University of Economics in Prague

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Major: Economic analysis

Effect of income inequality on quality of tertiary education: Should professors from Cambridge thank to Robin Hood?

Diploma thesis

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Hereby I declare on my honor that I wrote this master thesis independently, and used no other sources and aids than those indicated.

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Abstrakt

Kvalitu vysokých škol ovlivňuje mnoho faktorů. Současný výzkum nejčastěji pracuje s čistě ekonomickými veličinami jako HDP, výdaje na terciární vzdělání atd. Objevují se ovšem i práce, které zkoumají vliv sociálních aspektů na kvalitu terciárního vzdělání. V této práci jsem zkoumal, jaký vliv na kvalitu terciárního vzdělání má rozdělení příjmů ve společnosti. Pomocí analýzy socioekonomických dat z 76 zemí se mi podařilo dokázat, že neexistuje lineární vztah mezi rozdělením příjmů ve společnosti a kvalitou terciárního vzdělání. Dále se mi podařily identifikovat hlavní veličiny, které ovlivňují kvalitu terciárního vzdělání – velikost populace, HDP na obyvatele a fakt, že v dané zemi je hlavním jazykem angličtina. Modifikovaná verze modelu ukázala také pozitivní vliv výdajů na vědu a výzkum na kvalitu terciárního vzdělání.

Klíčová slova: Kvalita vzdělání, Giniho koeficient, nerovnost příjmů, Tobit model

Abstract

Many factors influence quality of higher education. Current research mostly works with economic factors (GDP, higher education expenditures etc.). However, there are also publications that examine an impact of sociological aspects on quality of higher education. My research examined the impact of income inequality on quality of tertiary education. In the analysis of socioeconomic data of 76 countries I have proven that there is no linear relationship between income inequality and quality of tertiary education. According to my results the size of population, GDP per capita and being English speaking country are main drivers of quality of tertiary education. Modified model without outliers also shows that there is a positive effect of R&D expenditures on quality of tertiary education.

Keywords: Education quality, Gini coefficient, income inequality, Tobit model

JEL Klasifikace / JEL Classification: I21, I24, I28, C24

Content

1. Introduction

Since an education is considered to be an investment in individual´s human capital, education has become the relevant economic topic for many researchers. After discovery of the theory of human capital by Theodore Schultz and Garry Becker, Mincer (1974) also quantified a gain of individual investment in human capital using wage differential between educated and non-educated people. Now for many researchers and policy makers the question has become important again: What is the main driver of quality of education?

There are several studies that examined drivers of quality of tertiary education. Li, Shankhar and Tang (2009) examined why US universities dominate academic rankings. They examined the impact of socioeconomic factors of several countries on quality of tertiary education. They found out that financial resources and the size of population mainly influence the quality of tertiary education.

Also Depkem and Mazonaite (2009) made their own research and examined which socioeconomic factors influence quality of tertiary education. In their research also GDP per capita was significant. They also identified out a strong impact of other socioeconomic factors on quality of tertiary education, which were not mentioned in the paper of Li, Shankhar and Tang – amongst them freedom, illiteracy and the level of industrialization of the country. According to these results we can say that not only economic factors (spending on education, GDP per capita etc.) influence the quality of higher education.

In this paper I have examined the effect of income inequality and quality of tertiary education. As Alessina and Dani (1994) discovered a negative relationship between inequality and economic growth and Li, Shankhar and Tang discovered a positive relationship between GDP per capita and quality of education I have assumed a negative relationship between income inequality and quality of education. For my research I have used Tobit model to overcome the problems of latent variables.

My sample, which I have obtained mainly from The World Bank Database, showed that there is no clear relationship between income inequality and quality of tertiary education. This result supported the hypothesis of many researchers (for example Kuznets, 1955) that there is no linear relationship between income inequality and economic growth.

In my research I have expected a presence of endogeneity – higher quality of universities and better education may create a kind of very educated high-class society and increase the income inequality in the country. However if there is no clear relationship between income inequality and quality of tertiary education, the presence of endogeneity is not likely in my sample.

The balance of my work proceeds as follows. In section 2 I have presented the concept of income inequality, showed methods of measurement of income inequality and discussed which method is the most suitable for my analysis. In section 3 I have discussed academic quality and compared particular academic rankings according to their methodology. In section 4 I have described my data and shown descriptive statistics. In section 5 I have introduced the Tobit model, discussed used variables and showed results of my econometric analysis including statistical verification included. Discussion of results and recommendations for public policy are written in section 6. Section 7 concludes my work and discusses the potential fields of future research.

2. Income inequality

2.1. Income inequality and economic growth

In the view of the effect of income inequality on economic growth prevail that there is a negative relationship between income inequality and economic growth (for example, Persson and Tabellini, 1991). According to Persson and Tabellini income inequality is harmful for economic growth because it leads to policies, which do not allow full private appropriation of returns from investment.

On the other hand some economists found out the non-linear relationship between income inequality and economic growth. Kuznets (1955) examined a data from United States, United Kingdom and Germany and found an inverted U-shaped relationship between income inequality and economic growth (measured by GNP). Income inequality increases during the early stage of development (due to urbanization and industrialization) and then it decreases when industries attract a larger fraction of the rural labor force.

Aghion, Caroli and García-Peñalosa (1999) also identified at least three reasons why inequality may have a direct negative effect on the growth:

1. Inequality reduces investment opportunities
2. Inequality worsens borrowers´ incentives
3. Inequality generates macro-economic volatility

Thus redistribution could be growth-enhancing in such an economic environment.

There is no clear linear impact of education on income inequality. Rehme (2006) found that higher education does not necessarily decrease inequality. He says that firstly an increase in education rises and then it decreases income inequality measured by Gini index. Ravi and Glom (1992) examined the effect of investment in human capital using overlapping generations model. They identified the difference between public education and private education. The income inequality declines faster in the system of public education. Private education also generates higher incomes.

