CHARLES UNIVERSITY
Faculty of Social Sciences
Institute of Economic Studies

Bachelor Thesis

2019 Dorian Ardeleanu

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What is the effect of income inequality on economic growth?

Bachelor Thesis

Prague 2019

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Academic Year: **2018/2019**

Bibliographic Note

ARDELEANU, Dorian. *What is the effect of income inequality on economic growth?* Prague 2019. 66 pp.
Bachelor Thesis. Charles University. Faculty of Social Sciences. Institute of Economic Studies.
Supervisor: PhDr. Jaromír Baxa, Ph.D.

Abstract

The impact of income inequality on the level of economic growth is an important question, but the existing literature did not reach a consensus about the sign of its effect. This thesis studies the impact in 93 countries over the years 1995-2015. We apply two different methods: the fixed effects with Newey and West standard errors, and the first-difference generalized method of moments. The main findings emphasize that a widening wealth gap has an overall negative influence over the real GDP per capita growth. Besides that, the effect is stronger among low-income countries than among high-income ones. Moreover, we find that the impact of income inequality on economic growth depends on the governing party's doctrine. It is negative and statistically significant only in states with centrist governments.

JEL Classification	C33, D63, D73, E62, H21, H23
Keywords	income inequality, economic growth, fixed effects, GMM, cross-country comparison, redistribution
Title	What is the effect of income inequality on economic growth?
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Abstrakt

Vliv příjmové nerovnosti na ekonomický růst je důležitá otázka, na kterou ale existující články neposkytují uspokojivou odpověd'. Tato práce používá ke studiu daného tématu údaje o 93 zemích světa z let 1995–2015. Model je odhadován pomocí fixních efektů s Newey-West standardními chybami a pomocí GMM. Hlavním zjištěním je, že vyšší příjmová nerovnost má negativní vliv na růst reálného HDP na obyvatele. Kromě toho, je tento dopad významnější mezi chudšími zeměmi ve srovnání s vyspělými. V práci bylo také zjištěno, že vliv příjmové nerovnosti na ekonomický růst záleží na politické doktríně vládnoucí strany. Ten je záporný a statisticky významný jenom ve státech, kde vládnou centristické strany.

Klasifikace JEL	C33, D63, D73, E62, H21, H23
Klíčová slova	příjmová nerovnost, hospodářský růst, fixní efekty, GMM, porovnání států, přerozdělování
Název práce	Jaký je vliv příjmové nerovnosti na hospodářský růst?

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Declaration of Authorship

I hereby proclaim that I wrote my bachelor thesis on my own under the leadership of my supervisor, using only the listed resources and literature. The thesis has not been used to obtain any other academic title.

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Prague, May 9, 2019

Acknowledgments

I am especially grateful to PhDr. Jaromír Baxa Ph.D. for his precious suggestions, guidance and patience. Further, I am thankful to Pamela Cotte M.A. for her recommendations regarding Academic English, and to Mgr. Victoria Donu for her advice and encouragement. Additionally, I would like to thank my parents for their selfless love and support.

Bachelor Thesis Proposal

Author	Dorian Ardeleanu
Supervisor	PhDr. Jaromír Baxa, Ph.D.
Proposed topic	What is the effect of income inequality on economic growth?

Motivation

During the last decades, many countries have registered an increase in their income inequalities. At the same time, they have witnessed higher incomes, GDP per Capita, and lower poverty rates. However, it is still not clear whether there is a causation between them, or the countries have continued to develop in spite of higher income inequality between households. The aim of this paper is to explore the existence of this trade-off between innovation, economic development and GDP per capita on one hand and income inequality on the other hand.

Expected Contribution

The results provided by authors are ambiguous. For example, Julia Włodarczyk in her paper "Innovations and income inequalities – a comparative study" concludes that: "In general, higher gross domestic expenditure on R&D as a percentage of GDP tends to increase inequalities, while a higher number of patent applications or a higher value of the Creative Economy Index has an opposite effect". At the same time, the paper by Cristiano Antonelli and Agnieszka Gehringer affirms that: "the proper investigation of the relationship between technological change and income inequality requires the recognition that it works both ways". This thesis might contribute by confirming one of these two parts, or by finding that the answer depends on concrete circumstances. Another meaningful contribution might be finding new positive and negative relationships between income inequality and other indicators.

Methodology

We will use the cross-sectional and time-series data analysis. It is also appropriate to use multi-year averaged data, as in (Antonelli & Gehringer). The same paper suggest using the feasible generalized least squares (FGST) methodology. The methodological basis would be running several regressions and analysing their results.

Outline

1. Introduction. Brief information about the particular characteristics
2. Literature review. Stating the main literature and the reasons why I am going to use it
3. Theoretical part. Describing the relevant theory
4. Data description
5. Methodology used
6. Discussion of the results based on the previous parts
7. Conclusions

Core bibliography

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Author

Supervisor

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Acronyms

ADF	Augmented Dickey-Fuller (test)
BLUE	Best Linear Unbiased Estimator
CPI	Corruption Perception Index
FE	Fixed Effects
GDP	Gross Domestic Product
GMM	Generalized Method of Moments
KPSS	Kwiatkowski, Phillips, Schmidt, and Shin (test)
OECD	Organization for Economic Cooperation and Development
OLS	Ordinary Least Squares
RE	Random Effects
VIF	Variance Inflation Factor
WB	World Bank

Contents

1 Introduction

Economic inequality has long been a very serious and complex issue that has been affecting humanity from various perspectives since the Industrial Revolution. It has become an important discussion topic among economists, sociologists and politicians especially since the second half of the 20th century. The distribution of wealth is indeed extremely uneven: according to Shorrocks et al. [2018], the richest 1% of adults own 47% of the total wealth held by households, whereas the richest 10% have 85% of the aggregate income. At the same time, people from the bottom half of the economic ladder jointly own less than one percent of total income. Naturally, we usually agree on the ethical part of the problem, claiming that a bigger gap between the poor and the rich is detrimental to our society. However, if we abstract from the moral part of the question, the effect of income inequality on the level of economic growth still remains a debatable issue. Different studies revealed both positive and negative impacts, as well as unclear or ambiguous results. The ambivalence of outcomes obtained by other researchers served as the primary motivating factor for studying this subject.

This investigation will contribute to the analysis by working with a larger sample that will make the results more precise and generally applicable. The reason is that many researchers, such as Voitchovsky [2005] and Cingano [2014], tend to use smaller samples that contain mainly developed countries. Such an approach does not shed light upon the comprehensive impact of income inequality on the real GDP per capita expansion. However, some last years' results and theoretical reasoning suggest that the effect is negative. For that reason, we wish to verify whether the hypothesis of the negative impact of income inequality on economic growth is still viable when a larger data set that contains a similar number of high-income and low-income states is used.

We can also expect the Gini coefficient to have a different influence over the economic growth depending on the country's development level. Indeed, some studies indicate that low-income states might be more heavily affected by an uneven distribution of wealth. Therefore, our next objective will be to verify the hypothesis suggested by Fawaz et al. [2014] that poorer countries suffer more from higher income inequality than richer ones.

The attitude towards the unevenness of wealth is also closely related to the political preferences since parties tend to decide on the extent of redistribution depending on their political ideologies. Thus, it might be particularly compelling to see what is the impact of income inequality on the level of economic growth in countries with predominantly left-wing, centrist, and right-wing oriented governments.

The subsequent chapters of the thesis are organized in the following way. First, we introduce the existing literature on the topic and demonstrate that the results obtained by other researchers are often mutually antithetical. Besides that, the literature review also contains an explanation of several theories and ideas proposed by economists, which will be useful during our further research. Secondly, we describe the data set and present the included regressors. Then, we explain the methodology: introduce the empirical model, choose the most appropriate estimation methods, report the potential estimation issues and decide how to solve them. Afterwards, we present and comment the regression results, thereby giving answers to the questions and hypotheses stated above. The last section serves as a conclusion of the whole work.

2 Literature Review

This chapter describes other studies that researched the impact of income inequality on economic growth. We demonstrate the ambiguity of previous analyses through reporting results of either negative or positive causal relationship, as well as papers according to which the impact depends on other factors. In this way, we show that the topic of the thesis is still of current interest since there is no definitive answer in this regard. Where possible, the literature appears in chronological order to show the evolution of methods, results and interpretations. Afterwards, we present several theories that are not directly related to the study of income inequality, but are essential in justifying the choice of independent variables in the Data Description section, as well as in explaining the model configuration in the Methodology section.

2.1 Negative Effect

The research done by Clarke [1992] used White's heteroskedastic consistent standard errors to assess the effect of income inequality on GDP per capita growth between the years 1970 and 1988. The author found a negative causality that remained strong regardless of the regressors chosen. Particularly suggestive for our research is including the trade share of GDP as an independent variable that indicates the trade policy. Also important is showing that the initial conclusion remains valid for particular groups of countries, such as democracies and non-democracies. The author supposed that the reason for this causality lies in the fact that higher inequality makes the redistribution of income more troublesome, requiring the state to increase the taxes and to involve more in this process.

A similar study was performed by Alesina and Rodrik [1994], who used the Gini coefficient for land in 54 countries around the year 1960. They found that inequality was deleterious to the economic growth during the 1960-1985 period. The negative impact was even stronger for the 1970-1985 period. The lack of data was the reason for choosing land ownership as an imperfect proxy for wealth, this being the most suitable alternative available. An essential independent variable was the primary school enrollment ratio used as a proxy for human capital. The explanation of the negative effect is similar to the previous research: when a big segment of the population ”does not have access to the productive resources of the economy”, it requires massive income redistribution. As a result, the authors claim, this is detrimental to the economic growth.

The financial crisis of 2007-2008 has motivated researchers to investigate the reasons for this predicament. Brescia [2010] argues that income inequality was one of the main causes and catalysts of crisis due to several factors. Firstly, the easier access to credit could have been the response of politicians to an increasing income dissimilarity. Secondly, richer sectors might have lobbied the policymakers to act in their favour. And thirdly, income inequality led to larger social disparity, which resulted in greater predatory lending. Therefore, there is evidence that income inequality is not only bad for the long-run growth, but it can also lead to sudden and unexpected economic emergencies.

