SCHOOL OF
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# Is inequality harmful for sustainable development?

by

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It is obviously expected that sustainable development is the primary target to raise prosperity and life standards of nations. It is necessary to ensure social, political, and economic stability. But what about the stimulus factors that motivate sustainable development? Can income inequality be one of them?

Some literature has examined the role of income distribution on economic growth, but to test the relationship between inequality and sustainable development has not been done. To answer the questions above, 139 countries covering 48 years between 1970 and 2018 have been tested in this context by Fixed-effects and Ordinary Least Squares estimations.

According to the results, although no relationship has been observed between income inequality and sustainable development for the short and middle term, there is a negative and statistically significant relationship for the long term. Furthermore, the approach has been reapproved that income inequality may foster economic growth for the short and middle run, although its impact is still negative for the long run.

*Keywords: Income inequality, Sustainable development, Adjusted Net Savings, Weak sustainability, Strong sustainability, Economic growth*

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# 1 Introduction

*"Humanity has the ability to make development sustainable to ensure that it meets the needs of the present without compromising the ability of future generations to meet their own needs." (WCED, 1987)*

There is an agreement among academics, society members, and policymakers that some global and severe challenges threaten humanity. Some of them are economic factors, like poverty and high inequality; others are related to ecological like biodiversity loss, water scarcity, and droughts increased by environmental degradation or climate change (Chaminade, 2020). These are called "globally networked risks" (Galaz et al., 2017) that should be solved (at least reduced) urgently; otherwise, these issues will call for new challenges like famines, conflicts, humanitarian crises, and violent extremism (Chaminade, 2020).

To overcome all of these issues ensuring sustainable development should be the main target. So, what is sustainable development?

Sustainable development is one of the well-known topics that have been popularized, especially with a declaration of Agenda 21 that has been signed by 178 countries which target to protect the environment and improve human lives in the Rio Summit in 1992 (United Nations, 2021a). It was the primary event in the UN's history that reached its aim of raising awareness for the planet's future.

Accepting Millennium development goals on eliminating poverty until 2015 can be viewed as one of the most critical steps in that context. It covered eight important development targets, from eradicating extreme poverty and hunger to achieving universal primary education or promoting gender equality to reducing child mortality (United Nations, 2015). Reducing poverty was the project's immediate success, with a substantial decrease from half of the developing world population from 1990 to 14 percent until 2015 (United Nations, 2015).

The 2030 Agenda for Sustainable Development with 17 SDGs is the last but not least of the documents adopted by the UN to acquire sustainable development for all over the world (United Nations, 2015). It is the standard blueprint for prosperity and peace for humanity which aims to eliminate poverty, reduce inequality, improve health and education, sustain economic growth, and so on (United Nations, 2015, 2021b).

As it is mentioned above, one of the SDGs is reducing inequality. In general views, inequality has been accepted as one the most critical issues that prevent growth and development, and of course, results in a less prosperous and less stable nation (Alesina & Perotti, 1993; Gallagher & Hanson, 2009; McGregor, Smith & Wills, 2019). However, some economists argue that instead of inequality's negative impact on economic growth for the long term, it may be an accelerator of economic performance for the short-run (Forbes, 2000).

## 1.1 Aim and Scope

The aim of this thesis is to examine the relationship between income inequality and sustainable development in all countries of the world between 1970 and 2018 for three different time intervals.

These research questions will be analyzed in this thesis:

*1. How income inequality affects sustainable development?*

*2. How income inequality affects economic growth?*

## 1.2 Outline of the Thesis

The thesis has been structured as follows. Chapter 1 presents an introduction to the topic, mentions some critical events of the issue, and explains research questions. Chapter 2 includes a literature review that covers former research and theories. Chapter 3 is the data section that refers to the structure of the data that have been collected and will be used in the thesis. Furthermore, the type and format of variables will also be included in this part. The empirical strategy, models, and hypothesis of the thesis will be presented in Chapter 4. In Chapter 5, results, robustness checks, and discussion will be detailed. In conclusion, Chapter 6 is the section where concluding remarks of the thesis will be represented.

# 2 Previous research

The following section consists of previous research and theories on two important issues of humanity. First, studies and ideas on sustainable development will be discussed in section 2.1. Second, literature and approaches on causes and results of the income distribution will be covered in section 2.2.

## 2.1 Sustainable development

What is sustainable development? It is one of the most popular questions asked since the second half of the twentieth century. It has been popularized as one of the primary topics debated in the academic environment since observing fundamental shifts towards severe global warming and experiencing terrific results of climate change. As these issues started to threaten humanity besides hunger, poverty, deforestation, ocean acidification, and other human waste-related acts, the new habit is related to using sources appropriately have been tried to promote by scientists. The main feature of these new habits is that these have been explained as acts associated with ethics (like justice or freedom) but not related to movements that can be experienced or be seen (Döring, 2010; Michelsen et al., 2016; Renn, Knaus & Kastenholz, 1999). And the primary aim of the discussions is to save part of natural sources for the next generation by ensuring sustainable development.