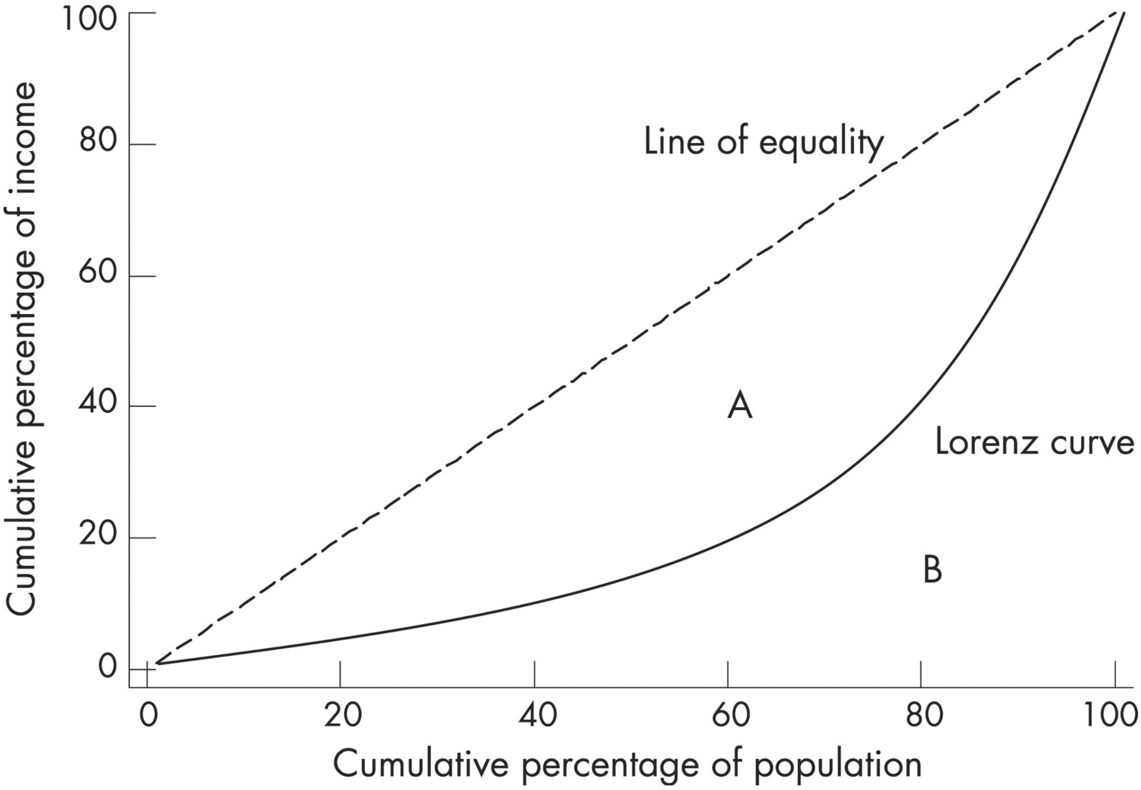
2.2. Measurement of inequality

The most frequently used tool for measuring income inequality are Lorenz curve and Gini coefficient. Lorenz curve (*L)* plots the percentage of total income earned in population when population is ordered by the size of income (for example, Gastwirth, 1971). Absolute equality of incomes in society is presented by 45˚ degrees line (*P)*. More convex Lorenz curve indicates higher income inequality in the society.

The Gini coefficient is derived from the Lorenz curve. The Gini coefficient refers to the ratio of the area between the Lorenz curve and 45˚ degree line to the area 45˚ degree line (which is ½). It is calculated as an integral that summarizes how much the Lorenz curve deviates from perfect equality (Farris, 2010).

The area between the Lorenz curve and 45˚ degree line is called area of concentration. Gini coefficient values range from 0 to 1. Value of 0 represents perfect equality where every person in society has the same share of good and value of 1 represents a situation in society where one person owns everything (Farris, 2010). A typical Lorenz curve is shown below:

Figure 1 – Lorenz curve



Source: edEcon, 2014

Based on Lorenz curve presented in Figure 1 the formula for calculation of Gini coefficient is following:

$$G = \frac{A}{A + B}$$

According to Krol and Miedema (2009) there are two main problems of Gini coefficient.

Gini coefficient measures the size of an area rather than a shape so countries with similar Gini coefficients may still have different income distributions.

The Gini coefficient is the most sensitive to inequalities and income transfers in the middle part of the income spectrum and it does not emphasize inequalities in the top or bottom spectrum.

Krol and Miedema also described other methods how to measure income inequality: Robin Hood index, Theil´s Entropy measure, Atkinson index and Coefficient of variation.

The Robin Hood index is another indicator of income inequality derived from Lorenz curve. It measures the portion of total income that would need to be redistributed in order to have a perfect equality.

The Robin Hood index is easy to interpret but much like Gini index it is not sensitive to income transfers between households on the same side of the mean income.

Median share of income measures the proportion of income held by households whose incomes fall below median household income. This measure is very simple to calculate but it is not sensitive to varying proportions of the income distribution within the upper or lower 50% of the distribution.

Thiel´s Entropy measure is based on an income contribution or share that each individual or groups holds. There are two ways how to calculate Thiel´s Entropy measure – individual level calculation and group level calculation. When individual data is available, each individual has an identical population share (1/N) so each individual´s Thiel´s Entropy measure is determined by his proportional distance from the mean.

Calculation of Thiel´s Entropy measure is difficult and interpretation is hard. Thiel´s Entropy measure also cannot be used to compare populations with different sizes or group structures because the calculation is dependent on number of individuals in the population or group.

The Atkinson index is an inequality measure, which can vary between 0 and 1. The Atkinson index is the most suitable for comparison between regions (like the Gini coefficient). In the addition Atkinson index includes a sensitivity parameter (ε) which can range from 0 to infinity. As the sensitivity parameter approaches higher values, the Atkinson index is more sensitive to changes at the lowest income groups. As the sensitivity index approaches 0, the Atkinson index is more sensitive to changes at the higher income groups. The Atkinson index is represented by the following equation:

$$I = 1 - y_\varepsilon / \mu$$

where I is the Atkinson index, y_ε is the equity sensitive average income and μ is the mean income. If an income distribution in society is more equal, the y_ε is closer to μ and therefore it leads to lower Atkinson index (I).

The main advantage of using Atkinson index is that a sensitivity parameter is directly included into the equation. On the other hand the sensitivity parameter means that a subjective judgment has been made about inequality and thus this index is not too intuitive.

The coefficient of variation represents other way how to calculate an inequality in a society. To calculate coefficient of variation requires dividing the standard deviation of income distribution by the mean of the same distribution. More equal income distributions will be represented by lower coefficient of variation.

Coefficient of variation is not suitable tool to measure income inequality because outliers influence the mean and standard deviation used for calculation and incomes are not normally distributed. So results are affected in this way.

In my analysis I have chosen the Gini index due to availability of data and simple interpretation of results. The Gini index also allows comparing income inequality between geographic areas.

An alternative to Gini index is the Robin Hood index, but Gini index seems to be better indicator due to mentioned availability of data. On the other hand, median share of income, Atkinson index, Thiel´s Entropy measure and coefficient of variation are not suitable indexes for my analysis due to their imperfections (Krol and Miedema, 2009). Median share of income is not sensitive to varying proportions of the income distribution within the upper or lower 50% of the distribution. The Atkinson index involves a judgment about inequality. Thiel´s Entropy measure does not allow to compare countries with different size of populations directly, which is absolutely not suitable for my analysis considering that my dataset contains 76 different countries. Coefficient of variation cannot be used if income distribution is not normal.

3. Academic quality

Mincer in his work (1972) empirically proved that individual´s income depends on years of schooling and years of working experience. Further according to Becker (1992) individuals make a decision on their education and training by weighting of costs and benefits. Costs are not only financial but especially in terms opportunity costs (duration of study).

Investment in education is a kind of investment under uncertainty. Individuals do not know if their investment in higher education will be adequately rewarded on labor market. This uncertainty comes from information asymmetry on labor market. We can describe this problem using Akerlof's theory of "Lemon market" (Akerlof, 1970).