Thanks to an increasing accessibility of robust statistical methods in the 21^{st} century, it became especially compelling to revise the effect of income inequality on the economic progress over the past decades and to compare the new outcomes with older results. Herzer and Vollmer [2012] worked with a panel data set comprising 46 countries that covered the period 1970-1995, and used panel cointegration techniques to solve issues such as country heterogeneity and endogeneity [Pedroni, 2001]. The results, however, were similar: the impact of income inequality on growth is negative in the whole sample, as well as in democracies, non-democracies, developing, and developed countries apart.

The study done by Assa [2012] builds on the model introduced by Alesina and Rodrik [1994], but uses more recent data (GDP per capita for 1998-2008) and methods (2SLS and OLS with heteroskedasticity-robust standard errors). The effect, though, remained negative and significant regardless of the technique and of the dummy variables included.

A recent analysis of this topic was performed by Berg et al. [2018], who found that an increasing net inequality (after taxes and transfers) has a negative effect on the level and on the durability of economic growth. The authors highlight the importance of human capital accumulation as one of the most important channels through which inequality is detrimental to development. Another conclusion was that redistribution starts to be harmful only when it is too large.

2.2 Positive Effect

The research done by Li and Zou [1998] concluded that the effect of income inequality on economic growth is positive and statistically significant. One reason for such a contrasting result might be a different data set, which covered 46 countries over the period 1947-1994. Another cause could be the usage of panel data estimators without checking the assumptions for these approaches, which might have led to t-statistics that are not entirely valid.

Forbes [2000], using a data set with 45 states, found a positive impact of income inequality on the economic development between the years 1966 and 1995. The effect stayed significant regardless of the method applied: either Fixed Effects, Random Effects, Chamberlain [1984] π-matrix, or Arellano and Bond [1991] technique.

Positive impacts were encountered in newer papers as well. For instance, the study performed by Naguib [2015], based on a sample of 33 OECD countries over the years 1971-2010, shows that an increase in the Gini coefficient would result in faster economic growth. The results remained similar when using both fixed effects and the GMM approach.

2.3 Ambiguous Results

Barro [2000] studied the effect of inequality on growth between the years 1965 and 1995, using data on 84 countries with minimum one observation regarding the Gini coefficient, and 68 countries with at least two observations on it, so the sample is considerably unbalanced. It was found that income inequality has a negative impact on the level of economic growth among low-income countries, albeit more developed states experience a positive effect of inequality on economic development.

The research done by Voitchovsky [2005], who applied the first-difference estimator approach on a homogenous sample of 21 states over the years 1970-1995, concluded that inequality amongst the richest affects the growth positively, whereas inequality amongst the poorest has a negative impact on the economic expansion. The author claims that using a single income inequality for the whole country might not be appropriate because the above-mentioned opposite effects can diminish each other and return less significant outcomes.

Shin [2012], using a theoretical stochastic optimal growth model, compared smaller regions and even particular countries. For instance, the author juxtaposed East Asian and South American countries since they differ much in terms of income inequality and speed of economic growth: East Asian countries have declining inequality and develop quickly, while South American states experience slower growth and higher inequality. The author came to the conclusion that the income disparity affects the economic evolution negatively in developing countries because many people might not have the opportunity to invest and "to participate in product activity". The impact transforms into positive as the country becomes more developed due to the fact that rich people in high-income countries tend to have higher saving rates, as the author mentions. Wealthy people in developed states might also be demotivated to work if the reallocation of income is too big.

Similar results were obtained by Madsen et al. [2018], who studied the impact of income disparity on growth in 21 states over a longer period of time - between the years 1870-2011. Worth mentioning is the analysis of 4 particular channels through which inequality affects the economic development: savings, investment, education, and knowledge production. All these channels were found significantly and negatively affected by higher inequality in underdeveloped states, whereas developed countries are much less influenced.

The research made by Fawaz et al. [2014] is arousing curiosity because the authors focused only on the developing economies over the period 1960-2010, using the system-GMM approach. It was found that significant divergences persist even among developing countries. The regression based on a sample of 55 low-income developing states suggested a negative effect, whereas among 56 high-income developing countries this impact was found to be positive.

2.4 Meta-Analyses

Apart from demonstrating the popularity and noteworthiness of the topic, meta-analyses will help us get a more objective view of this matter. Thus, we will avoid potential issues and biases that were found by meta-analyses in other papers. Neves et al. [2016] came to the conclusion that some authors are biased towards statistically significant results. Besides that, the outcomes differ depending on the countries included and on the way the researcher interprets the concepts of income and inequality. Generally, the impact of inequality on economic growth is negative and more noticeable in low-income than in high-income states. Therefore, having a big and diverse sample size is crucial in designing an impartial research.

Posvyanskaya [2018] also found that the publication bias is present since some researchers tend to overvalue the real size of the effect. Interestingly, the papers published before the 2008 crisis tended to be biased towards negative effects, whereas after 2008 the bias changed towards effects that are predominantly positive. The author claims that the impact of inequality on economic development is a complex and probably nonlinear question.

2.5 Essential Theories

The purpose of this section is to briefly present the ideas and theories that will be used later on in the Data Description and in the Methodology sections.

2.5.1 The growth equation

Deriving the growth equation is necessary since it elucidates the further choice of independent variables. It builds on the growth model developed independently by Solow [1956] and by Swan [1956], but rather splits the human and the physical capital:

$$Y(t) = K(t)^{\alpha} H(t)^{\beta} (A(t)L(t))^{1-\alpha-\beta}, \quad 0 < \alpha < 1,\ 0 < \beta < 1 \tag{1}$$

where Y is output, K is physical capital, H is human capital, A is the level of technology, L is labour, α is the partial elasticity of output with respect to physical capital, β is the partial elasticity of output with respect to human capital, and t is the time period. Further on, Mankiw et al. [1992] have shown that income growth depends on the initial level of income and on the steady state:

$$ln(y(t)) - ln(y(0)) = (1 - e^{-\lambda t}) \Bigg[\frac{\alpha}{1-\alpha-\beta} ln(s_k) + \frac{\beta}{1-\alpha-\beta} ln(s_h) - \\ - \frac{\alpha+\beta}{1-\alpha-\beta} ln(n+g+\delta) - ln(y(0)) \Bigg] \tag{2}$$

where $y(t) = \frac{Y(t)}{A(t)L(t)}$ is the level of output in efficiency units at time t, $y(0)$ is the steady state level of output in efficiency units, $\lambda = (n+g+\delta)(1-\alpha-\beta)$ is the convergence rate, s_k is the part of output invested in physical capital, and s_h is the part of output invested in human capital. Also, n is the exogenous growth of labour L, g is the exogenous growth of technology A, and δ is the depreciation rate of physical capital, K.

Following the equations (1) and (2), Cingano [2014] presented the equation that describes the determinants of economic growth between particular time periods. This formula serves as justification for including the regressors described in the Data Description section and for the model presented in the Methodology section:

$$\begin{aligned} ln\,y(t) - ln\,y(t-s) = -\phi(\lambda) ln\,y(t-s) + \phi(\lambda)\frac{\alpha}{1-\alpha-\beta} ln\,s_k + \\ +\phi(\lambda)\frac{\beta}{1-\alpha-\beta} ln\,h^* - \phi(\lambda)\frac{\alpha+\beta}{1-\alpha-\beta} ln(n+g+\delta) \end{aligned} \tag{3}$$

where s is any time period before t, $\phi(\lambda)$ is a function of the convergence rate: $\phi(\lambda) = 1 - e^{-\lambda s}$, and h^* is the steady-state stock of human capital.

Therefore, as the author mentioned [Cingano, 2014, p.43], "in a Solow model output growth is a function of the initial level of income and of the ultimate determinants of the steady state".

2.5.2 Convergence Theory

Convergence represents the process during which poorer countries reach the level of economic development of richer ones [Mankiw, 2016, p.248]. However, according to the Solow-Swan Model, it will happen only when countries have different capital stocks, but the same steady state. Regardless of this limitation though, Barro et al. [1991] have demonstrated that the gap between developed and developing countries decreases at a rate of about 2 percent a year.

2.5.3 Kuznets Curve

This theory, stated by Kuznets [1955], represents the inverse of our current study. The author observed that, during the country's economic development, its income inequality firstly increases since only already rich people have the resources to invest and become even wealthier. Afterwards, thanks to industrialization, urbanization and democratization (that represent one of the pillars of the country's economic development, according to Rostow [1959]), the average income increases as well. As a result, the gap between the poor and the rich starts to decrease.

Therefore, the Kuznets curve has an inverted U-shape that can be also represented by the formula:

$$Gini_{it} = \beta_0 + \beta_1 GDP_{it} + \beta_2 GDP_{it}^2 \tag{4}$$

3 Data Description

The purpose of this chapter is to present the data sources, as well as to explain the choice of the regressors that will be afterwards used in our empirical model. We use a panel data set with information regarding various economic indicators in 93 countries over the period 1995-2015, with a five-year gap between each of the 5 time intervals. There are several reasons for choosing this time span:

- The last 20-25 years seem to contain the most reliable, precise and full data. However, some countries provide with information on economic growth and on demographics with a slight delay. This is why the last several years do not contain all the required details and had to be excluded from our analysis.

- Many developing countries do not have all necessary data regarding every single year, whereas the developed states tend to impart more annual details regarding their economic situation thanks to better research facilities and transparency. Therefore, using a 1-year gap would have led to data missingness that is not random, but rather depends on the level of economic development. In turn, it would have implied biasedness of results, according to Gelman and Hill [2006].

- Other researchers also tend to use the 5-year distance between observations, which makes the comparison of our outcomes with other results more intelligible.