The term - sustainability has been brought to literature for the first time, known in history by Hanns Carl von Carlowitz – a German mining director, in 1713 in his treatise that focused on reusing and recovering the forests (Grober, 2007). But although more than two centuries passed, sustainability had not been attracted globally until the mid-XX century. Except for limited research from time to time by limited researchers, it had not been accepted as a severe topic of growth and development. In the early XX century, sustainability had been called back in the fishing industry as having maximum yield without depreciation (Michelsen et al., 2016). But still, it could not get attention and did not find a place among urgent topics of socio-economic issues until the mid-XX century. More importantly, as economic issues of some nations, particularly western countries, have been solved by the Industrial Revolution, ecological or environmental issues were not appropriately evaluated as they have been deserved (Michelsen et al., 2016).

In the second half of the XX century, several natural catastrophes resulted in an increase of awareness among countries on the sustainable use of natural resources (Michelsen et al., 2016). The United Nations Conference on the Human Environment in Stockholm in 1972 played an essential role in finding out countries' attitudes on environmental issues and has been accepted as the landmark event in a rise in international environmental policies (UN, 1972). On the one hand, developed economies supported more sustainable development that would be acquired by using natural resources in a sustainable way. However, on the other hand, part of developing countries did not agree with a transition to more eco-friendly production without eliminating hunger, poverty, and having a better education and healthcare (Michelsen et al., 2016). Instead of all objections, an agreement has been signed. Then two events that the UN has organized played a leading role in pushing all leading economies towards preparing a more sustainable roadmap: the publication of "Report of the World Commission on Environment and

Development: Our Common Future" in 1987 (UN, 1987) and the signing of the Agenda 21 at the conference of the UN on Environment and Development in Rio de Janeiro in 1992 (UN, 2007). These two projects established the environment where the initial steps to use resources more sustainable way have been taken.

Two types of sustainability have been developed based on their definition of substitutable and the features of goods that should be saved for the next generations: strong and weak sustainability (Michelsen et al., 2016).

### 2.1.1 Weak sustainability

Supporters of weak sustainability defense that every kind of natural capital can be substituted as other forms of capital. In the end, if the total capital does not change its total value, it means sustainability has been ensured (Ott, 2019). If total wealth stays the same through reinvesting the rents from natural capital to other forms of capital, it has been accepted as proof of justice for all generations (Blum, Ducoing Ruiz & Mclaughlin, 2017; Cabeza Gutés, 1996; Solow, 1974). According to this theory, parks can be an alternative to forests, or swimming pools can be an alternative to lakes (Michelsen et al., 2016).

"Technical optimism," which is the primary argument of weak sustainability proponents, supports the idea that technological innovations will provide better solutions to substitute goods from one form to another and save them as their final shape (Hartwick, 1977; Michelsen et al., 2016). Hartwick Rule sees the process as a transition of natural resources to reproducible types of machinery that can be transferred to future generations, and in that way, issues related to injustice would be solved (Hartwick, 1977). Science and technological innovation's role in this transition process and reducing dependency on natural resources besides solving ecological issues is irreplaceable (Chaminade, 2020). In today's world, economies' main aim is to acquire economic growth, and the straightforward method of obtaining it is possible by traditional way-utilization of natural capital, which concludes with environmental degradation and ecological collapse (1994). Especially in low and middle-income economies, it is still the primary option of catching up. But, will these issues be solved as a consequence of economic growth?

The issue is that low-income economies cannot access high technologies, which may limit environmental degradation with less pollution, less waste, and more high-quality end products during utilization. Moreover, as high technologies belong to especially high-income economies, it is not always possible to transition them to low and middle-income economies, diminishing technological innovation's role in sustainable development.

### 2.1.2 Strong sustainability

Strong sustainability is the movement that motivates complementation instead of substitution of goods and supports the theory that not all natural resources can be substituted but some of them (Ott, 2019). The main difference from weak sustainability is that its target is the quality of resources instead of quantity and up for non-declining natural capital (Blum, Ducoing Ruiz & Mclaughlin, 2017).

The notion has been developed by the proponents of ecological economics and strengthened with the concept of the stationary state argument that has been supported by Adam Smith, Thomas Malthus, Karl Marx, John Mill, John Keynes, Herman Daly, and others (Daly, 2007; Michelsen et al., 2016; O'Connor, 1997; Smith, 1776).

According to Adam Smith, a stationary state brings a way to poverty, but others see it as a development covering ecological factors (Michelsen et al., 2016). Herman Daly also supports the steady-state approach and mentions the negative influence of quantitative growth that results in a more uneconomic state (Daly, 2007; Michelsen et al., 2016). On the one hand, the difference between marginal cost and marginal utility explains uneconomic growth, and based on Daly's (2007) approach, even optimization in households in micro-level concludes with uneconomic activity at some point where marginal costs reach marginal benefits. On the other hand, he explains the macro-level uneconomic process by the transition from the green flow, which refers to natural capital, to brown flow that assigns artificial products, and mentions: *"As we expand the brown flow, we reduce the green flow, and we maybe will keep doing that as long as the additions to the brown flow are greater than the subtractions from the green flow in terms of its usefulness to us"* (Daly, 1999). In that case keeping production in an "optimum" level at some point seems like the solution which is also impossible as population growth, immigration, employment, and other factors do not stay stable at constant point (Michelsen et al., 2016).