Let´s assume that there are two groups of people on the market: people with productivity A and people with productivity B. Let´s also assume that A>B. Potential employer is willing to pay wage 1 to people with productivity B and wage 2 to people with productivity A. Both groups of people are demonstrating their skills on the job market, although the demonstrated skill may vary from the real skill of people (people with productivity B may pretend that they productivity is A). If potential employer is not able to distinguish between A and B groups, he will offer wage 1 to both groups. That means potential employers need some proof in order to distinguish those two groups of people.

Spence (1973) solved this problem using job market signaling theory. As I have described before, hiring a new employee means making a decision under uncertainty. To overcome this uncertainty a potential employer should collect all relevant information about potential employee. Considering that collecting information is costly, it is very expensive for potential employer to get all relevant information he needs. If potential employee provides relevant signal about his skills he can increase his chance of hiring. Tertiary education is one of the most relevant signals.

If a person is maximizing his future wage and making a decision about his investment in human capital will choose education at university. According to signal theory this education must be considered as quality education for potential employer. If an individual invests in education that is considered as non-quality for potential employer, his investment is not evaluated.

We can see that there is a lack of information on both sides – potential employers must know individual´s productivity and potential employees must know which universities are considered as good ones.

3.1. Academic rankings

Due to rising importance of tertiary education, market based orientation and worldwide expansion of access to tertiary education cause a kind of competition between educational institutions in order to attract the most students and the best students. It is almost impossible for a common consumer (a perspective student) to get all information about quality of each educational institution in the world.

Academic rankings are trying to satisfy the demand of information about quality of universities. Academic rankings significantly reduce costs of searching the information about the academic quality and also they reduce information asymmetry. This fact has led to high importance of academic rankings and it made them the key factor in the process of evaluating quality of particular educational institution.

According to Li, Shankar and Tang (2009), academic talent can be considered as a specific type of human capital. Similar to other types of human capital, academic talent cannot be directly measured but we can measure academic performance of people.

According to Federkeil (2008) there are several instruments of quality assessment – academic rankings, institutional audit, accreditation or quality management (based on European Foundation for Quality Management or DIN ISO 9000f).

Academic rankings and league tables are the most objective and respected methods to evaluate a quality of educational institutions. Academic rankings are periodically published and they evaluate certain number of universities by selected criteria. They compare both the quality and prestige of those universities. However academic rankings are often criticized for statistical bias, inappropriate selected criteria or corruption (Dill and Soo, 2005). Dill and Soo also mentioned that this corruption is more likely to occur in Canada and US due to weaker state regulation.

The QS World University Ranking and the Academic Ranking of World Universities (ARWU) are well known and often cited by academics and the media (Hazelkorn, 2012).

The QS ranking is published annually. 873 educational institutions were ranked in 2012 and 501 institutions obtained some score. Selected criteria consist of: academic reputation – the survey of academics, employer reputation – also based on a survey, student to faculty ratio, international faculty, international students and citations per faculty. The QS ranking is criticized for its subjectivity (especially using criteria Academic reputation and Employer reputation which account for 50% of total score) and very high volatility of the rankings (Li, Shankar and Tang, 2009).

The Academic Ranking of World Universities is also published annually. 500 educational institutions were ranked in 2012 but only first 100 institutions obtained some score. Selected criteria are described in several papers (for example Buela-Casal, Gutiérrez-Martínez, Bermúdez-Sánchez, Vadillo- Muňoz, 2006): total number of the staff, the alumni winning Nobel Prize or Fields Medal (30% of the total), publications (60% of the total) and the size of institution (total scores of previous indicators is divided by the number of full-time equivalent academic staff). Size of the institution refers for 10% of the total.

Further in my analysis I have selecte the QS ranking due to availability of a large number of scored institutions. I do not consider criteria like academic reputation or employer reputation to be harmful, they are in accordance with signaling theory. Li, Shankar and Tang (2009) used ARWU ranking for their analysis due to supposed subjectivity of the QS ranking criteria. They just used a number of institutions in TOP 500 of ARWU and summed them up by country. This summarization should represent the quality of tertiary sector of each country. I found this method inappropriate because it does not take into account a difference in quality between universities, which are on the first places of the ranking, and universities that are on the bottom of the ranking.

The better method is based on indexation of points per universities by their rank. It means that for example, top 100 universities are all ranked by 5 points; universities in second percentile are ranked by 4 points etc. However, is a problem of marginal gains/loss of points for universities, which are very close to each other, but they belong to another percentile. For example, a difference between 100th university and 101st university would be much higher according to this method than it is in reality.

I have found the best method using an absolute value of score by which is a particular university ranked. This system clearly distinguishes quality between institutions and it avoids the problem of marginal gain/loss of points. For this method the QS ranking is more suitable because 501 universities obtained some score in 2012. On the other hand, only 100 universities obtained some score in the ARWU ranking. Then other universities are just sorted without score.

To see if QS ranking results are similar with ARWU ranking results I have summed up the score of top 100 universities by country also according to the QS ranking and the ARWU ranking. There is a strong positive correlation between the QS score and the ARWU score for top 100 universities summed up per country (93%). According to this result we can expect that results obtained by using the QS ranking would be very similar to results obtained by the ARWU ranking.

Another analysis of the ARWU ranking showed a big difference between country with the highest score (US) and the country with the second highest score (UK). While in case of the QS ranking the difference is 78%, using the ARWU ranking brings the difference 499%. It is obvious that the ARWU ranking favors US universities much more than the QS ranking do. Unfortunately due to lack of further scoring I am unable to make an analysis for more than 100 institutions.

The importance and popularity of academic rankings in last years proves the presence of many national rankings (Hazelkorn, 2012). Those national rankings are targeted to local students and help them overcome information asymmetry about the quality of a selected university. National academic rankings also help increasing competition between domestic universities and they push them to improve their quality. Those rankings are very important in countries with very limited number of universities rated in international rankings as the QS or the ARWU.

In addition to these rankings there are many alternative rankings (for example, The Tilburg University Top 100 Worldwide Economics Schools Research Ranking) focused on overall quality of universities or only on a particular field of study. Those rankings mainly use other criteria than traditional rankings and they may play a significant role in the future.

4. Data

4.1. Overview

In my analysis I have used a data from QS World University Rankings and macro-data about socioeconomics conditions of 76 countries.

Data obtained from QS World University Rankings are used as a dependent variable. Each ranked university in the QS ranking has a certain amount of assigned points. I have made a summarization of those points by country. The resulting value for each country is the indicator of quality of tertiary education system.

My analysis was based on data from the year 2012. In 2012 ranking 501 universities had some amount of assigned points. All points obtained by university are distributed between 50 countries. However my analysis contains only 38 countries out of those 50 due to missing explanatory data. The countries in my sample that have no ranked university in the QS ranking in 2012 are ranked by 0 points.