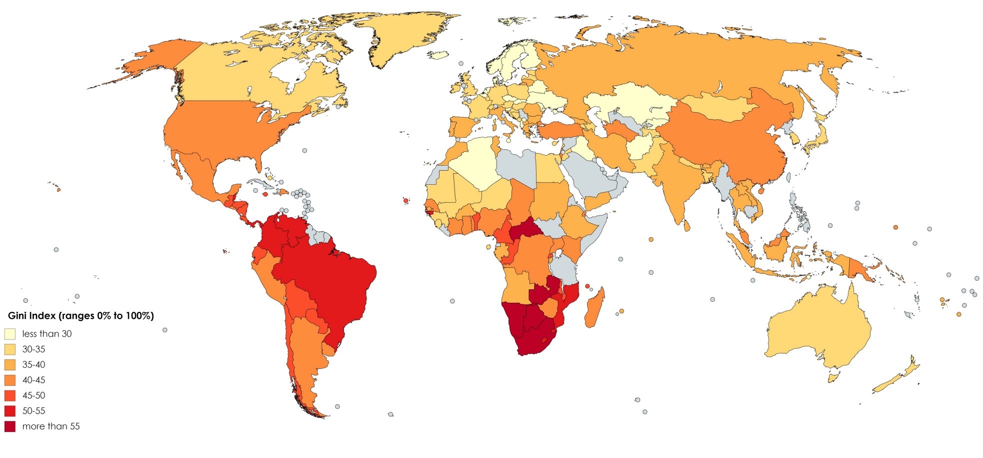
The data concerning GDP per capita are provided by the World Bank (WB [2019a]), and are in constant 2010 U.S. dollars. For this variable, all 465 observations are available. We use the real GDP per capita because it captures only the economic growth, in comparison with the nominal GDP per capita that is not adjusted to inflation.

3.1 Gini Coefficient

The majority of studies operate with the Gini coefficient as a measure of income inequality because it is the most widely used indicator. Our observations are selected from the World Bank data that come from household surveys done by government statistical agencies and by World Bank country departments [WB, 2019b].

An important distinction we should make is between the net Gini coefficient and the Gini coefficient after taxes and transfers. We work with the latter since the taxes collected by the government tend to redistribute the income across citizens and to contribute to the public well-being. Therefore, what really matters for our analysis is the final income inequality after the redistribution of income. Fortunately, the data provided by the World Bank are after taxes and transfers, which is confirmed by the direct comparison of their data set with the data set provided by Rost [2018].

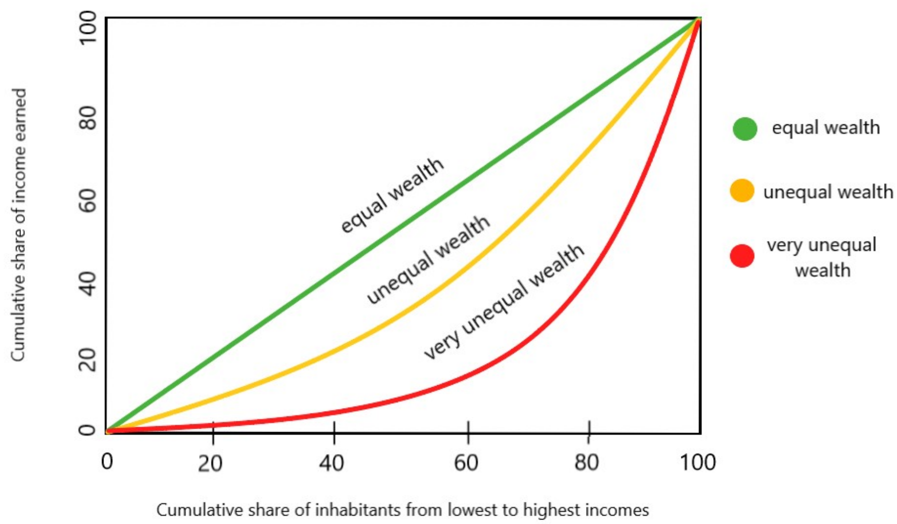
Figure 1: World Map Gini Coefficient



Source: author's map based on data from the World Bank

This coefficient was developed by Gini [1912]. It can have values between 0% and 100% (or 0 and 1, respectively), where 0% represents the perfect equality - when everyone has the same wealth, and 100% indicates the situation when one person has all the money and everyone else has no income. Although this will not influence our final conclusions, it should be indicated that we will use the Gini coefficient version that ranges between 0% and 100%. Theoretically, values over 100% are possible if one person has all the money and other people have negative income or wealth, as mentioned by Kenton [2019]. The Gini coefficient can also be expressed as the degree to which the Lorenz curve [Lorenz, 1905] digresses from the straight diagonal of equal wealth [Christopher Pass, 1993, p.89].

Figure 2: Lorenz Curve



Source: author's drawing

3.2 Other Explanatory Variables

The current paper uses a simplified version of the equation (3). It follows the selection of regressors suggested by Cingano [2014], so it does not take into account the depreciation rate, λ, and the exogenous technology growth, g. In comparison with the study done by Cingano [2014], though, it controls for the population growth, n, as well as for other regressors that determine the economic expansion. This became possible since losing the degrees of freedom is less an issue in our bigger sample ($n = 34$ in Cingano's paper and $n = 93$ in this paper). These are the explanatory variables included:

1. **Investment to GDP Ratio**
   This variable serves as a proxy to s_k (the fraction of income invested in physical capital) from the equation (3). It is calculated as the fraction of total investment to GDP, and is collected from the World Bank database [WB, 2019c].

2. **Average Years of Schooling**
   The human capital is measured by the average years of total schooling of people over 15 years old. It is used as a proxy to s_h (the fraction of

income invested in human capital) since it is expected that countries that invest more in education have citizens that study longer. The information on this explanatory variable is extracted from the Barro and Lee [2013] data set, which contains data up to the year 2010. We, however, will use it with a lag, thus 2010 is the last required year and no information will be missing.

3. **Population Growth**
A higher population extension is associated with higher fertility rates, which, according to Barro [2008], should have a negative impact on the level of economic development. The data regarding population growth were extracted from the World Bank source [WB, 2019e].

4. **Economic Openness**
This indicator is usually associated with a higher economic expansion and was included in other studies on this topic: for example, by Naguib [2015]. The information is provided by the World Bank [WB, 2019d]. The level of economic openness is calculated in the following way:

$$openness_{it} = \frac{imports_{it} + exports_{it}}{GDP_{it}}$$

5. **Corporate Income Tax**
The decision to include the corporate tax rather than the income tax is motivated by the fact that the corporate tax seems to be the most deleterious to economic growth [Johansson et al., 2008, p.2]. The historical experience of particular countries also proves this: for example, Sweden succeeded to overcome the crisis at the beginning of the 1990s by decreasing the corporate tax rate substantially, while keeping the personal income tax rate quite high [Agell et al., 1996]. The source for the OECD countries is the OECD [2019] database. In order to find information regarding other countries, we used the available data from the national taxation offices and from papers that previously studied taxation. Since it is a quantitative indicator and not an estimation like the Gini coefficient, extracting the numbers from different sources should not lead to any issues.

The panel data set is unbalanced due to the fact that the total amount of observations is smaller than $T * N$, where T are the periods of time and N is the number of observations in each period. In other words, not every country has all the information available in each year. The gravity of this problem, however, depends on the nature of the "missingness mechanism", described by Gelman and Hill [2006]. Initially, it could have been plausible to expect that low-income countries have fewer data available since they might not have enough resources to research their economic condition as deeply as developed states do. In consequence, if data are not missing completely at random, it can lead to potential issues.

In order to solve the problem stated above, we did not include in our sample many developing states that lacked a dangerously high amount of data. Also, when the information regarding a certain year was not available, we used the closest accessible observation. For example, if the World Bank database does not provide with the Gini coefficient for a certain country in the year 2000, but rather contains the Gini for the year 2001, then we will use the latter instead. When possible, the linear mean imputation between observations situated at the same distance from the year of interest was applied. For instance, if the corporate tax for the year 2005 is not available, but we know the corporate tax for the years 2004 and 2006 instead, then the mean between these two will be included. In consequence of these procedures, we end up with only 4.1% of missing data, which should not have a big influence over our final conclusions.

4 Methodology

This section will describe the consequent steps of building our model. Firstly, the empirical model and its regressors will be explained. Secondly, the most relevant estimation method will be chosen. This will be performed through a series of tests. And thirdly, after accomplishing this part, we will investigate the potential problems that appear due to the violation of concrete assumptions, and make our initial approach robust to these issues.

4.1 The empirical model

Before digging into working with different methods and solving possible issues, we present the equation that has to be estimated:

$$y_{i,t} - y_{i,t-1} = \alpha_0 + \alpha_1\, y_{i,t-1} + \gamma\, gini_{i,t-1} + X_{i,t-1}\beta + \delta D_t + a_i + u_{i,t} \tag{5}$$

Here, the observation for each country is represented by the index i, $i = 1, ...N$, $N = 93$, while t stands for each period of time, $t = 1, ...T$, $T = 5$.

The dependent variable is the GDP per capita growth between two subsequent five-year time periods. It can be expressed as:

$$y_{i,t} - y_{i,t-1} = ln(GDP_{i,t}) - ln(GDP_{i,t-1}) = ln\frac{GDP_{i,t}}{GDP_{i,t-1}} \tag{6}$$

The inclusion of the independent variable $y_{i,t-1}$ is explained through the equation (3). We expect the sign of α_1 to be negative since, according to the theory of convergence, GDP per capita is anticipated to grow faster for countries with lower GDP, and vice versa. The equation (5) can be rewritten as:

$$y_{i,t} = \alpha_0 + \alpha\, y_{i,t-1} + \gamma\, gini_{i,t-1} + X_{i,t-1}\beta + \delta D_t + a_i + u_{i,t} \tag{7}$$

where $\alpha = \alpha_1 + 1$.

The Gini coefficient - the independent variable of our interest - has been included with a time lag. Such an idea is suggested by Naguib [2015], who claims that including $gini_{it}$ without lag would cause endogeneity bias. The reason for endogeneity lies in the inverse relationship between GDP per capita and the Gini coefficient, which is described by the Kuznets Curve.

The lagged variable, $gini_{i,t-1}$, satisfies the requirements for a good instrumental variable [Wooldridge, 2013, p.463] since it is exogenous, but at the same time it is correlated with $gini_{it}$.

Other independent variables, which are described in more detail in the Data Description section, are represented through the vector $X_{i,t-1}$. The investment to GDP ratio and the average years of schooling are in logarithms, which is in concordance with the theory of economic growth. All regressors are included with a time lag in order to capture their effect on the subsequent economic development rather than the correlation between them. In other words, we see the vector $X_{i,t-1}$ as a growth determinant that is already given in time period t. The vector D_t indicates the dummy variables, which are particularly essential to include. If the dummy variables had not been inserted, then the overall GDP per capita growth would have been attributed to other independent variables [Wooldridge, 2013, p.437]. The variable a_i is the unobserved effect containing time-constant factors that exert influence over the dependent variable, and u_{it} is the idiosyncratic error.