Its reliability compared with weak sustainability is more robust in some contexts. For example, proponents of the latter theory see the problem profoundly and propose a more legit solution. Technological innovation may contribute substantially in that context, but the primary justification is economizing using natural resources. Although its implementation is still challenging with the rising population, its contribution to the prosperity of current and future generations would be more reasonable.

### 2.1.3 Measuring sustainable development

Adjusted net (genuine) savings is the numerical indicator of weak sustainability (Bolt, Matete & Clemens, 2002; Hartwick, 1977) and has been accepted as an indicator of sustainable development at the macro-level for the long-term period (Arrow et al., 2012; Blum, Ducoing Ruiz & Mclaughlin, 2017; Gnègnè, 2009; Greasley et al., 2014; Hamilton & Clemens, 1999; Pezzey, 2004; Qasim & Grimes, 2018).

It is calculated by subtracting resource depletion and environmental degradation from net national savings and adding human capital (Hamilton & Clemens, 1999). A positive ANS signifies that economic growth is on a sustainable path and adds wealth to a country's total wealth, resulting in better well-being (ed. World Bank, 1997, 2013). The definition has been explained clearly by the World Bank (2007) in the World Development Indicators report as *"Adjusted net savings measure the change in the value of a specified set of assets, excluding capital gains. If a country's net savings are positive and the accounting includes a sufficiently broad range of assets, economic theory suggests that the present value of social welfare is increasing. Conversely, persistently negative adjusted net savings indicate that an economy is on an unsustainable path."* (World Bank, 2007).

Bolt, Matete, and Clemens (2002) published the measurement method of Adjusted net saving (ANS) with a current formula where all indicators have been expressed as a percent of Gross National Income:

***Net national saving*** = *Gross National Saving – Consumption of fixed capital* *(1)*

***Adjusted net saving*** = *Net national saving + Education expenditure – Energy depletion – Mineral depletion – Net forest depletion – Carbon dioxide damage – Particulate emissions damage* *(2)*

where *consumption of fixed capital* shows replacement value of capital that exhausted in the production process; *education expenditure* refers to public expenditures on education that covers salaries and wages but exclude investments in equipment and buildings; *energy depletion* is the measurement of the physical quantity of energy extracted and product of unit resource rents from coal, natural gas, and crude oil; *mineral depletion* specifies the same indicator as energy depletion with different natural resources: gold, zinc, tin, iron, lead, nickel, copper, bauxite, silver and phosphate; *net forest depletion* is the unit resource rents product and surplus of Roundwood crop over natural growth; *carbon dioxide damage* is measured as the amount of emitted carbon multiplied by $20 (per ton of carbon); *particulate emission damage* is the limit of the cost that can be paid to avoid mortality and morbidity which is related to particulate emissions (World Bank, 2007).

## 2.2 Income inequality

Income distribution is one of the most important topics among scientists that focus on economic and social sciences. Politicians are also interested in that issue because it threatens countries' sovereignty by instability and regime change (Alesina & Perotti, 1993; Gallagher & Hanson, 2009; McGregor, Smith & Wills, 2019). And it will keep its essentiality as long as humanity exists and if assets will be there to share. As perfect equality among society members is almost impossible, the discussion will never end. However, it can be argued that it is only possible in utopic societies but not in the real world. There are some examples in history where more equal societies have been established artificially at the cost of several other social, economic and political issues.

For example, the policies of the Soviet Union should be taken into consideration in that context. The socialist system that the Soviet Union has implemented has acquired equality until some point and established an equal society where the wages were similar in different sectors and positions, and everyone had the same rights on accessing to house and accessing land, etc. (Novokmet, Piketty & Zucman, 2017). As a result, Soviet Russia experienced its lowest inequality in the mid-XX century. However, a long-run U-shaped pattern has been experienced that started from Tsarist Russia with high inequality, through lower inequality during the Soviet Union, to today's Russian Federation with even higher inequality (Novokmet, Piketty & Zucman, 2017). Transition to the market economy, privatization, and new institutions that support the market economy resulted in a redistribution of wealth where income inequality rose its peak during history (Milanovic & Ersado, 2011; Novokmet, Piketty & Zucman, 2017).

Although between-country inequality decreases due to satisfactory growth rates of emerging economies, within-country inequality does not follow the same trend and rises in all countries

with different rates (Alvaredo et al., 2017, 2018; Piketty & Goldhammer, 2014). China, India, North America, and Russia are leading geese in that context, who experienced a rapid increase in the last 40 years (Alvaredo et al., 2018). Experiencing a stagnation in bottom income groups resulting from a poorly organized tax system and unequal process of privatization are among the primary reasons for an increase in inequality in the US and China, respectively (Alvaredo et al., 2017). However, Sub-Saharan Africa, Middle East, and Brazil save their position as "inequality frontiers" of the world since the second half of the last century (Alvaredo et al., 2018).