The macro-based data applied for modeling explanatory variables are obtained mainly from two sources – OECD iLibrary statistical database and The World Bank statistical database. All those data (except dummy variable) are averages of years 2006-2009. Average data allow me to use them as cross-sectional data which is the most appropriate way for my analysis. Average data is also the good way how to overcome "one year" specific shocks in socioeconomic data which may distort the analysis.

The gap between QS data and the last year of average of the socioeconomic data is applied in order to overcome the time-lag. We may expect that not all socioeconomic conditions are shown immediately in the quality of universities and their rankings. Li, Shankar and Tang (2009) are using four years time-lag. For my analysis three years time-lag is used due to availability of data.

I have also used dummy variable which indicates if current country is English speaking or not. The dummy variable takes default values of 0 or 1 (0 for non-English speaking countries and 1 for English speaking countries). This indicator is checked in according to CIA – The World Factbook. The overview of used data is shown in the table below

Table 1 – Overview of used variables.

Name	**Definition**	**Source**
QS	The sum of university score per country	QS World Universities Ranking 2012
GINI	Gini coefficient (average 2006-2009)	OECD iLibrary, The World Bank database
POP	Total population of country (average 2006 - 2009)	The World Bank database
GDPPC	GDP per capita based on purchasing power parity converted to international dollars (average 2006 -2009)	The World Bank database
RD	R&D expenditures (both public and private) as % of GDP[1] (average 2006-2009)	The World Bank database
EXPEDU	Public expenditures on education[2] as % of GDP (average 2006-2009)	The World Bank database
ENG	Dummy variable refers if the country is English speaking	CIA – The World Factbook

[1] Expenditures for research and development cover basic research, applied research and experimental development.

[2] Education refers to primary, secondary and tertiary.

4.2. Descriptive statistics

For statistical analysis of selected data I have used several indicators: Minimum, Maximum, Average, Median, Standard Deviation, Skewness and Kurtosis. According to those indicators we can observe the nature of the data and identify outliers.

According to descriptive statistics it is obvious that there is a huge difference of QS index in observed countries. While the minimum value is 0, the maximum value is 5473. There is also a big difference between average value of QS index (286) and median of QS index (27). Big standard deviation (747) shows us uneven distribution of QS index. Only 22% of observed countries are reaching the average value of QS index. Also only 49% of observed countries have non-zero value of QS index. The QS index is skewed right (long tail points right) and strongly leptokurtic. According to strong dominance of United States score (5473) we can expect this country will be an outlier in my analysis.

There are also big differences between explanatory variables. The biggest standard deviation (54 501 870) is observed in variable which refers for total population of country. The variation of population of selected countries is very high – from small countries like Iceland (312 815 inhabitants) or Estonia (1 341 541 inhabitants) to large countries like United States (302 619 153 inhabitants) or Russian Federation (142 115 000 inhabitants). The average is higher than median by 286% which indicates that also this variable has uneven distribution but not as uneven as QS index. Population variable is not also so skewed right and so leptokurtic as QS index is.

The GDPPC variable has also high standard deviation (14 214) but the difference between average and median is not so high (the average value is higher than median by 134%) what is supported by results of skewness and kurtosis (GDPPC is slightly skewed right and platykurtic). Only 33 countries in my sample have the same or higher GDP per capita than average GDP per capita of countries in my sample. While average value of QS index of those 33 countries is 632, the value of QS index of other countries is only 33. This may indicate a strong positive effect of the size of GDP per capita on QS index.

Despite the high difference between minimal and maximal value the public expenditures on education as % of GDP seems to be normally distributed. This fact is supported by the minimal difference between average and median (4%) and the value of skewness (0,176) and kurtosis (0,326). Surprisingly the highest % of GDP on education spends Moldova (8,385), followed by Nordic countries.

On the other hand there is a huge difference between average R&D expenditures (as % of GDP) and median of R&D expenditures. Due to this fact we can say that in general there is no big difference in public expenditures on education as % of GDP between selected countries but there is a great difference in expenditures on R&D. This fact can be explained by two ways:

1. Beside the public expenditures on education, the R&D expenditures are not only public but also private. It is possible that the difference between the public expenditures on education and R&D expenditures is given by the amount of private expenditures.
2. According to strong positive correlation between GDP per capita and R&D expenditures (80%) we can expect that R&D expenditures are a kind of luxury goods and only rich countries invest a high percentage of their GDP to research and development.

The key explanatory variable GINI is only slightly right skewed and leptokurtic. It shows us that the distribution of GINI data is rather close to normal distribution. The lowest value of Gini coefficient is measured for Slovenia, Denmark and Norway. On the other hand the highest value of Gini coefficient is measured for South Africa, Colombia and Bolivia. Using the correlation analysis I have found a negative relationship between the value of Gini coefficient and GDP per capita (-0.51). Using the correlation analysis for Gini coefficient and QS index I have found only weak negative relationship (-0.12). However this week relationship could be distorted by the fact that I have used latent variable as dependent variable (QS index).

According to ENG dummy variable we can say that 13 countries out of 76 are English speaking. The overview of descriptive statistics is shown in the table below.

Table 2 – Descriptive statistics.

	QS	GINI	POP	GDPPC	RD	EXPEDU	ENG
Min	0	0,236	312815	499	0,058	1,428	0,000
Max	5473	0,653	302619154	56428	4,649	8,385	1,000
Average	286	0,370	36133717	17472	1,059	4,725	0,171
St. Dev.	747	0,093	54501870	14215	1,053	1,327	0,377
Median	27	0,341	12615195	13080	0,596	4,910	0,000
Skewness	5,198	0,940	2,828	0,690	1,363	0,176	1,783
Kurtosis	31,964	0,226	9,108	-0,625	1,204	0,326	1,208

Source: Own calculations based on data described in Table 1

The relationship between individual variables was tested by correlations. The correlation matrix is shown below.

Table 3 - Correlation coefficients, using the observations 1 – 76.

	QS	ExpEdu	Gini	POP	GDPPC	R_D	ENG
QS	1,0000	0,1374	-0,1143	0,5544	0,5173	0,4431	0,3588
ExpEdu		1,0000	-0,2897	-0,1642	0,4390	0,4662	-0,0909
Gini			1,0000	0,1258	-0,5105	-0,4464	0,1422
POP				1,0000	0,0475	0,0952	0,2365
GDPPC					1,0000	0,7970	0,0583
R_D						1,0000	0,0231
ENG							1,0000

Source: Own calculations based on data described in Table 1

5. Model

5.1. Methodology

As one half of examined countries have a zero QS score we can see that a dependent variable has the form of latent variable – depended variable is not observed when it falls below a certain value (z) while explanatory variables are available.

Countries with a zero QS score cannot be simply excluded because of selection bias. While OLS model is unsuitable to use for this kind of data (dependent variable is not measured for all cases) I have used Tobit model (a kind of Limited Dependent Variable models) to accommodate for zero and non-negative observations. The Tobit model is easily defined by equation:

$$y^* = X\beta + u; \quad u \sim N(0, \sigma^2)$$

This is related by observation of binary variable y by:

$$y_i = \begin{cases} y_i^*, & y_i^* > z \\ 0, & otherwise \end{cases}$$

The estimation of Tobit model is based on maximization of likelihood function. The maximum likelihood estimates of β and σ is obtained by maximization of the log-likelihood, where log-likelihood is the natural logarithm of the likelihood function (Wooldridge, 2012).