Since the lagged version of the dependent variable has also been included as a regressor, the presence of unit root should be verified. Namely, in the equation: $y_t = \alpha_0 + \alpha_1 y_{t-1} + e_t$, $|\alpha_1|$ should be smaller than 1. This is the requirement for a stable AR(1) process. Libanio [2005], while describing unit root tests in macroeconomic time series, mentions that the usual augmented Dickey-Fuller test has low power. The author, however, points out that it is feasible to perform tests that have an inverse approach to the one used by the ADF test. Therefore, we decide to run the KPSS test developed by Kwiatkowski et al. [1992], under which:

$$\begin{aligned} H_0 &: \alpha_1 < 1 \\ H_A &: \alpha_1 = 1 \end{aligned} \tag{8}$$

As a result, all three KPSS tests (without drift and without trend; with drift and without trend; with drift and with trend) return p-values higher than 0.1, which means that we do not reject the null hypothesis of trend stationarity.

4.2 Panel Data Method Selection

The decision regarding the method that is best applicable to equation (5) has to be made between pooled OLS, fixed effects and random effects estimation.

In comparison with the other two methods, the pooled OLS does not split the unobserved effect, a_i, and the idiosyncratic error, u_{it}, but rather takes them together, as a composite error, ν_{it}. Due to the fact that a_i, in our case, is likely to be correlated with at least one explanatory variable, it might result in heterogeneity bias. For example, smaller states tend to have more opened economies. It means that the country's area, which is included in a_i, is correlated with the regressor, $openness_{i,t-1}$. Our argumentation is proven by the F test for individual effects. It rejects the null hypothesis that these effects are not significant at a p-value of $2.5611 * 10^{-7}$, thereby confirming the inapplicability of pooled OLS.

Now we should choose between the fixed effects and the random effects estimation. Both models explicitly include the unobserved effect, but the fixed effects estimation allows it to be correlated with the regressors, whereas the random effects estimation does not permit it. Usually, the former model is more suitable because the explanatory variables are often correlated with specific, time-constant characteristics [Wooldridge, 2013, p.444]. The formal decision between these two methods is performed through the test proposed by Hausman [1978]. The p-value of 0.001 means that we surely reject the null hypothesis under which $Cov(x_{itj}, a_i) = 0$. The unobserved effect is thus correlated with the regressors, and only fixed effects estimation can be applied.

4.3 Fixed Effects Estimation

After the verdict regarding the most acceptable estimation method has been made, the fixed effects estimation will be explained in further detail. Then, the formal assumptions of exogeneity, homoskedasticity and no autocorrelation will be checked, as well as the presence of multicollinearity. Finally, we will present a method that is robust to the identified problems.

Our equation can be expressed in the following way [Wooldridge, 2013, p.435]:

$$y_{it} = X_{it}\beta + a_i + u_{it}, \quad i = 1, ...93, \quad t = 1, ...5, \tag{9}$$

where y_{it} is the dependent variable, X_{it} is the vector containing all the explanatory variables that are changing over time, a_i is the fixed effect and u_{it} is the idiosyncratic error.

In order to get rid of the fixed effect, several steps must be performed. Firstly, we calculate the means of the dependent and independent variables:

$$\bar{y}_i = \frac{\sum_{t=1}^{5} y_{it}}{5}, \quad \bar{X}_i = \frac{\sum_{t=1}^{5} X_{it}}{5}, \quad \bar{u}_i = \frac{\sum_{t=1}^{5} u_{it}}{5} \tag{10}$$

Then the equation (9), averaged over time, will take the form:

$$\bar{y}_i = \bar{X}_i \beta + a_i + \bar{u}_i \tag{11}$$

Afterwards, we obtain the following equation that uses the deviations of variables from the group means:

$$y_{it} - \bar{y}_i = (X_{it} - \bar{X}_i)\beta + (u_{it} - \bar{u}_i) \tag{12}$$

The last equation does not contain the unobserved effect because a_i is fixed over time. As a result, the equation (12) can be estimated by pooled OLS since the initial problem of heterogeneity bias is avoided.

4.3.1 Multicollinearity

Multicollinearity represents the case when there is a large correlation among some explanatory variables, although a concrete benchmark defining it is not well stated [Wooldridge, 2013, p.764]. One of the main difficulties of multicollinearity lies in the incapacity to recognize the distinct contributions of regressors experiencing this issue. Another consequence is that the estimates become less precise and the regression model becomes weaker. Moreover, multicollinearity can lead to estimates that are very sensitive to small changes in data. Otherwise speaking, the estimate can change substantially if only a few more observations are added [Willis and Perlack, 1978, p.57]. Multicollinearity can be identified using the variance inflation factor (VIF). It represents the factor by which the variance of the estimator is higher than it should have been if the explanatory variables were not correlated at all. It takes values higher than 1, being suggested that multicollinearity is a problem when $VIF > 10$ [Wooldridge, 2013, p.86].

4.3.2 Endogeneity

The regressor is considered endogenous when it is correlated with the error term. We distinguish three sources of endogeneity: omitted variable, measurement error, and simultaneity [Wooldridge, 2013, p.759].

The omitted variable bias, although being a serious problem, cannot be fully solved because we cannot know for sure whether the additional regressor decreases or increases the bias. Clarke [2005] points out that the particular effect of the independent variable "depends on the effects of the included and excluded variables" and on the correlations between them, as well as "on the variances of all variables". Unfortunately, not all these impacts can be detected in practice, that is why a balance between including too little and too many regressors had to be found. We included only independent variables with enough trustful data, the effect of which is relevant enough and can be presupposed. In this way, we also avoided the potential measurement error.

An attempt to solve the problem of endogeneity bias due to simultaneity was already made by including the Gini coefficient with a lag. This, however, still remains the biggest potential issue of the fixed effects estimation.

4.3.3 Heteroskedasticity

This problem appears when the variance of errors is not constant, so the assumption FE.5 [Wooldridge, 2013, p.458]:

$$Var(u_{it}|X_i, a_i) = Var(u_{it}) = \sigma_u^2, \quad \forall t = 1, ..., T \tag{13}$$

is violated. In consequence, the fixed effects estimator remains unbiased, but it is not BLUE anymore, which means that it does not necessarily have the lowest variance. To check whether this is an issue, the Breusch-Pagan test for heteroskedastic disturbances has to be performed [Breusch and Pagan, 1979]. If the p-value will be lower than 0.05, then the null hypothesis of homoskedasticity will be rejected.

4.3.4 Serial Correlation

Another assumption that has to be true in order to obtain estimators that are BLUE is the absence of autocorrelation (FE.6). This assumption represents the zero relationship between the disturbances in different time periods:

$$Cov(u_{it}, u_{is}|X_i, a_i) = 0, \quad \forall t \neq s \tag{14}$$

The Breusch-Godfrey test will be performed in order to verify the existence of serial correlation in our panel data model [Breusch [1978], Godfrey [1978]]. If the p-value will be below the threshold of 0.05, then we will reject the null hypothesis of no serial correlation.

4.3.5 Normality of Residuals

This assumption makes sure that the t and F statistics of the fixed effects estimator have exact t and F distribution [Wooldridge, 2013, p.458]. In our case, we can rely on asymptotic approximations thanks to a large number of observations, $N = 93$, and a small number of time periods, $T = 5$.

4.3.6 Standard errors that are robust to issues

If not all standard assumptions for the fixed effects model are satisfied, then we will need to use an estimator that is robust these issues. Thus, the outcomes presented in the Results section (5) will be based on the covariance matrix estimator presented by Newey and West [1987], which is robust both to heteroskedasticity and to autocorrelation. The idea behind the Newey-West standard errors is described in greater detail in the Appendix (6).

4.4 First-Difference GMM

Regardless of the fact that the method presented above solves the majority of issues that we encountered, the problem of endogeneity still seems to be present, and is caused by the nature of the dynamic panel data model itself. According to Nickell [1981], the fixed effects transformation makes the explanatory variable $y_{i,t-1}$ in equation (7) endogenous, because it is correlated with the disturbance, $u_{i,t}$. In consequence, the estimator of α in equation (7) becomes biased [Cingano, 2014, p.15]. Due to the fact that $\alpha_1 = \alpha - 1$, then α_1 in equation (5) is also biased. Finally, because $Cov(y_{i,t-1}, gini_{i,t-1}) \neq 0$, the estimator of γ seems to be biased as well.

In order to solve this problem, we will use the first-difference GMM approach developed by Arellano and Bond [1991]. It is based on the generalized method of moments introduced by Hansen [1982], and uses the assumption that the instruments necessary to overcome the issue of endogeneity are inside the model itself. That is, the lagged values of the regressors ($y_{i,t-2}$, $gini_{i,t-2}$ and so on) are used as instruments for the first-difference change in these regressors. Therefore, we will get the following matrix of instrumental variables:

$$X_i = \begin{pmatrix} 0 & 0 & 0 & .. & .. & .. & 0 & 0 & 0 & 0 \\ y_{i,1} & 0 & 0 & .. & .. & .. & 0 & 0 & 0 & 0 \\ 0 & y_{i,2} & y_{i,1} & .. & .. & .. & 0 & 0 & 0 & 0 \\ : & : & : & . & .. & .. & .. & .. & .. & .. \\ : & : & : & .. & . & .. & .. & .. & .. & .. \\ 0 & 0 & 0 & .. & .. & . & y_{i,T-2} & y_{i,T-1} & .. & y_{i,1} \end{pmatrix}$$

The first row shows that no instrumental variables are available for the difference $y_{i,2} - y_{i,1}$, but the number of obtainable instruments increases as we get closer to the time period T, where we can use $y_{i,1}, ..., y_{i,T-2}$. The main difference of this approach from the standard 2SLS is the fact that the inclusion of additional instruments does not imply losing observations. The first-difference GMM can also be made robust to the panel-specific autocorrelation and heteroskedasticity through an asymptotically efficient two-step estimation, as mentioned by Mileva [2007].

It is important to explain why we decided to use the first-difference GMM instead of system GMM. It was done because the system GMM has an additional requirement that is particularly hard to achieve [Blundell and Bond, 1998]. This requirement demands that the initial distance of each individual (in our case, of each country) from its steady state to be uncorrelated with the fixed effect [Roodman, 2009, p.144]. The author highlights that this requirement is especially often violated in economic growth equations. Therefore, the system GMM is avoided.

We will perform the Sargan-Hansen and the Arellano-Bond tests and adjust the first-difference GMM in the case of issues found.