Several authors discussed the relationship between income inequality and economic development, covering both possible aspects: the impact of economic growth on income distribution and the effect of income distribution on economic growth. Additionally, all researches contain strong arguments that have been supported by historical data and events. Taking into account this fact, proponents of each approach will be presented with their views.

### 2.2.1 Causes of income inequality

This relation has been discussed broadly after the publication of an American economist - Simon Kuznets' paper called "Economic Growth and Income Inequality" (Kuznets, 1955). An invented-U curve, also called the Kuznets curve, was invented in the article where the author examines the long-term changes of income distribution and stresses the importance of transition among sectors in economic growth and income distribution. According to Kuznets (1955), income inequality is rising in the early years of development when a shift from agriculture to manufacturing happens. A rise in inequality continues at a high rate at some point until it reaches the next stage of development, where a transition of the labor force from manufacturing to the service sector starts (Kuznets, 1955).

One of the scholars who share a similar view with Kuznets is Van Zanden. He invented the "super Kuznets curve" to be influenced by Kuznets instead of sharing different perspectives on the causes of this transition related to structural change (Van Zanden, 1995). He sees the reason for shifts from one stage to another as a result of *"[t]he transition from 'premodern growth' to 'modern economic growth"* (Van Zanden, 1995).

Acemoglu and Robinson (2002) discussed the relationship differently and showed institutions as the main reason for economic growth and income distribution. They have explained the turning points of the Kuznets curve with a political change in any country. So positive or negative outcomes of institutions are related to historical facts and events, especially in the case of the colonial background of undeveloped countries (where reversal of fortune has been empirically proved) have been taken into consideration (Acemoglu, Johnson & Robinson, 2002). The theory has also been motivated by Nunn (2008) with his research on the impact of the slave trade on African countries' economic performance. According to the result of the study, slavery has negatively affected economic performance and today's less developed countries that have been participated in the slave trade were among the most advanced African countries 500 years ago (Nunn, 2008). In conclusion, poor institutions have been established due to limited natural resources, unfavorable geographical locations, and ethnic fractalization (Nunn, 2008), which is the primary cause of the high inequality and slow economic performance of Sub-Saharan African economies.

Thomas Piketty (2014) also touched on the inequality issue in his "Capital in the Twenty-first Century" book with one of the strongest arguments of recent years – a higher return on capital. First of all, the author quoted that the Kuznets curve has exposed not all countries that have passed the structural change. Piketty (2014) justified his claim with redistribution of income after the 1980s in the US, where income inequality has started to rise again. It has been accepted as a violation of the Kuznets curve as the trend is positive again instead of a transition process from manufacturing to service sector has been already started.

It is worthwhile to mention that some scholars call the process "Kuznets waves" (Milanović, 2016) instead of the curve, and according to Milanovic, the cause of this confusion is related to uncompleted data that has been used by Kuznets (Piketty & Goldhammer, 2014). As Kuznets' paper has been published in 1955, which could not cover the reversal trend of the US, it has been referred to that a decline in the curve has been conjectured as a result of subjective events back to the mid-XX century. Piketty (2014) decoded the last stage of the Kuznets curve – a decline before the 1980s with two major indicators: two world wars between 1910 and 1950s and higher taxation in some countries that have been implemented to cover war expenses (Piketty, 2014, p. 20). In the following steps, progressive taxation and education have been shown as the main contributors of a rise in income inequality after the 1980s, besides higher returns on capital (Piketty, 2014, p. 498). It has been interpreted as wealth being distributed more unequally and concentrated on only the elite's hands when the return on capital is higher than the growth rate (Piketty, 2014, p. 351).

As it is mentioned before, Branko Milanovic (2016) also joined the debate with his new approach, which is an alternative to the Kuznets curve. He argued that the Kuznets waves could be repeated several times during history. So, the primary difference is that it can be implemented in various economies at all times. For example, the author has expounded on the rise of inequality after the 1980s as the second Kuznets wave (Milanović, 2016). So-called the first phase of the second Kuznets wave had happened thanks to an increasing number of high-tech companies which need high-skilled and more educated human capital (Milanović, 2016, p. 47). In addition, higher-paid jobs in the service sector such as pharmaceuticals, finance, and telecommunications are also among the reasons for the new trend after the 1980s (Milanović, 2016, p. 103). As a result, a decreasing trend of inequality in China has been categorized as the second phase of the first Kuznets wave (Milanović, 2016, p. 47). So, it means that these waves can explain every trend. The main difference between waves and the curve is that the whole transition process among sectors has been accepted as a single formula in the curve, the process has been divided into two parts measuring waves: a transition from agriculture to manufacturing is called the first phase and the second phase starts with migration from manufacturing to the service sector (Milanović, 2016, p. 93).