According to Li, Shankar and Tang (2009) the number of universities in top 500 in ARWU ranking summed up by country (in my analysis QS index) represents a function of the size of the country´s academic talent stock A over some threshold level A*, which is a function of the "world"[3] average level of academic talent stock. Since academic talent is the latent variable, the Tobit model is given by equation:

$$y_i = \begin{cases} \ln\left({}^{A}/_{A^*}\right), & \ln\left({}^{A}/_{A^*}\right) > 0 \\ 0, & otherwise \end{cases}$$

where y_i is QS index for 2012.

Since the dependent variable measures a country´s talent stock against the "world" average, the explanatory variables should be also measured relatively to their "world" average values. However, using the cross-section data solves the problem because the "world" average values of explanatory variables can be absorbed into the constant term (Li, Shankar and Tang, 2009).

The variable ENG, referring whether the country is English speaking or not, is in the binary form (dummy variable). A dummy variable is used for description of two

[3] "world"refers to all countries in my sample

states (the most often used example is man/woman) and it can takes value of 0 or 1. Since I have used ENG = 1 for English speaking countries and ENG = 0 for other countries, dummy variable is used as a control variable to measure the additional effect of English language to quality of education. Omitting of other control variables and using only model with a constant and dummy variable is a straightforward way to compare the means of two groups (Wooldridge, 2012). This simple model is described by the equation:

$$QS = \alpha + \delta_0 ENG + u$$

The parameter δ_0 is a difference between quality of education (QS index) of English speaking countries and other countries. Thus parameter δ_0 determines if English speaking countries have an advantage against other countries (in terms of quality of education). If δ_0>0 there is an advantage to be an English speaking countries. If parameter δ_0 is negative, there is a disadvantage of English speaking countries. In terms of expectations we can describe:

$$\delta_0 = E(QS|English\ speaking) - E(QS|Others)$$

5.2. Variables

In the econometric analysis I have used variables shown in the Table 1. As a dependent variable I have used QS which is the proxy variable measuring the quality of tertiary education system. As a dependent variables I have chosen socioeconomic data which could influence (both negatively and positively) quality of tertiary education. My model includes those dependent variables: logarithm of population size (LPOP), logarithm of GDP per capita (LGDPPC), R&D expenditures as % of GDP, public expenditures on education as % of GDP, Gini coefficient and dummy ENG.

The expected effect of logarithm of population size on quality of tertiary education is positive. If the academic talent is randomly distributed around the world we can expect that country with larger population should have larger academic stock (Li, Shankar and Tang, 2009) and higher probability to find more academic talented people. The expected effect of logarithm of GDP per capita is also positive. This variable is used as indicator of financial resources available in the particular country. Intuitively wealthier countries could be able to spend more money on tertiary education.

Public expenditures on education measure a specific source of financing of education system. Expected effect of public expenditures on education system is positive and there are two channels of this effect. At first, public expenditures on education system contains expenditures on all three levels of education – primary, secondary, tertiary. The first channel is direct allocation of financial resources from government to tertiary education sector. The second one is indirect channel, which is focused on primary and secondary education. Higher expenditures on primary and secondary education improve their quality and they produce prospective tertiary students and academics (Li, Shankar and Tang, 2009). So the second channel is creating higher stock of human capital for tertiary sector.

R&D expenditures (both public and private) as % of GDP also measure a specific source of financing of education system. Hazelkorn (2012) mentioned that in many countries like Russia the strategic research and development is based outside the universities. However, according to correlation analysis R&D expenditures are connected more directly with tertiary education than public expenditures. Even if research and development is not observed only at universities, we can expect a good spillover effect between academic and non-academic institutions (Belleflamme and Peitz, 2010). We can also assume that a motivation of tertiary students and scholars are higher if there are significant expenditures on research and development in their country. High expenditures on research and development could indicate that R&D institutions are significant employers on national labor market. People who would like to be employed in R&D should demonstrate their skills via their own research and publication which increases the score of university in rankings. High expenditures on R&D could also demonstrate that researchers are well paid which may also increase the motivation of students and scholars.

The English language dummy tests if English speaking countries have an advantage of their research due to the fact that a research and publications are mostly done in English (Li, Shankar and Tang, 2009). According to Liu and Cheng (2005) scholars in English speaking countries are more integrated into the global academic environment than scholars outside the English-speaking world and it may lead to bias against institutions outside the English-speaking world.

There are many institutions outside the English-speaking world that teach and publish in English (for example, many universities in Netherlands offer master´s study only in English) but this argument is no so strong to reject an expectation of a significant positive effect of English language to quality of tertiary education. Scholars at universities outside the English-speaking world have to invest their human capital to handle English language and they could not invest this amount of their human capital in research and publishing. This hypothesis is supported by Hazelkorn (2012) who also mentioned that publications written in English language are more widely read and thus more widely cited. He also mentioned that authors are more likely to reference other authors whom they know or authors from their own country.

Therefore non-English language research is cited less often, because researchers from US universities tend to cite colleagues they know. Considering the size and quality of US tertiary sector, this phenomenon may play a key role in the importance of ENG variable.

Gini coefficient shows us what kind of income distribution is in a certain country (how egalitarian the society is). It is rather difficult to estimate the effect of distribution of income in society on quality of universities and this is the goal of this work. However, according to results of Li, Shankar and Tang (2009) GDP per capita is a significant factor which influences quality of tertiary education. If we use the GDP per capita as a proxy of quality of universities we can expect the same effect of Gini coefficient on economic growth and quality of universities. Alesina and Dani (1994) found the negative effect between income inequality and economic growth.

We can also discuss an impact of social environment on quality of tertiary education. According to human capital theory, individuals consider their education as investment in their human capital. As with any investment, they expect some rate of return. As the study of Persson and Tabellini (1991) shows that in a society with income inequality policies does not allow full private returns from investment we can say that also returns from investment in human capital will be negatively affected. In the society with low returns of investment in human capital we can consider that individuals will be less willing to invest their money, time and effort in higher education. This fact may negatively affect the quality of students and therefore the quality of universities in a particular country. It may also lead to migration of the most talented individuals to study and do research in other country.

Using this logic we can expect that the effect of Gini coefficient on quality of tertiary education should be negative.

The mathematical notation of the tested model is following:

$$QS_i = \alpha + \beta_1 EXPEDU_i + \beta_2 GINI_i + \beta_3 RD_i + \beta_4 LPOP_i + \beta_5 LGDPPC_i + \delta_0 ENG_i + u$$

$$i = 1,\ldots,76$$

where α refers to a constant, β refers to estimated parameters, δ refers to estimated parameter of dummy variable, u refers to error and i refers to number of observations.

5.3. Results

At first I have run Tobit model with 6 explanatory variables using 76 observations. The results of this model are shown and described below.