4.4.1 Sargan-Hansen Test

The validity of instruments should be verified using the test of overidentifying restrictions, developed by Sargan [1958], and adapted to the case of generalized method of moments by Hansen [1982]. It checks the null hypothesis that the excluded instruments are independent of the error process, being exogenous. If $p < 0.05$, then we reject H_0 and the obtained estimates are not valid.

4.4.2 Arellano-Bond Test

The test for autocorrelation in residuals of order 2 will be provided through the approach introduced by Arellano and Bond [1991]. Mileva [2007] points out that the 2^{nd} order serial correlation is more essential since "it detects autocorrelation in levels", whereas the 1^{st} order autocorrelation is regarded as likely because the residual $u_{i,t-1}$ is contained in both following equations:

$$\Delta u_{i,t} = u_{i,t} - u_{i,t-1}$$

$$\Delta u_{i,t-1} = u_{i,t-1} - u_{i,t-2}$$

Nevertheless, the author recognizes that autocorrelation of first order is not always encountered, even if it is expected. The null hypothesis of no serial correlation of 2^{nd} order will be rejected if the p-value of the Arellano-Bond test will be lower than 0.05.

5 Results

The purpose of this section is to report the outcomes obtained after analyzing the overall effect of income inequality on economic growth, discuss their suggestions and compare them with the results acquired by other researchers. Afterwards, we will give answers to the other two questions of our interest: whether this impact differs depending on the country's level of economic development, and whether it differs based on the political doctrine of the ruling party. Each section will also contain the outcomes of the tests described in the Methodology section. All the presented results will be based on equation (5), where the dependent variable is the real GDP per capita growth. The word $lag(.)$ means that the variable has been included with a time lag. Other abbreviations for different regressors are further explained in Table 6.

5.1 Overall Effect

We examine the general impact of income inequality on GDP per capita growth through two methods: the first one is Fixed Effects with Newey and West standard errors, and the second one is First-Difference GMM. Both results are displayed in Table 1.

5.1.1 Fixed Effects Outcomes

While checking the potential FE estimation issues, multicollinearity was not found to be a problem among any of our regressors since maximum VIF is 2.544433. Moreover, the variable of interest - the Gini coefficient, has a VIF equal to 1.206931, which is well below any suggested threshold. However, heteroskedasticity is present, as advocated by the Breusch-Pagan test that returns a p-value of 0.00261. Serial correlation is also an issue to be dealt with since the Breusch-Godfrey test has a p-value equal to 0.000148. This explains the usage of the Newey and West estimator that solves the problems mentioned above.

	Dependent variable: GDP per capita Growth (the t-values are in parentheses)	
	Newey and West Fixed Effects	*First-Difference GMM*
	(1)	(2)
lag(lgdppc)	-0.18739^{***}	-0.05886
	(-3.0235)	(-0.5227)
lag(gini)	-0.00552^{**}	-0.01412^{**}
	(-2.3437)	(-2.5277)
lag(popgrowth)	-0.61347	-3.74898^{***}
	(-1.2075)	(-3.5639)
lag(log(invtogdp))	-0.04715	-0.13625
	(-1.1675)	(-1.3171)
lag(log(schooling))	0.11650	0.19522^{*}
	(1.6441)	(1.7156)
lag(openness)	0.00081	0.00155^{**}
	(1.8446)	(2.4053)
lag(ctax)	0.00030	-0.00032
	(0.2212)	(-0.1642)
d00	0.01775	0.13442^{***}
	(0.6151)	(2.5770)
d05	0.03079	0.09388^{**}
	(1.4600)	(2.4510)
d10	0.00449	0.04277^{*}
	(0.3507)	(1.7593)
Observations	93	93
R^2	0.80736	
Adjusted R^2	0.70306	
F Statistic	5.633^{***} (df = 10; 181)	
Note:		$^{*}p<0.1$; $^{**}p<0.05$; $^{***}p<0.01$

Table 1: Overall Regression Results

The estimated coefficients in the first column of Table 1 suggest that the impact of income inequality on the subsequent economic growth is considerable since the t-value equals to -2.3437. In our log-level model, a 1 point decrease in the Gini coefficient would evolve in a GDP per capita growth that will be 0.552 percentage points faster during the next 5 years (or 0.1104 percentage points per year on average). It shows a two-times quicker potential development than the result obtained by Knowles [2005], who found that a similar decrease in the Gini coefficient by 1 point would expand the growth rate by 0.057 percentage points per year on average. Such a dissimilarity in the results is, however, quite natural. It can be explained by different data sets, regressors and methodology applied.

5.1.2 GMM Outcomes

In the first-difference GMM, the p-value equal to 0.23766 in the Sargan-Hansen test proves that the instruments chosen are valid. The Arellano-Bond test suggests that there is no autocorrelation of order 2 in residuals (p-value = 0.5175).

The estimate of γ from the equation (5) is, however, quite different from the one obtained when the previous method was used. Under this approach, the same 1 point reduction in the Gini coefficient is associated with a subsequent economic growth by 1.412 percentage points during the next 5 years, or by an average of 0.2828 percentage points per year. The GMM approach is more trustful since it solves the problem of endogeneity and has been more often used during the last decade among researchers. It is statistically significant as well (t-value = -2.5277).

For example, Cingano [2014], who used the system GMM, came to a similar conclusion: a 1 point decrease in the Gini coefficient would result in an economic growth that is faster by about 1 percentage point in the next five years (the outcome depends on the used regressors and varies between 0.774 and 1.257, and it is always statistically significant).

5.1.3 Explanation of results

Regardless of the differences between FE and GMM estimates, they are both negative, significant and in line with other researchers' results. Therefore, we can interpret the logic behind them concomitantly.

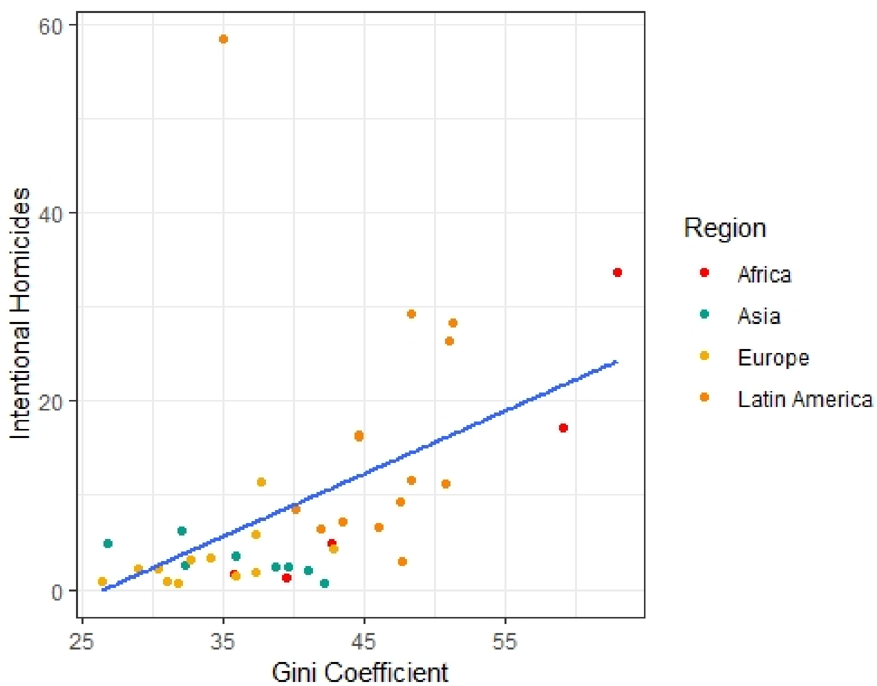
One possible explanation of a negative effect of income inequality on the level of economic growth lies in the Human Capital Theory, which emphasizes the importance of education on the subsequent development [Olaniyan and Okemakinde, 2008]. When the difference between the rich and the poor is big, then the latter will most likely have worse access to schooling due to a higher relative cost of education. In consequence, a considerable part of the population will have poorer skills and knowledge. This idea has empirical confirmation: Reardon [2011] found that higher income inequality is positively associated with a bigger academic achievement gap between the rich and the poor students. As a result, those from low-income countries will not be able to achieve their true potential. Accordingly, the whole country's economy will not develop effectively enough since only a fraction of the workforce will be able to contribute productively to the progress. Moreover, Cingano [2014] found a problem that worsens the issue described above. It says that, in countries with higher income inequality, people with low educated parents are less likely to obtain tertiary education. Therefore, the income and social status rigidity is an intergenerational difficulty that is inimical to people's incentives.

The idea of distributive efficiency was derived from the law of diminishing marginal utility and developed by Lerner [1944]. It claims that rich people will gain less utility from an additional sum of money, in comparison with poorer citizens, for whom the same amount could be vital. Indeed, the latter would probably allocate the obtained resources more logically and efficiently, and thus contribute more to the prosperity in society. For example, a bigger redistribution of income will make sure that more people have a healthy diet. As a result, fewer citizens will suffer from diverse diseases, which will reduce the government spending on healthcare. Nevertheless, it should be recognized that redistribution cannot continue up to perfect equality. This fact is also mentioned by Lerner [1944]. We need to take into account people's personal incentives due to the fact that utility is not a universal, but rather an individual attribute.

Big contrasts among the citizens' earnings can also result in greater socio-political instability, as mentioned by Alesina and Perotti [1996]. In high inequality countries, more inhabitants that have low incomes might be willing to involve in criminal activities since this could be the simplest and sometimes the only visible way to enrich. Also, inequality can increase the share of votes obtained by radical parties, which could be a potential threat to the political solidity [Dorn et al., 2018]. Afterwards, this instability might reduce investment, demotivate people from opening new enterprises and even force them to emigrate. All these consequences are harmful to economic growth.

The following graph reveals that there is a positive cross-country correlation between the Gini coefficient and the number of intentional homicides, which is an indicator of socio-political instability. It demonstrates that the argument given by Alesina and Perotti [1996] is still relevant today. Only countries with the GDP per capita between 3,000$ and 20,000$ as of 2015 (in 2010 dollars) were included in order to show that the correlation persists even among countries that do not differ extremely in terms of economic development. The source for murders is the World Bank database [2015].