Walter Scheidel (2017) has evaluated the issue in terms of historical perspective based on four critical events: revolutions, mass mobilization wars, plagues, and collapses called the Four Horsemen of the Apocalypse. Revolutions and mass mobilization wars could be added to the same category, distinguished as full of blood and violence (Scheidel, 2017, p. 393). Wars also have been consisted of two sub-categories: wars among nations, countries, or groups of countries and civil wars. According to the author, on the one hand, the former sub-category contributes to an equal society by progressive taxation, which targets to share wealth more equally among society members. For example, the US, Canada, Japan, and France could be shown as an example of this approach (Scheidel, 2017, p. 309).

On the other hand, income distribution is being harmed due to civil wars as it concludes with the loss of human and physical capital and the labor market (Scheidel, 2017, p. 383). Furthermore, it results in wealth concentration in the hands of limited elites, who abused weak states to preserve their power (Scheidel, 2017, p. 383). Revolutions that have happened, especially in the XX century, have been mentioned as one of the main contributors to leveling. A transition process in Russia, China, Cambodia, and Vietnam has reduced income inequality thanks to the redistribution of lands among peasants (Scheidel, 2017, p. 425). The process in Russia and China was distinctive based on the rate of violence and being bloody that pushes revolutions to the same category as wars (Scheidel, 2017, p. 425). Black Death and the plague were other causes of an equal society as millions of people were killed, creating labor deficiency (Scheidel, 2017, p. 551). A decline in land prices derived from labor deficiency has contributed to access to wealth for peasants, which decreased income inequality for a limited period (Scheidel, 2017, p. 551). System collapse and state failures are the last Horsemen argued as the destructive role of governments by supporting elites with their acts of concluded with wealth concentration (Scheidel, 2017, p. 474). Barre family in Somali, Tang aristocracy in China, elites in Western Roman Empire have been mentioned as an example of the devastating role of elites on income distribution (Scheidel, 2017, p. 474). Furthermore, income distribution has started to be improved after resigning these families and the disintegration of the Western Roman Empire (Scheidel, 2017, p. 474).

### 2.2.2 Results of income inequality

Discussions on the relationship between economic growth and income inequality date back to the 1950s. Lewis (1954) and Kaldor (1957) are among the leading scholars who showed better economic performance as a positive outcome of income inequality. According to scholars, income inequality, especially initial years of growth, is one of the main contributors to economic growth, explained by scholars with different arguments.

According to Lewis (1954), income inequality motivates to form a productive environment for capital formation in the capitalist system, resulting in an expansion in employment. So, capital formation, besides technical progress, does not only contribute to wages. It contributes to the share of profits in national income, which can be argued as one of the leading indicators of economic growth (Lewis, 1954). And he explained the economic backwardness of undeveloped countries with fewer savings not as a result of poor people but as a result of lower capitalist profits compared with national income (Lewis, 1954). In other words, the theory argued that concentrated wealth in limited hands concludes with a procreative environment for investment and contributes to economic growth in that way.

Perotti (1996) has rejected the view of equal income distribution's positive effect on economic growth. The impact of income inequality on growth has been reassessed by Kristin Forbes (2000) in his paper "A reassessment of Relationship Between Inequality and Growth," in which He investigated the relationship between two indicators for both short, medium, and long-term effects. The research results have proved the positive relationship between income inequality and economic growth for the short and medium-term (Forbes, 2000). 180 observations from 45 countries between 1966 and 1995 have been tested where a positive effect of income inequality on growth for short and medium terms have been approved (Forbes, 2000).

Barro (2000) also touched on the issue and concluded that it impacts differently based on the income level of countries. He argued that income inequality's effect on different income groups

is various. So that, instead of acting as a catalyst for rich countries (where GDP is above 2000 $) with support to economic growth, its effect in poor countries (where GDP is below 2000 $) is opposite by tempering it (Barro, 2000).

### 2.2.3 Measuring income inequality

Several theories (115 of them have been mentioned by De Maio (2007)) have been published on measuring inequality. The Gini coefficient (Gini, 1914), the Hoover index (Hoover, 1936), the Theil index (Theil, 1967), the Atkinson inequality index (Atkinson, 1970), and the Palma index (Palma, 2006, 2011) are some of them which have been prepared by using distinctive methods. And that's why different results may be observed from various techniques as they have a distinct conceptual and theoretical framework.

One of the most well-known formulas used to measure income distribution is the Gini coefficient (Cobham & Sumner, 2013; De Maio, 2007; Palma, 2011). Two main components form the Gini coefficient: The Lorenz curve and the perfect equality line. The Lorenz curve of a population's income is compared with distribution with a perfect equality line to acquire the Gini coefficient (De Maio, 2007). The Lorenz curve expresses the percentage of total income received by an aggregate rate of the population (De Maio, 2007). $45^0$ line of equality or perfect equality line shows an imaginary equal society where income is distributed equally among society members. For example, in that scenario, 25% of the total income is being distributed among the poorest 25% of the population or 50% of the total income distributed among the poorest 50% of the population (De Maio, 2007). And, in a perfectly equal society, the Lorenz curve would follow that perfect equality line; otherwise, its deviation from the line shows the income distribution of any country (De Maio, 2007).