Model 1: Tobit, using observations 1-76

Dependent variable: QS

Standard errors based on Hessian

	Coefficient	*Std. Error*	*p-value*
CONST (alpha)	-17490,8	2391,78	<0.00001***[4]
EXPEDU	-56,5064	97,5789	0,56253
GINI	755,014	1079,15	0,48416
RD	128,552	110,044	0,24273
LPOP	488,758	79,0741	<0,00001***
LGDPPC	926,777	178,76	<0,00001***
ENG	910,408	209,994	0,00001***

[4] *, **, *** indicates significance at the 10%, 5% and 1% level.

Statistics of the model

p-value	2,91e-20
Log-likelihood value	-304,6716
Sigma	554,496

Source: Own calculations based on data described in Table 1

According to results obtained by using Tobit model for 76 observations we can see that the model is significant on 1% level of significance (p-value < 0,01). Alpha is negative due to using latent variable. Besides the alpha there are three variables statistically significant on 1% level of significance – logarithm of population, logarithm of GDP per capita and dummy variable for English language (all of them have p-value < 0,001). On the other hand public expenditures on education, Gini coefficient and R&D expenditures are not statistically significant even on 10% level of significance. Based on this model we can say that only total population, GDP per capita and English language have (positive) effect on quality of tertiary education. Reasons are discussed in section below.

I have run also the OLS model (Model 2) based on the same parameters as the Model 1 to compare estimated coefficients with Model 1. There are three significant differences between those models. Apart from the Model 1 there is a positive effect of public expenditures on education and a negative effect of Gini coefficient. Considering that those two variables are not statistically significant in both models there is no need to take this fact into account. On the contrary we can see that OLS model underestimates the effect of GDP per capita on quality of tertiary education.

Model 2: OLS, using observations 1-76

Dependent variable: QS

	Coefficient	*Std. Error*	*p-value*
CONST (alpha)	-5007,97	1265,81	0,00018***
EXPEDU	40,1116	59,6288	0,50339
GINI	-40,4414	830,704	0,96131
RD	148,899	98,3442	0,13458
LPOP	194,499	54,7069	0,00069***
LGDPPC	177,063	80,624	0,03144**
ENG	591,912	186,136	0,00221***

R^2	0,453
Adjusted R^2	0,406

Source: Own calculations based on data described in Table 1

In the next model (Model 3) I have excluded a big outlier (United States) from analyzed observations due to the fact that the score of their QS index is higher by 90% compared with the second highest QS index country (United Kingdom) and higher by 1837% than average QS index of countries in my sample.

Model 3: Tobit, using observations 1-75

Dependent variable: QS

Standard errors based on Hessian

	Coefficient	*Std. Error*	*p-value*
CONST (alpha)	-11248,6	1598,88	<0,00001***
EXPEDU	-61,9627	60,2702	0,30391
GINI	187,658	664,217	0,77754
RD	91,8855	67,9471	0,17628
LPOP	304,322	51,6054	<0,00001***
LGDPPC	646,12	115,179	<0,00001***
ENG	579,946	135,597	0,00002***

Statistics of the model

p-value	7,56e-18
Log-likelihood value	-279,6502
Sigma	343,162

Source: Own calculations based on data described in Table 1

According to results obtained by Model 3 we can see that this model is also significant on the 1% level of significance. Alpha is less negative due to excluding the US from the model. According to significance of explanatory variables the result of this model is the same as Model 1. It is obvious that excluding the US did not have a big effect on the key factors of model.

Comparing results of Model 3 with the OLS model based on the same parameters (also with excluded the US) shows us that OLS model (Model 4) underestimates the effect of GDP per capita, although it overestimates the effect of R&D expenditures on quality of tertiary education.

Model 4: OLS, using observations 1-75

Dependent variable: QS

	Coefficient	*Std. Error*	*p-value*
CONST (alpha)	-2953,62	772,375	0,00029***
EXPEDU	9,98002	35,4659	0,77926
GINI	-259,909	493,072	0,59982
RD	112,15	58,4182	0,05908*
LPOP	114,066	33,2155	0,00102***
LGDPPC	126,245	48,0283	0,01059**
ENG	324,638	112,894	0,00538***

R^2	0,469
Adjusted R^2	0,422

Source: Own calculations based on data described in Table 1

The next identified outlier in my sample is United Kingdom. In the following model (Model 5) I have excluded also United Kingdom from my analysis due to the fact that it´s score is higher by 64% than the score of the closest country (Germany) and higher by 920% than an average QS index of countries in my sample.

Model 5: Tobit, using observations 1-74

Dependent variable: QS

Standard errors based on Hessian

	Coefficient	*Std. Error*	*p-value*
CONST (alpha)	-8141,9	1077,27	<0,00001***
EXPEDU	-77,5698	39,1511	0,04756**
GINI	97,3895	427,468	0,81978
RD	113,247	43,8502	0,00981***
LPOP	221,519	34,026	<0,00001***
LGDPPC	484,737	77,3062	<0,00001***
ENG	313,732	92,8202	0,00072***

Statistics of the model

p-value	1,04e-22
Log-likelihood value	-256,2262
Sigma	219,994

Source: Own calculations based on data described in Table 1

Model 5 is also significant on 1% level of significance and alpha is even less negative due to excluding UK. There are three explanatory variables significant on 1% level of significance – logarithm of population, logarithm of GDP per capita and dummy for English language. R&D expenditures are also significant of 1% level of significance. Public expenditures on education are statistically significant on 5% level of significance. Based on results of this model we can say that not only total population, GDP per capita and English language derive the quality of tertiary education but also R&D expenditures do. Public expenditures on education also positively influence quality of tertiary education.

In this case the OLS model brings us the main differences in comparison with the Model 5. It overestimates the effect of GDP per capita and the effect of public expenditures and GDP per capita. However, according to the OLS model English language has no effect on quality of education.

Model 6: OLS, using observations 1-74

Dependent variable: QS

	Coefficient	*Std. Error*	*p-value*
CONST (alpha)	-2067,28	525,671	0,00020***
EXPEDU	-11,9299	23,849	0,61855
GINI	-169,599	330,059	0,60905
RD	139,751	39,2021	0,00068***
LPOP	89,1932	22,3877	0,00017***
LGDPPC	79,5276	32,5332	0,01714**
ENG	121,84	78,6783	0,12619

R^2	0,552
Adjusted R^2	0,512

Source: Own calculations based on data described in Table 1

All models were tested for the presence of heteroscedasticity (using White test) and multicolinearity. Based on those tests we can say that all models are statistically significant. Test of presence of autocorrelation is not required due to nature of the data.

I have also run additional two models with dependent variable based only on top 100 universities according to QS ranking and ARWU ranking. The reason of this analysis is to compare results given by using another academic ranking. Comparing those two models shows that Gini coefficient is significant (with a positive sign) on the 1% level of significance and English language is not significant at all in any model based on ARWU top 100. There is no other important difference between those two models. Model based on ARWU ranking shows us that more inequality in society leads to better quality of universities. Unfortunately this conclusion could be strongly affected by limited number of scored institutions in AWRU ranking and thus not so relevant.