Figure 3: The linear correlation between the Gini coefficient and the number of intentional murders per 100,000 people



Besides that, income disparity tends to be unfavourable for the safety of property and contract rights [Keefer and Knack, 2002]. Thus, insecurity could be another reason why inequality is detrimental for growth, because fewer investors and entrepreneurs will be willing to bear the risks of dealing with a more hazardous country.

Some theoretical literature claims that the countries with lower income inequality after taxes and transfers usually achieve this condition through more redistribution, which alters people's economic decisions, reduces the propensity to invest, and dwindles the economic growth [Barro, 1999, p.4]. The empirical study performed by Ostry et al. [2014], though, demonstrated that the fiscal redistribution is generally not harmful to the economic development. And, even if the hostile impact of redistribution exists, then it is usually less powerful than its beneficial effect. Only in special cases, when the redistribution is very large, it can affect the development negatively. This is why, in our overall sample, more redistribution and lower income inequality is good for economic growth.

An important remark needs to be made regarding the effect of the investment to GDP ratio and of the years of schooling on the level of economic development, which look insignificant and even negative in some cases, according to Table 1. This does not correspond to the growth model described in subsection 2.5. Such an outcome can be explained through the fact that both these factors are quite stable over time. In this case, the first-difference GMM instruments become weaker and the estimates get less accurate [Cingano, 2014]. The Fixed Effects also tend to have lower t-statistics, thus creating the feeling of insignificant regressors, when, in reality, the regressors are statistically significant [Pritchett, 2000, p.239]. Similar results with insignificant effects were found, when using the same methods, by Bond et al. [2001] and by Castelló-Climent [2010]. The positive effect of human and physical capital on the level of economic growth can be, however, demonstrated through the usage of advanced Pooled Mean Group techniques [Pesaran et al., 1999].

5.2 Countries divided by their economic development

In this section, we check whether the impact of income inequality on economic growth depends on the country's income level. Previous studies have proven that the effect is not always the same. It is usually significant and negative in less developed states, whereas in high-income countries it can be either significant and positive [Barro, 2000], [Shin, 2012], or insignificant [Madsen et al., 2018]. It is important to answer this question since it can help the government design the redistribution policy based on the current economic situation.

The average World GDP per capita is used as a threshold that separates the low-income states to the high-income ones. According to the World Bank [WB, 2019a], in 2015 this boundary was 10,307$ (in 2010 dollars). Therefore we obtain two samples: the first contains 50 low-income countries and the second has 43 high-income states, respectively. The list with the countries is presented in Table 7. A similar approach was used by Fawaz et al. [2014], who also divided the initial data set based on the level of economic development.

5.2.1 Results presentation

We prefer to introduce only the first-difference GMM results in Table 2 because endogeneity under the Fixed Effects estimation can be a serious issue. Using just the first-difference GMM approach makes the comparison of outcomes between the two groups of countries clearer, easier to interpret and presumably closer to reality. In each regression, the Sargan-Hansen test demonstrates the validity of the chosen instruments since the p-values are equal to 0.55234 and 0.47809, respectively. The Arellano-Bond test suggests that the models do not suffer from autocorrelation of order 2 because the p-value of the test is equal to 0.9439 in the sample with low-income countries, and to 0.6208 in the sample with high-income countries.

What we observe is that less developed countries suffer more from income inequality. According to the first column of Table 2, if the Gini coefficient decreases by 1 point, then GDP per capita will grow faster by 1.801 percentage points during the next five years, or by 0.3602 percentage points every year on average. This effect is also statistically significant since the t-value equals to -2.0793. At the same time, the more developed group of states experiences a much less notable impact of income inequality on the economic growth, with a t-value of -1.2802. The effect itself is almost two times smaller: a 1 point decrease in the Gini coefficient is predicted to expand the GDP per capita by 0.973 percentage points in the following five years (or by an average of 0.1946 percentage points per year).

	Dependent variable: GDP per capita growth (the t-values are in parentheses)	
	First-Difference GMM results	
	low-income	high-income
	(1)	(2)
lag(lgdppc)	-0.40581^{**}	-0.09482
	(-1.9834)	(-0.6090)
lag(gini)	-0.01801^{**}	-0.00973
	(-2.0793)	(-1.2802)
lag(popgrowth)	1.18341	-2.24219^{***}
	(1.0788)	(-2.6999)
lag(log(invtogdp))	-0.11342	-0.14410
	(-1.5475)	(-1.5336)
lag(log(schooling))	0.10581	0.45004
	(0.9430)	(1.0854)
lag(openness)	0.00056	0.00076
	(0.03656)	(1.0658)
lag(ctax)	-0.00059	-0.00076
	(-0.2594)	(0.00299)
d00	-0.24815^{*}	0.16098^{**}
	(-1.9577)	(2.0555)
d05	-0.06629	0.09408
	(-0.8962)	(1.6137)
d10	-0.00272	0.02649
	(-0.0600)	(0.8863)
Observations	50	43
Note:		*p<0.1; **p<0.05; ***p<0.01

Table 2: Regression Results (countries divided based on income)

5.2.2 Explanation of results

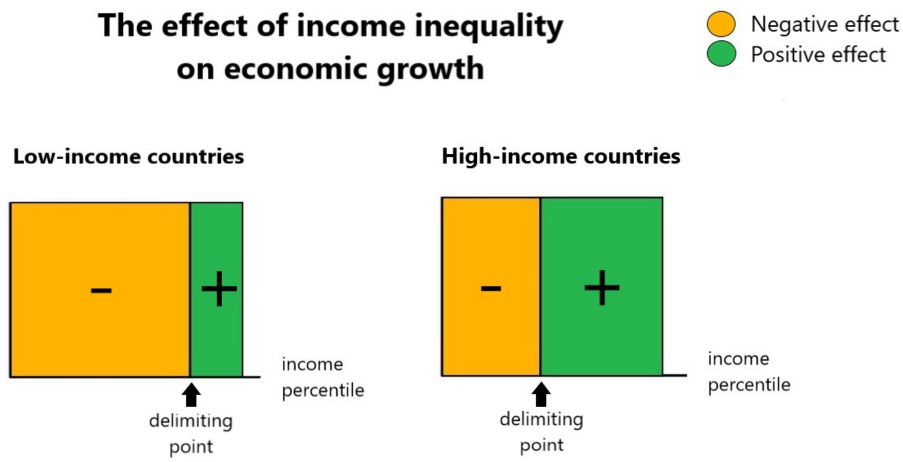
The reason for such a dissimilarity seems to lie in a different situation of poorer inhabitants in developing and in developed states. Clearly, people from the bottom of the economic ladder in advanced economies might be poor in comparison with other citizens of the same country, but they are richer than the poverty-stricken people in developing countries. That is, they would suffer less from the lack of access to education, they would still be able to obtain credits and make use of their skills. In other words, the poor inhabitants in developed countries endure similar problems as the poor inhabitants in developing states, but to a less extent thanks to overall higher standards of living and better functioning financial markets in high-income countries.

There is also a clear inverse relationship between the country's level of economic development and the percentage of people below the poverty line [World Poverty Clock, 2019]. Therefore, it is quite probable that the negative impact of income inequality on economic growth becomes stronger when the country has more people under the poverty line since these people are the main ones that are not able to reach their true potential through a poor investment in education and business. In consequence, it leads to slower economic build-out.

We can link the idea described above to the study of developed countries done by Voitchovsky [2005], who found that inequality among the poorer part of the population is responsible for slower economic growth. In the upper end of the distribution, however, the author found that income inequality has a positive effect on economic development. In other words, if the gap between the poorest and the middle class increases, then it is harmful to growth. At the same time, if the gap between the rich and the very rich people increases, then it might be favourable for the economic development.

Therefore, there can be an income margin that delimits the negative impact to the positive. If such a delimiting point exists, then developing countries have more people with an income below this margin, with especially more inhabitants living under the poverty line. Perhaps they represent a bigger "weight" overall, thus contributing to a stronger negative effect of income inequality on economic growth. The figure below represents a theoretical portrayal of this idea:

Figure 4: Explanation of differences in outcomes



Source: the author's surmise and graphic

We must recognize that, unfortunately, it is complicated to verify this assumption empirically. Voitchovsky [2005] found the presence of this effect and of the potential delimiting point only in developed countries. But low-income states still suffer from the lack of data about the distribution of income in their populations. Therefore, it is hard to find a certain income percentile in developing countries, above which the effect of inequality on economic growth changes from negative into positive the way it does in developed states, if such a delimiting point exists at all.

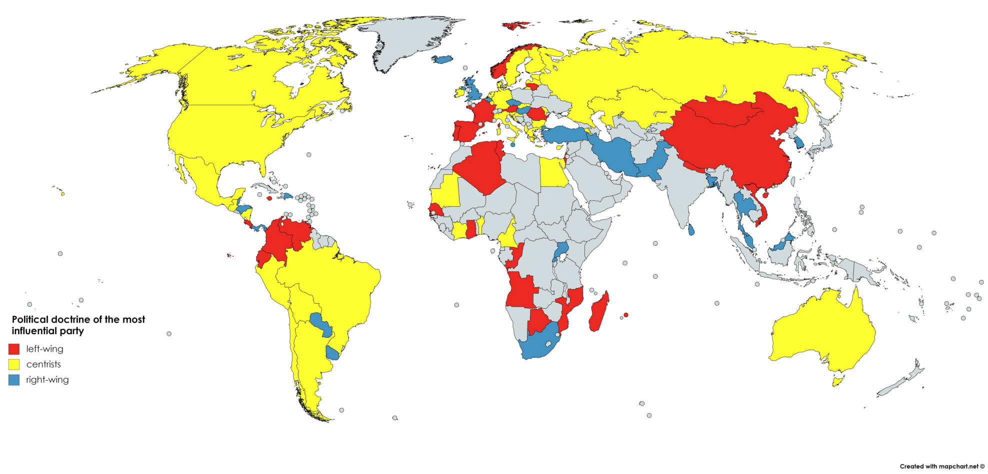
5.3 Countries divided by the doctrine of the ruling party

Now that we encountered that income inequality has a negative impact on the level of economic growth, it might be useful to find what is the political ideology under which this effect is the least noticeable. Some attempts to bind our topic of study with the system of government have been previously made. For instance, Clarke [1992], Assa [2012], and Herzer and Vollmer [2012] discovered that both democracies and non-democracies experience a similar negative influence of a higher Gini coefficient on the GDP per capita growth. We decided to go deeper and to check whether it differs depending on the political ideology of the leading party.