It is presented between 0 and 1, where 0 shows perfect equality, and 1 represents perfect inequality (De Maio, 2007). The formula of the Gini coefficient is:

$$Gini = 1 - \sum_{i=1}^{N}(x_i - x_{i-1})(y_i - y_{i-1}) \qquad (3)$$

where $x_i$ refers to an aggregate measure of well-being such as income or expenditure of individual *i,* and $y_i$ is the sign of accruing population up to individual *i* (McGregor, Smith & Wills, 2019).

Although it is the most widely used formula to measure inequality, it is criticized for some shortages. Both for implicit assumptions that have been used for essential social welfare function, which is unacceptable, and lack of consistency in using summary statistics of different countries that use various measurement methods are among deficiencies (Atkinson, 1970). Cobham and Sumner (2013) also criticized the Gini index on the same issue and judged it for considering only half of the income distribution, like the Palma ratio. Furthermore, an opaque and hitherto undiscovered way that is being used to calculate Gini and an unclear result that is complicated to comprehend by a non-technical audience is also among critiques (Cobham & Sumner, 2013). Additionally, incompetent to differentiate the various type of inequalities and to be sensible, especially for the middle part of the income spectrum, are other issues argued by De Maio (2007) and Solt (2020a). A smaller effect on the coefficient's value is being observed in case of changes of values of extremes (De Maio, 2007; Palma, 2011).

In a general context, some issues are being faced in data collection for measuring income distribution. First of all, it has been calculated based on formal earnings and informal earnings, such as rental income, where returns from assets are not being included (McGregor, Smith & Wills, 2019). The second issue is related to the under-reporting of top incomes during data collection (Alvaredo, 2010; McGregor, Smith & Wills, 2019). However, the latter problem has been solved by using tax records data for top income shares (Atkinson & Piketty, 2007, 2010; McGregor, Smith & Wills, 2019). Instead of these deficiencies, the Gini coefficient is still the most famous indicator of the income distribution.

# 3 Data

This section is divided into three subsections. Section 3.1 mentions the sources of data for different variables and shows limitations. Section 3.2 discusses the types of variables that will be used in different models. The last section – 3.3, includes descriptive statistics for all variables of the analysis.

## 3.1 Source Material

Data for the research has been collected from several data sources. World Bank's World Development Indicator (2021), Harvard University's SWIID project (2020b), Freedom House (2021), United Nations (2019), and UNESCO (2015) have been used as the primary sources of the data to run the regressions (Table 1).

The data on all outcome variables - adjusted net savings (both variants - including particulate emission damage and excluding particulate emission damage), consists of 149 countries between 1970 and 2018. However, data for the former indicator has been started to be collected since 1990, there have enough data for the latter group from 1970 to 1990, and these two databases have been combined to acquire a larger dataset. The World Bank's World Development Indicator database (2021) is the source of this variable.

Additionally, the primary explanatory variable - the Gini coefficient data, has been acquired from The Standardized World Income Inequality Database (SWIID), version 9.0 (Solt, 2020b). This database has been distinguished with a high rate of coverage of data on income inequality. It has covered 156 countries from 1970 to 2018. The database has been developed by collecting data from the United Nations University's World Income Inequality Database (WIID) and several other sources. In addition, World Bank's World Development Indicator database (2021) has also been used to run alternative checks to ensure data quality even though its coverage area is limited.

Furthermore, United Nations, UNESCO, and Freedom House are the sources of 3 crucial control variables – life expectancy, education, and institutions, respectively. The data on life expectancy has been obtained from the United Nations Department of Economic and Social Affairs' Population Prospects 2019 report (2019), and it covers 199 countries from 1970 to 2018 with five-year intervals. Education, which covers 187 countries from 1970 to 2015, has been acquired from UNESCO Institute for Statistics database (2015). Besides these, Freedom House (2021) has been used as the initial source of institution data (the Gastil index).

And finally, the rest of the variables are also acquired from the World Development Indicator database (2021). These are net national saving, education expenditure, resource rents (depletion of energy, minerals, and forest), CO2 damage, GDP per capita, Foreign Direct Investment, trade openness, Investment, public consumption, the degree of financial freedom, population growth, urban population and dependency ratio that cover all countries during the coverage period.