I have supposed a problem with endogeneity in the model based on the fact that Gini coefficient could be derived by quality of university and it is not an independent variable. This is based on hypothesis that better universities may produce a higher human capital and this fact may lead to higher wages of educated people in the society. As individuals with diploma earn much more than others there is a higher inequality in society. Results obtained by models did not support this hypothesis.

Analyzing actual vs. fitted values in the Model 1 shows a strong gain in QS index of United States against predicted value of QS index. The actual value of QS index is 5473, 27, while the fitted value is only 3276,56. There is no other country with such a big difference between actual and fitted value except low-income countries like Burundi or Mozambique. However QS index of those countries is strongly outperformed due to latent variable form of data. Using Tobit model treats this fact. The gain in QS index of United States is discussed in the next section.

6. Discussion of results

Econometric analysis revealed three key determinants of tertiary education quality – total population, GDP per capita and English language. We could also take into account R&D expenditures, which are significant in the model without outliers.

The strong positive effect of total population on quality of tertiary education supports the hypothesis that academic talent is equally distributed around the world and countries with a larger population have bigger level of academic stock.

According to R&D model (Romer model) the stock of knowledge is positively driven by population growth (Romer, 2011). Thus conclusion of Romer model supports my results.

Possible explanation of this fact is that academic talent is largely inborn (fallen from the sky) and good educational institutions may only develop this talent but they not create it. Thus even if there are many educational institutions in a country with small population, there is a lack of talented individuals who are able to fully benefit from attending the university. This fact may lead to “inflation” of diplomas in the country (many non-talented individuals with a degree) and create a bad environment for developing naturally talented individuals (they may lose their motivation or move to a country with better educational system).

GDP per capita also positively affects the quality of educational system. This result is consistent with the logic that richer countries can afford to spend more financial resources on their tertiary education.

The fact that a country is English speaking has a strong positive effect on quality of tertiary education. This result supports the hypothesis that universities in English speaking world strongly benefit from their language.

R&D investments as % of GDP are statistically significant with a model without outliers. Based on this result we can accept the hypothesis that even if strategic R&D is not done at universities there is a good channel between research and development outside the universities and the level of quality of tertiary education.

On the other hand public expenditures on education as % of GDP are not affecting the quality of tertiary education as much as R&D expenditures. There are several explanations of this fact:

1. There is no good channel between primary/secondary and tertiary education. Investments on first two levels of education do not create a larger a quality stock of perspective tertiary students. On possible explanation of this phenomenon could be a migration – talented perspective students may simply go study abroad. Another explanation is that tertiary education is not easily accessible for all individuals (for example, due to its high price). Finally environment in society can break this channel. There may be other opportunities for talented high school graduates than tertiary education (for example, entrepreneurship). The conditions of society also may not allow to individuals benefit from their university degree (very low wage differential between secondary and tertiary educated people).
2. Public expenditures are not used efficiently. This idea is supported by higher significance of R&D expenditures, which contain both public and private part of investment, on quality of tertiary education.
3. As public expenditures are expressed as a % of GDP, poor countries may spend high % of GDP on education but if the % comes from small GDP the final effect will be smaller than in case of countries with very high GDP and low % spent for education. Poor countries may be also more focused on primary and secondary education more than on tertiary education. This is supported by the

fact that R&D expenditures, which are closely connected with financing of tertiary education, are much more correlated with GDP per capita than public expenditures on education.

However, we should take into account that a channel between first/secondary education and tertiary education takes several years before it makes effect. It also takes another several years to reflect the increased quality of tertiary education in academic ranking. Unlike GDP per capita or total population, governments may sharply increase expenditures on education from a year to year. The values of public expenditures on education in my sample could be affected by some big change (even if I have used a four years average and three years time lag) and this may play a significant role in the future.

Inequality in society seems to be irrelevant for quality of tertiary education. Correlation analysis based on my data supports the statement of Alesina and Dani (1994) that inequality in society has a negative impact on economic growth. However GDP is not only one driver of quality of tertiary education. There is also not such a significant relationship between Gini coefficient and GDP per capita in my data. This conclusion is supported by work of Rehme (2007). According to results of Rehme´s model there is no functional relationship between growth and measured income inequality.

Also unclear relationship between economic inequality and quality of tertiary education is also not in any conflict with the result of Depken and Mazonaite (2009). They discovered a positive relationship between economic freedom and number of universities in top 500 by QS ranking. However, according to Bennett and Vedder (2013) there is no linear relationship between economic freedom and income inequality. They discovered that there may be and inverted U-shaped relationship between economic freedom and income inequality.

Analysis of actual vs. fitted values revealed a high outperformance of United States. It is in according to socioeconomic indicators of this country. R&D expenditures of the United States are one of the highest in my sample. This country also has a large amount of financial resources (expressed by one of the highest GDP per capita in my sample) and large population (the largest in my sample). Moreover, United States is blessed being English-speaking country.

There could be also en effect of the good reputation of universities in the US. Considering that according to university rankings the best universities are located in United States there could be a strong effect of academic migration to the US – the good reputation of the US universities may attract the most talented people in the world. The measured quality of universities based on academic rankings could be also influenced by manipulation as Dill and Soo (2005) mentioned in their work. They found out that some US universities were increasing their average score of student entry tests or they lowered their count of reported alumni.

Other indicator, which may cause the outperformance of some educational institutions, is a history of universities and educational system in a current country. Rehme (2007) identified that the history as one indicator which may influence the educational level. According to QS ranking 2012, the youngest university in top ten was established in 1907 (Imperial College London). As academic reputation is one criteria of quality of universities according to QS rankings we can expect that academic reputation is influenced by history of university. This may be a reason why UK (known for traditional universities like Oxford or Cambridge) is the second most outperformed country according to actual vs. fitted values analysis.

As public expenditures on higher education seem to be inefficient I have made an analysis of selected OECD countries to accept or refuse this hypothesis. I have taken a data about a proportion of public and private investments (expressed as % share of total investments) on higher education of 31 countries (data from 2009) and compared them with their QS index using followed method:

$$D = share\ of\ private - share\ of\ public$$

Then I have made a correlation analysis of *D* with QS index. According to my analysis there is almost 46% positive correlation between *D* and QS index. We can thereby say that private investments are more positively correlated with the quality of tertiary education than public investments[5].

[5] It is also interesting that all countries with positive *D* (Chile, South Korea, UK, US, Japan and Australia) have significantly higher share of household expenditure on private investments than share of expenditure of other private entities.

6.2. Implications for public policy

According to my analysis there are several implications for public policy to improve a quality of higher education. As total population and GDP per capita are not variables which could be immediately influenced (according to human´s lifecycle it takes almost 20 years until a new generation comes to universities) I am more focused on a short term tools.

As it is proven that expenditures on research and development directly influence the quality of higher education, the government may increase this quality by larger investments in R&D sector. There are two general ways how to increase investments in R&D sector – public investments or to attract private investments.