Our sample is divided based on the prevailing doctrine of the governing parties in the period 1990-1995: either left-wing, centre, or right-wing. The list with countries is presented in Table 8. Such a time span is chosen in order to avoid the potential endogeneity bias: if a later period was selected, then the electorate's choice would depend on the level of inequality, as well as on the effect of inequality on growth. For example, higher income inequality might be the reason for electing politicians that promote a left-wing ideology, which leads to endogeneity bias. The interval 1990-1995 is relevant because the effects of policymakers' decisions are likely to be long-lasting.

The moderate centre-left and centre-right affiliations and different combinations among them are deemed as centrist. Also, if the country was ruled approximately the same period of time by right-wing and by left-wing parties, then we consider these countries as centrist as well. In the case of parliamentary systems and constitutional monarchies, we take into account the ideology of the head of government (usually, this is the prime minister). In presidential and in semi-presidential systems, the official political doctrine of the head of state (usually, of the president) is used instead. We conclude that left-wing parties are more influential in 27 states, centrist parties - in 37 states, and right-wing parties - in 23 states. Figure 5 shows the distribution of countries based on this principle:

Figure 5: Division based on the doctrine of the ruling party



Source: the author's study

We should, however, acknowledge the relative subjectivity of this approach: if, for example, the party belongs to the Socialist International, then it does not mean that it will surely act as leftist. However, a certain degree of correlation exists. For example, Angelopoulos et al. [2012], and Stein and Caro [2013] demonstrated that left-leaning governments tend to tax more and to have higher tax revenues.

This study can provide with meaningful suggestions not only for the policymakers, but also for the electorate. It can shed light on the question whether a certain political belief is more resistant to inequality. Also, it could give us more details regarding the trade-off between equality and efficiency, which was discussed by Okun [1975].

5.3.1 Results presentation

The sample sizes become quite small, but we are limited due to the unavailability of data. Such a problem is often encountered among researchers who study similar topics. For instance, Herzer and Vollmer [2012] ended up with two samples containing 30 democracies and 13 non-democracies, respectively. Therefore, we will use fewer regressors in order to avoid losing many degrees of freedom. The Sargan-Hansen tests suggest that the chosen instruments are valid, whereas the Arellano-Bond tests indicate the absence of serial correlation of order two, because their p-values are above the threshold of 0.05. The results of all tests are presented in Table 3:

Test\Sample	**Left-Wing**	**Centrist**	**Right-Wing**
Sargan-Hansen (validity of instruments)	0.26615	0.078661	0.1545
Arellano-Bond (autocorrelation of order two)	0.08532	0.1329	0.3734

Table 3: GMM tests (p-values)

	Dependent variable: GDP per capita growth (the t-values are in parentheses)		
	First-Difference GMM Results		
	left-wing	centrist	right-wing
	(1)	(2)	(3)
lag(lgdppc)	−0.03748	−0.18087	−0.51813*
	(−0.2719)	(−1.0303)	(−1.7434)
lag(gini)	0.01035	−0.01188*	0.00513
	(1.0511)	(−1.9391)	(0.5038)
lag(popgrowth)	−1.01776	0.15342	−0.20524
	(−1.0914)	(0.1171)	(−0.3932)
lag(log(invtogdp))	0.07370	0.01317	−0.07798
	(0.7647)	(0.1146)	(−1.0182)
lag(log(schooling))	0.13082**	0.50064	0.15567
	(2.1415)	(1.4246)	(0.5051)
d00	0.08770	0.11525	−0.21332
	(1.3952)	(0.9874)	(−1.3845)
d05	0.05409	0.10760	−0.13637
	(1.2273)	(1.4573)	(−1.1044)
d10	0.03092	0.04196	−0.07306
	(1.4382)	(1.0701)	(−1.1954)
Observations	27	37	23
Note:			*p<0.1; **p<0.05; ***p<0.01

Table 4: Regression Results (countries divided by political doctrine)

Table 4 shows that the results differ substantially depending on the ideology of the ruling party during the previous five years. Only countries with a centrist government tend to experience a negative impact of income inequality on growth, where a 1 point decrease in the Gini coefficient would lead to GDP per capita growing faster by about 1.188% during the next five years, or by 0.2376% per year on average. The result is almost statistically significant at the 5% significance level since the t-value is -1.9391.

At the same time, income inequality is less important in determining the economic growth under leftist and rightist policymakers because the t-value of the lagged Gini coefficient is equal to 1.0511 and to 0.5038, respectively. That is, the results are even slightly positive. It is not in concordance with the overall results, but there are some logical explanations for this phenomenon.

The problem of insignificant regressors and of the negative effect of investment to GDP ratio on the level of economic growth in the column 3 of Table 4 seems to be even more serious than in previous cases, but it is due to the fact that we decreased the size of our samples. As we explained in the last paragraph of subsection 5.1.3, many macroeconomic indicators do not fluctuate much over time, which leads to estimates that are less precise and less significant, according to Cingano [2014]. Now that the sizes of our data sets are smaller, the probability of type II error increases [Mittelhammer, 2013, p.536]. There is a higher risk that we do not reject the null hypothesis of no effect of a certain factor on the level of economic growth, when, in reality, H_0 should have been rejected, and these factors are indeed important.

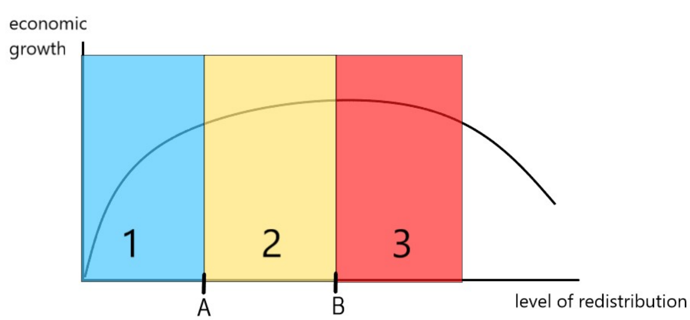
5.3.2 Explanation of results

The obtained results of the Gini coefficient effect on the subsequent economic growth do not follow a clear changing path from the left to the right of the political spectrum. Thus, there might be more than one factor that determines this impact, and each factor might be applicable only to a certain doctrine.

Firstly, let us explain why the influence of income inequality on economic growth might be slightly positive in countries with a left-wing background. What we work with is the Gini coefficient after taxes and transfers, so it already contains the government's attempt to redistribute wealth. Communist, socialist and social-democratic parties tend to promote redistribution more. Therefore, it might be that the leftist policymakers provoked the biggest "distortions of economic decisions", as described by Barro [1999]. Otherwise speaking, if the government in such countries decides to redistribute less through decreasing taxes and unemployment benefits, then this decision will increase the Gini coefficient, but it will also motivate opening businesses and investing more, thereby promoting economic growth. And vice versa, if the leftist policymaker increases taxes and tries to regulate businesses even more, then this might be deleterious to the evolution of the economy. At the same time, centrist and right-wing governments tend to reallocate as well, but apparently less than those ruled by leftist parties, so it does not have such a demotivating effect on entrepreneurs and investors. Berg et al. [2018] came to a similar conclusion that decreasing inequality via more redistribution is generally beneficial for economic development, but only when this redistribution is not too extensive.

Thus, it might be that the government can promote growth through reallocation of income only up to a certain level. After reaching this level, each additional attempt of the policymaker to redistribute wealth might have no effect or even slow down the economic development. Our assumption is derived from the idea presented by Okun [1975], and it claims that there are diminishing returns to redistribution as displayed in the following figure:

Figure 6: The diminishing effect of more income redistribution on the level of economic growth

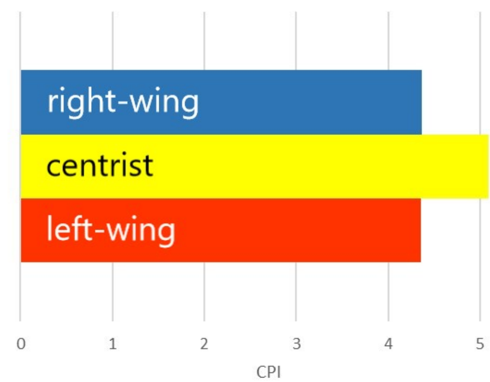


Source: the author's graphic

Figure 6 presumes that right-wing governments tend to redistribute only up to point A. In area 1, decreasing income inequality through redistribution has a very positive impact on economic growth. Centrist policymakers might want to pursue in their redistribution of wealth up to point B. In area 2, this effect is already weaker but still exists. Finally, left-wing governments might have continued too much in their attempt to redistribute the income, and they are somewhere in area 3. Each additional effort of a left-wing policymaker to decrease inequality through more redistribution might have no impact on the economic development, or it can even impede the growth.

Our explanation, however, does not correspond to the outcomes presented in the third column of Table 4. Countries with a right-wing government background do not experience the most negative impact of income inequality on economic growth, as we would expect from Figure 6. Instead, the effect is statistically insignificant, so there is an inverse factor that makes decreasing inequality undesirable for the economic development in the rightist states. Such a factor can be the lower efficiency of redistribution in right-wing countries in comparison with centrist states, which could be demonstrated through the Corruption Perception Index. It can have values between 0 (extremely corrupt) to 10 (very clean). In the latest ratings, this range goes from 0 to 100, but we adjusted it to previous indexes.

Figure 7: Average CPI between years 1995-2015



Source: Transparency International [2015]

Countries with rightist governments seem to be more corrupt than centrist states (the average CPI over years 1995-2015 is equal to 4.3707 and to 5.0944, respectively). According to Tanzi [1998], higher corruption makes the public investment less productive. Also, Mauro [1997] found that bribery worsens the composition of public expenditure. In other words, the governments of corrupt countries tend to spend less on sectors that are the most responsible for economic growth, like education. Perhaps they choose to spend on less transparent branches where bribery is less visible. As a result, the redistribution process in rightist countries experiences two effects that neutralize each other: on the one hand, according to Figure 6, more redistribution should lead to faster economic growth; but on the other hand, the redistribution process suffers from ineffectiveness and wrong decisions, which leads to a slower economic development.

In the left-wing countries, both these arguments tend to go into the same direction, that is why they experience the most positive effect of income inequality on the economic enhancement. Leftist policymakers might impose demotivating taxes, which can already have unfavourable effects on the GDP growth, as suggested by Figure 6. Moreover, as Figure 7 indicates, these states are also quite corrupt (CPI = 4.3549), so the policymaker might redistribute the obtained income less effectively.