*Table 1. Sources of data*

| Variables | Dataset | Authors |
|---|---|---|
| Gini coefficient | SWIID 9_0 | Solt (2020) |
| Life expectancy | UN World population prospects | UNDP (2019) |
| Education | UNESCO Institute for Statistics | UNESCO (2015) |
| Gastil index | Country and Territory Ratings and Statuses, 1973-2021 | Freedom House (2021) |
| ANS, NNS, education expenditure, resource rents, CO2 damage, GDP, FDI, trade openness, Investment, Consumption, financial freedom, urban population, Dependency ratio | World Development Indicators | World Bank (2021) |

Several limitations have been faced during data collection. One of the main constraints of data is related to the primary outcome variable – adjusted net savings. Although all calculations have been done for up to 50 years that cover from 1970 to 2018, the data on *adjusted net savings, including particulate emission damage*, is available in World Bank's database since 1990. Thus, there is a 20 years gap in between. To overcome the issue, the data on *adjusted net savings, excluding particulate emission damage,* has been combined with the former indicator for 20 years interval between 1970 and 1990.

The second issue is related to the Gini coefficient. So that, data on income inequality is limited in several databases. Despite acquiring from the most extensive database, some countries have been excluded from the database because of data missing. But still, the SWIID project is a well-organized database to test hypotheses related to income inequality. Additionally, data on education is also scarce and limited to essentially high-income countries, similar to all other statistics of different indicators

## 3.2 Variables

There are six main outcome variables in this thesis that measure sustainable economic development (Adjusted net saving; net national saving; net national saving without subtracting CO2 damage; net national saving without subtracting education expenditures; net national saving without subtracting CO2 damage and education expenditures) and economic growth (GDP). While the Adjusted net saving is the primary outcome variable that will be used in all models, other outcome variables will be used in limited models.

Another outcome variable - GDP is defined as the logarithm of Gross Domestic Product per capita that has been acquired from the World Bank's database to use in the model where the relationship between inequality and economic growth will be tested.

The primary explanatory variable - the Gini coefficient, is defined as an income distribution measurement for all countries that have been collected since the 1960s. Two types of Gini coefficients will be used in the regressions: inequality that has been calculated based on disposable income; and inequality that has been calculated based on market income. Disposable income, which is the main ingredient of income inequality for the former method, has been explained by Solt (2020a) as *"[g]ross income minus direct taxes: 'post-tax, post-transfer income."* Market income's definition is *"[t]he amount of money coming into the household, excluding any government cash or near-cash benefits, the so-called 'pretax, pre-transfer income"* (Solt, 2020a).

Moreover, other explanatory variables have been divided into four groups to check their relationship with development based on their profile:

1) **Access to finance** covers FDI, investment and trade openness variables. FDI is a log of Foreign Direct Investment calculated based on net inflows of capital and expressed as a percentage of GDP. FDI is positively and significantly related to sustainable growth, particularly in low and middle-income countries unless (Berg & Ostry, 2011; Dell'Ariccia et al., 2008).

Investment is defined as the gross capital formation, which is calculated as a percentage of GDP. According to Ongo and Vukengeng (2014), a private investment expressed as a gross capital formation has a positive and strong relationship with economic growth, mainly thanks to technical progress and infrastructural development.

Trade openness is the degree of trade liberalization measured by the sum of imports and exports divided by GDP (Carrera & Vega, 2020; Jain-Chandra et al., 2018). According to Berg and Ostry (2011), trade liberalization is one of the main factors that make growth more durable by supporting competition, transmitting know-how, and enhancing market size.

2) **Capital accumulation** consists of consumption and education. Consumption refers to the general government's final consumption expenditure as a percentage of GDP. Landau (1985) has tested its relation to economic growth and concluded with a negative and statistically significant relationship. It results in a slowdown in growth per capita product of countries that support a pro-free market view that stressed the negative impact of governmental growth on economic growth (Landau, 1983, 1985).

Education represents the completion rate of lower secondary education calculated as a ratio between the number of new students to the last grade of lower secondary education and the total population that is a potential candidate to attend the same grade (UNESCO, 2015). It has been observed as a contributor factor to economic growth positively and highly significantly (Landau, 1983, 1985).

3) **Demographic change** covers the variables of life expectancy, population, urbanization, and dependency. Life expectancy refers to the logarithm of life expectancy at birth. Some views argue that an increase in life expectancy boosts the population substantially; a rise in GDP is also observed slightly (Acemoglu & Johnson, 2007; Ashraf, Lester & Weil, 2009; Cervellati & Sunde, 2011). However, as economic growth based on life expectancy was not enough to compensate population growth, a decrease in GDP per capita has been observed at some point (Acemoglu & Johnson, 2007; Ashraf, Lester & Weil, 2009).

The population is an annual percentage of population growth. Peterson (2017) has tested the effect for both high and low-income countries and found controversial results. On the one hand, low population growth in high-income countries brought some economic and social problems. On the other hand, a high population in low-income countries results in a slowdown in their economies. Furthermore, its adverse effect since 1980 has also been mentioned by Headey and Hodge (2009). However, Thornton (2001) found no relationship between these two variables.

Urbanization is the urban population measured as a percentage of the total population. Henderson (2003) argued that the "best degree of urban concentration" may foster economic growth by maximizing productivity. However, Zhang and Cheng (2009) have tested the impact of urbanization on economic growth via using CO2 emissions and concluded that there is no clear relationship between urbanization and economic development.