A public investment in R&D is the fastest way how to increase the size of % of GDP spent on R&D sector. However, there are several problems connected with the efficiency of public investments. The typical problem of public investments is rent seeking which Anne Krueger presented in 1974. According to rent seeking theory, there is a competition between potential recipients of public investment (in this case universities, research centers or scholars). The winner of this competition is a player who offers the highest bid to decision maker of public investment. Because this competition is illegal and bids are not offered in public (bids are in this case bribes or unaddressed gifts) players do not know the value of the winning bid but they believe that their bid is the winning bid. When the game is over only a player who offers the winning bid is a recipients of public investment and other players are not. The negative effect on rent seeking on efficiency and economic growth is described for example, in the work of Murphy, Shleifer and Vishny (1993).

There are several ways how to attract private investment in R&D sector in a particular country. Taxes and other subsidies seem not to be the most efficient way because of to rent seeking mentioned above. However, if the country allows an investor to fully participate from his investment in R&D, we may expect that there would be more investments in R&D sector in that country. This hypothesis is partly supported by research of Depken and Mazonaite (2009) where it is proven that economic freedom (expressed as economic freedom score from the Fraser Institute) has a strong positive impact on quality of tertiary education.

The problem of participation from investments in R&D is the form how to secure it. Nowadays the most popular form of the protection of intellectual property is a system of patent protection. The patent guarantees exclusively right of his owner to use his invention (idea) – it guarantees a monopoly position on the market of this invention. The patent is usually valid for some time, and then the invention is public. In the end there are two significant problems connected to a system of patent protection – patent thicket and patent trolls.

Patent thicket means that companies are using their patents to prevent their competitors from access to the market (Shapiro, 2001). On the other hand patent trolls are "non-practicing entities" which only develop new ideas and patents but they do not produce anything. When other company produces some product who meets criteria of a troll´s patent, a troll company uses lawsuits to get paid for using their patent even if other company produces this new product independently, but late. This problem is described for example, in the work of Bessen, Ford and Meuer (2011).

Other variable that can be immediately directly influenced is English language. I do not mean that country should change their official language to English but schools should be motivated to teach in English language.

As I have discussed in section 5.2. some universities already offer their programs in English and I have also mentioned that this system is not a perfect substitute to English speaking countries because students and researchers have to spend their effort on mastering this language instead of spending their effort on research and publishing. Primary and secondary education should play a key role in this problem.

If primary and secondary schools teach their students English language almost on the level of native speakers then universities could offer all their bachelor and master programs only in English. Then students of those universities would be much more integrated in global academic world than students who study in other language or start their study in English to the master´s program.

Policy makers can also change the structure of financing higher education institutions. As I have shown in section 6.1. private financing of universities seems to be more efficient than public financing. There are two ways how to finance universities from private sources – household expenditures and expenditures of other private entities (companies, donors etc.).

Private financing of tertiary education based on household expenditures increases price of investment in individual´s human capital (besides opportunity costs the individual has to pay also tuition fees). And those individuals would more considering their costs and benefits from their education. If expected benefits do not increase proportionally with tuition fees we will expect that number of students decreases. Tuition fees may also deter potential students from poor families or risk averse potential students from enrollment at university.

Expenditures of other private entities depend on several factors that are hard to predict. Incentives for those expenditures could be purely altruistic or based on some expected utility from this investment. As altruistic motivations are hard to predict, other investments could be predicted or influenced by regulation of labor market. If companies invested in educational institutions in order to have better potential employees there would have to be some bond that companies can benefit from those investments one day.

7. Conclusion

This paper is other extension of model of Li, Shankar and Tang (2009) who provided the first comprehensive econometric model measuring which factors influence quality of education. The aim of this work was to prove if income inequality has an effect on quality of higher education in several countries. According to my dataset, which has included 76 countries I have proven that income, inequality has no direct effect on quality of higher education.

Although this result is not in accordance with my hypothesis that says that there is a negative effect of income inequality on economic growth (then on quality of higher education), the result of my research is in accordance with the theory that there is no linear relationship between income inequality and economic growth (Kuznets, Rehme and others).

The quality of higher education seems to be more dependent on other factors. According to my research there are three main factors which positively drive the quality of universities – total population, GDP per capita and English language. If I have removed outliers from my model, also R&D expenditures positively drive the quality of higher education. All those factors are significant in the paper of Li, Shankar and Tang (2009) except from English language. The fact that English language is significant in my work is because I have used a different type of measurement of quality of tertiary education. While Li, Shankar and Tang used a count of universities in academic ranking by country, I have summed up points awarded per each university by country. Considering that US universities are dominant in academic rankings, the quality of US universities is expressed by points

There is a big potential of using other explanatory variables in model than those presented by Li, Shankar and Tang (2009) and looking for other factors which may influence the quality of higher education. For example Depken and Mazonaite (2009) found other important drivers of quality of higher education (freedom and being industrialized). In my point of view the history of higher education could be very significant variable but there is a problem with the measurement.

Also an analysis of time series may bring valuable results. Considering that some country can rapidly change some factors which directly or indirectly influence higher education (for example investment in universities) we can then observe how this change influenced quality of higher education. However, I face two problems, one is a problem with a time lag (it takes some time for universities to increase their quality by using more financial resources and it takes even more time until the increased quality is shown in academic ranking). The second problem of time series lies in academic rankings score (the history of academic rankings is too short).

The most challenging issue of quality of tertiary education is measuring its quality. Current academic rankings have many shortcomings and they could be easily manipulated. There are already some proposals how to solve this problem were made, for example alternative rankings, e.g. one of them was described by Hazelkorn (2012). I believe that focus on further expression and quantification of quality of higher education (endogenous variable) will be the aim of future research on this field.

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Appendix

Relative proportions of public and private expenditure on tertiary education in 2009

Country	% share of public sources	% share of private sources
Australia	45,42232	54,57768
Austria	87,67717	12,32283
Belgium	89,74085	10,25915
Canada	62,87967	37,12033
Chile	23,41859	76,58141
Czech Republic	79,91908	20,08092
Denmark	95,42938	4,570624
Estonia	80,17215	19,82785
Finland	95,77046	4,22954
France	83,051	16,949
Germany	84,3881	15,6119
Iceland	92,00947	7,990531
Ireland	83,78727	16,21273
Israel	58,16929	41,83071
Italy	68,57352	31,42648
Japan	35,26519	64,73481
South Korea	26,08523	73,91477
Mexico	68,68877	31,31123
Netherlands	71,95783	28,04217
New Zealand	67,9097	32,0903
Norway	96,09732	3,902678
Poland	69,74014	30,25986
Portugal	70,93585	29,06415
Slovak Republic	70,04114	29,95886
Slovenia	85,06821	14,93179
Spain	79,08784	20,91216
Sweden	89,78513	10,21487
United Kingdom	29,61969	70,38031
United States	38,07287	61,92713
Argentina	80,64168	19,35832
Russian Federation	64,60919	35,39081

Source: OECD iLibrary