6 Conclusion

The aim of this thesis is to give a complex answer to the widely studied, but still unclear impact of income inequality on the level of economic growth. In comparison with some other literature, it studies the economic evolution using a larger sample of 93 countries analyzed over the years 1995 and 2015. Along with the Gini coefficient, we include other regressors that are in concordance with the Solow-Swan model, such as the investment to GDP ratio, average years of schooling, and population growth, as well as other relevant independent variables. While investigating the overall impact, we apply two methods: the Fixed Effects estimation with Newey and West standard errors, and the first-difference GMM estimation. Only the first-difference GMM approach is used afterwards, while comparing the regressions on particular smaller samples.

We find that the Gini coefficient has a statistically significant negative effect on the subsequent level of economic growth, which is in correspondence to the bigger part of the last years' literature on this topic. Worse access to education and to business opportunities, social status rigidity and socio-political instability are among the gravest reasons that make the income inequality a serious barrier in front of the economic development. Various theories, such as the law of diminishing marginal utility and the human capital theory, confirm the fact that redistribution is not only the government's moral responsibility, but it is also beneficial to the economic progress.

Both low-income and high-income states experience a negative influence of the Gini coefficient on growth, but this effect is bigger and more significant in less developed countries. It could be explained through the fact that developing countries have more people under the poverty line, and these people are not able to reach their true potential due to weak schooling and worse access to funds. In richer countries, those from the bottom of the economic ladder are more often provided with some basic opportunities. Therefore, the developing states will benefit substantially if their governments will redistribute more by transmitting additional wealth to the poorest part of the population, thereby decreasing the number of citizens under the poverty line.

Finally, we find that the doctrine of the governing party has an ambiguous role in determining the influence of income inequality on economic development due to a variety of reasons that sometimes counterbalance one another. Left-wing parties could make this effect less significant or even positive because of their overmuch attempt to redistribute wealth, which tends to demotivate potential businessmen and investors. For centrist governments, the impact of inequality on growth is negative and similar to the overall results. At the same time, countries with both leftist and rightist policymakers tend to be more corrupt. It serves as another explanation why decreasing inequality through more redistribution does not have a positive effect on the level of economic development in any of these two groups.

This work is an attempt to shed light on the importance of income inequality in determining the pace with which the country develops. It demonstrates that unevenness is not exclusively a social and moral issue, but it is also disadvantageous to the economic growth of the whole state. We observe that reducing inequality through redistribution, up to a certain point, and if it is well organized and efficient, can be advantageous for the country's development.

It should be mentioned that many developing countries still suffer from the lack of data, and a bigger sample would have given even more precise and unequivocal answers. Dealing with such a data set, however, would require more advanced methods of estimation and of missing data imputation. Another way of getting more accurate results would be creating a more complex model that takes additionally into account the depreciation rate of physical capital and the exogenous technology growth. Therefore, this is still an open question and there is plenty of room in the study of this topic.

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Appendix

Newey and West Standard Errors

This illustration of Newey-West standard errors is based on the definition proposed by Newey and West [1987], as well as on the description of this approach presented by Greene [2007]. It is a more detailed explanation of the standard errors that are robust to autocorrelation and to heteroskedasticity, which were introduced in subsection (4.3.6).

Let us express the equation (5) in the following way:

$$y = X\beta + u, \quad Var(u) = \Omega, \tag{15}$$

where y is the dependent variable, X is the vector of regressors, and u is the error term. In case the residual suffers from autocorrelation and heteroskedasticity, then, according to Greene [2007], we can write the variance of $\hat{\beta}$ in the matrix form:

$$Var(\hat{\beta}) = (X'X)^{-1}X'\,\Omega\,X(X'X)^{-1} \tag{16}$$

Since Ω is not known in practice, then it needs to be estimated. Newey and West [1987] proposed the following estimator for Ω:

$$\hat{\Omega} = \begin{pmatrix} \hat{u}_1^2 & \xi_1\hat{u}_1\hat{u}_2 & \xi_2\hat{u}_1\hat{u}_3 & 0 & .. & 0 \\ \xi_1\hat{u}_1\hat{u}_2 & \hat{u}_2^2 & \xi_1\hat{u}_2\hat{u}_3 & \xi_2\hat{u}_2\hat{u}_4 & .. & .. \\ \xi_2\hat{u}_1\hat{u}_3 & \xi_1\hat{u}_2\hat{u}_3 & \hat{u}_3^2 & \xi_1\hat{u}_3\hat{u}_4 & .. & .. \\ 0 & .. & .. & .. & .. & 0 \\ .. & .. & .. & .. & .. & \xi_2\hat{u}_{T-2}\hat{u}_T \\ .. & .. & .. & .. & \hat{u}_{T-1}^2 & \xi_1\hat{u}_{T-1}\hat{u}_T \\ 0 & .. & 0 & \xi_2\hat{u}_{T-2}\hat{u}_T & \xi_1\hat{u}_{T-1}\hat{u}_T & \hat{u}_T^2 \end{pmatrix} \tag{17}$$

The main diagonal contains the quadratic estimates: $\hat{u}_1^2, ..., \hat{u}_T^2$, and it is designed to solve the issue of heteroskedasticity. In this regard, it uses the same logic as the standard errors developed by White et al. [1980]. The next diagonals solve the problem of autocorrelation between residuals. The number of these diagonals is limited, though, and is determined by the following formula:

$$number\ of\ diagonals = 4\left(\frac{T}{100}\right)^{2/9}, \tag{18}$$

where T is the number of periods of time. The values $\xi_1, \xi_2, ...$ are considered as "weights", which become smaller as we move farther from the main diagonal:

$$0 < ... < \xi_2 < \xi_1 < 1 \tag{19}$$

In this way, we obtain that:

$$Var(\hat{\beta}) = (X'X)^{-1}X'\,\hat{\Omega}_{NW}\,X(X'X)^{-1} \tag{20}$$

Afterwards, the variance of $\hat{\beta}$ can be used to obtain particular standard errors.

Auxiliary Tables

Variable	mean	st.dev	min	25pctl	median	75pctl	max
gdppc	15361	19873	170	2189	6230	22016	107648
lgdppc	8.76	1.435	5.139	7.691	8.737	9.999	11.586
gini	38.949	9.242	23.5	31.8	37.1	45.3	64.8
population (millions)	44.214	138.99	0.206	4.623	10.895	36.117	1,371
popgrowth	0.0594	0.0595	-0.19	0.021	0.057	0.098	0.302
invtogdp	24.057	7.123	8.247	19.743	22.793	26.953	61.469
log(invtogdp)	3.14	7.12	2.10	2.982	3.126	3.294	4.118
schooling	8.414	2.65	0.93	6.675	8.94	10.44	13.18
log(schooling)	2.06	2.65	-0.07	1.89	2.190	2.345	2.578
openness	84.2	47.27	16.98	52.24	72.00	105.99	410.17
ctax	28.185	8.23	0.01	24.2	28.47	33.99	72.1

Table 5: Descriptive Statistics of Variables

Abbreviation	Variable	Natural Logarithm	Source
lgdppc	GDP per Capita Growth	yes	WB
gini	Gini Coefficient	no	WB
popgrowth	Population Growth	yes	WB
log(invtogdp)	Investment to GDP Ratio	yes	WB
log(schooling)	Average Years of Schooling	yes	Barro and Lee data set
openness	Trade Openness	no	WB
ctax	Corporate Income Tax	no	OECD Database

Table 6: Description of Variables and Abbreviations Used

Low-Income Countries		**High-Income Countries**	
Albania	Kyrgyz Republic	Argentina	Korea, Rep.
Algeria	Madagascar	Australia	Latvia
Angola	Mauritania	Austria	Lithuania
Armenia	Mauritius	Belgium	Luxembourg
Bangladesh	Mexico	Brazil	Malaysia
Belize	Moldova	Canada	Malta
Benin	Mongolia	Chile	Netherlands
Bolivia	Morocco	Croatia	Norway
Botswana	Mozambique	Cyprus	Panama
Bulgaria	Nepal	Czech Republic	Portugal
Cameroon	Nicaragua	Denmark	Russian Federation
China	Nigeria	Estonia	Slovak Republic
Colombia	Pakistan	Finland	Slovenia
Congo, Rep.	Paraguay	France	Spain
Costa Rica	Peru	Germany	Sweden
Cote d'Ivoire	Romania	Greece	Switzerland
Dominican Republic	Rwanda	Hungary	Turkey
Ecuador	Senegal	Iceland	United Kingdom
Egypt, Arab Rep.	South Africa	Ireland	United States
Ghana	Sri Lanka	Israel	Uruguay
Guatemala	Thailand	Italy	Venezuela
Honduras	Tunisia	Kazakhstan	
Iran, Islamic Rep.	Uganda		
Jamaica	Ukraine		
Jordan	Vietnam		

Table 7: Countries divided by their GDP per Capita in 2015

Left-Wing		Centrist		Right-Wing	
Algeria	Madagascar	Albania	Greece	Bangladesh	Pakistan
Angola	Mauritius	Argentina	Guatemala	Belgium	Panama
Austria	Mongolia	Armenia	Ireland	Belize	Paraguay
Botswana	Mozambique	Australia	Italy	Czech Republic	Rwanda
China	Nepal	Benin	Kazakhstan	Dominican Republic	South Africa
Colombia	Norway	Bolivia	Latvia	Honduras	Sri Lanka
Congo, Rep.	Portugal	Brazil	Luxembourg	Hungary	Thailand
Costa Rica	Romania	Bulgaria	Mauritania	Iceland	Turkey
Ecuador	Senegal	Cameroon	Mexico	Iran, Islamic Rep.	Uganda
France	Spain	Canada	Moldova	Korea, Rep.	United Kingdom
Ghana	Tunisia	Chile	Netherlands	Malaysia	Uruguay
Israel	Venezuela	Cote d'Ivoire	Nicaragua	Malta	
Jamaica	Vietnam	Croatia	Peru		
Lithuania		Cyprus	Russian Federation		
		Denmark	Slovak Republic		
		Egypt, Arab Rep.	Slovenia		
		Estonia	Sweden		
		Finland	United States		
		Germany			

Table 8: Countries divided by political doctrine