,94	62,34	56,95	83,46	77,08	70,08	62,28	39,37	54,92	34,14	47,54
Lithuania	25,813	76,94	88,09	77,07	65,65	99,06	91,19	81,01	81,09	98,03	85,64	48,71	75,91	73,43	69,36	54,05	65,76
Malaysia	24,46	70,08	88,45	73,31	48,48	97,24	94,48	87,06	75,02	88,39	75	63,14	66,71	32,52	60,84	45,72	54,84
Mexico	16,284	70,02	78,15	72,91	59	96,81	89,42	76,46	49,91	89,8	62,58	64,86	74,38	71,7	61,77	48,36	54,18
Moldova	4,754	64,73	80,25	64,91	49,02	97,61	71,09	75	77,31	91,42	75,65	48,62	43,96	60,84	53,12	39,7	42,44
Netherlands	45,691	88,65	95,23	88,86	81,85	99,24	99,26	92,44	90	99,16	94,7	74,39	87,21	87,7	89,63	76,52	73,54
New Zealand	33,36	88,45	93,52	85,33	86,51	99,08	99,87	86,11	89,01	97,5	92,42	69,7	81,69	98,86	87,82	83,96	75,41
Nigeria	5,639	46,49	46,63	60,47	32,38	66,93	30,33	44,52	44,74	54,92	64,29	63,74	58,93	35,43	41,46	32,45	20,18
Norway	64,004	88,7	95,19	89,37	81,55	99,39	99,37	88,3	93,69	98,83	96,06	73,25	89,31	87,7	89,92	78,84	69,74
Poland	23,976	9,76	90,97	80,15	68,16	99,18	97,16	79,94	87,59	97,85	86,59	59,29	76,88	82,02	71,49	52,2	66,95
Portugal	26,184	83,88	93,14	84,17	74,34	99,05	99,89	85,04	88,58	98,32	84,38	70,48	83,52	83,15	78,01	75,8	60,39
Romania	19,098	72,23	84,26	74,91	57,52	98,04	82,96	76,45	79,6	93,81	78,69	59,4	67,72	63,16	68,03	43,33	55,58
Russia	23,293	64,19	79,31	69,27	44	97,88	83,43	77,78	58,15	97,63	75,12	39,08	65,25	25,42	56,4	36,15	82,08
Slovenia	28,153	84,27	93,75	83,13	75,92	99,45	99,15	83,53	92,89	98,74	84,83	65,82	83,13	90,9	80,26	67,83	64,68

country	GDP PPP (constant 2011 international $)	Social Progress Index	Basic Human Needs	Foundations of Wellbeing	Opportunity	Nutrition and Basic Medical Care	Water and Sanitation	Shelter	Personal Safety	Access to Basic Knowledge	Access to Information and Communications	Health and Wellness	Environmental Quality	Personal Rights	Personal Freedom and Choice	Tolerance and Inclusion	Access to Advanced Education
S. Korea	33,629	80,92	92,21	82,01	68,55	99,13	92,49	86,36	90,87	96,6	85,75	71,34	74,35	66,28	71,09	60,82	75,99
Spain	31,802	85,88	92,74	88,25	76,67	99,31	99,95	86,51	85,2	99,48	86,23	76,16	91,12	83,15	74,44	76,09	72,98
Sweden	44,034	88,8	95,42	88,68	82,31	99,43	99,77	88,42	94,04	95,68	94,44	72,33	92,28	87,7	88,09	79,62	73,85
Switzerland	55,26	88,87	96,26	88,44	81,89	99,38	99,96	91,8	93,92	96,86	91,34	75,22	90,34	87,7	89,6	75,39	74,88
Tanzania	2,421	49,99	47,13	60,95	41,9	66,84	23,35	36,47	61,84	61,14	51,57	64,31	66,79	48,84	54,01	39,04	25,7
Thailand	15,012	67,43	80,46	73,11	48,72	94,78	84,89	82,49	59,67	91,5	67,95	67,23	65,78	31,87	72,04	40,24	50,74
Turkey	18,869	67,82	84,72	70,03	48,69	97,94	98,33	79,71	62,92	94,93	68,61	62,33	54,25	52,25	57	38,98	46,54
UK	38,178	88,58	93,04	87,91	84,79	99,14	99,74	87,88	85,39	98,6	90,14	71,47	91,44	97,73	87,95	71,3	82,2
USA	52,118	84,62	92,81	80,3	80,75	98,81	98,78	90,35	83,31	95,82	87,35	62,3	75,73	82,03	83,12	71,02	86,82