Dependency is the sign of age dependency ratio that is measured as a percentage of the working-age population. Headey and Hodge (2009) support that although a rise in the adult population contributes to economic growth significantly, a negative and statistically significant relationship is observed for an increase in the young population (0-14 years old), notably after the 1980s. Moreover, Fougère and Mérette (1999) argued that population aging creates more opportunities for economic growth by stimulating investment in human capital formation by future generations.

4) **Institutional quality** includes institutions. Institutions are the democracy index cited for the Gastil index. The Gastil index is the report that evaluates countries based on several factors. And countries have been sorted into three grades: -1 if a country is not free, 0 if a country is partly free, and 1 if a country is free. The electoral process, freedom of speech, the rule of law and rights, the functioning of the government are among the factors that play a prominent role in the preparation of the report, which covers 192 countries since 1972 (Freedom House, 2021). It is one of the most critical factors contributing to sustainable growth by securing political accountability (Berg & Ostry, 2011) because strong institutions make a way to establish a well-developed domestic financial system and macroeconomic policy frameworks that let to keep crisis frequency at a low level and prevent macroeconomic volatility (Dell'Ariccia et al., 2008).

As an extra note, some variables in databases have been represented in current US dollars. These variables are ANS, NNS, education expenditure, and resource rents. They will be exchanged to constant 2010 US dollars using the CPI inflation calculator (CPI inflation calculator, 2021).

## 3.3 Descriptive statistics

Summary statistics have been shown in that section (Table 2). It covers all countries and years with all available data of sources that have been mentioned above from 1970 to 2018, and it has not been restricted to any purpose. Restricted list have also been prepared and added to the Appendix (see Appendix A, Table 15).

*Table 2. Summary statistics (unrestricted sample)*

| | N | Mean | Std. Dev. | min | max | skewness | t-value |
|---|---|---|---|---|---|---|---|
| ANS | 4546 | 10.034 | .178 | .63 | 10.982 | -31.591 | 3796.711 |
| NNS | 5373 | 10.043 | .229 | -4.516 | 11.064 | -47.101 | 3210.467 |
| ANS_E | 5334 | 9.108 | .229 | 7.305 | 10.816 | 3.169 | 2902.95 |
| ANS_P | 5315 | 8.605 | .386 | 6.295 | 10.784 | 2.11 | 1623.99 |
| ANS_EP | 5370 | 9.099 | .234 | 7.305 | 10.817 | 3.124 | 2855.017 |
| GINI (SWIID-disp) | 4779 | .385 | .089 | .198 | .672 | .181 | 298.439 |
| GINI (SWIID-mrk) | 4779 | .459 | .067 | .218 | .725 | .44 | 477.142 |
| GINI (World Bank) | 1710 | .385 | .092 | .207 | .658 | .598 | 172.592 |
| GDP | 8265 | 8.412 | 1.528 | 5.086 | 12.186 | .09 | 500.517 |
| FDI | 7044 | .377 | 1.772 | -13.121 | 7.441 | -1.166 | 17.866 |
| Investment | 7034 | 23.523 | 8.662 | -13.405 | 89.381 | .868 | 227.766 |
| Trade openness | 7474 | 4.214 | .648 | -3.863 | 6.758 | -1.658 | 562.469 |
| Consumption | 6997 | 16.269 | 7.13 | 0 | 76.222 | 1.85 | 190.864 |
| Education | 2891 | 59.125 | 33.256 | .24 | 206.604 | -.197 | 95.593 |
| Life expectancy | 1660 | 4.172 | .181 | 2.673 | 4.436 | -1.38 | 937.55 |
| Population | 10405 | 1.703 | 1.7 | -10.955 | 28.06 | 2.496 | 102.163 |
| Urbanization | 10332 | 53.027 | 25.176 | 2.845 | 100 | .093 | 214.091 |
| Dependency | 9329 | 69.933 | 20.389 | 15.743 | 120.52 | .168 | 331.294 |
| Institutions | 8006 | .121 | .821 | -1 | 1 | -.227 | 13.216 |

# 4 Methods

In that section, the methodological features of the analysis will be discussed. Section 4.1 covers the Empirical strategy that expresses which technique will be used. Models that will be tested will be explained in Section 4.2. Finally, the hypothesis of the thesis will be mentioned in Section 4.3.

## 4.1 Empirical strategy

It is quantitative research that has been motivated as a form of correlational design that is being used to show and test the degree of association between two or more variables (Creswell, 2014, p.41). Within variation Fixed Effect models and between variation Ordinary Least Square regression will be used to test the relationship for measuring short-run and long-run impact. As both of these methods have advantages at some point, the result that has been acquired from their combination would be more legit.

As the database covers a large dataset that includes all countries between 1970 and 2018 for 11 explanatory variables, evaluating the results of times serious and cross-sections would be beneficial to acquire consistent results. The difference between these methods has been explained by Kuh (1959) as *"[c]ross-sections typically will reflect long-run adjustments whereas annual time series will tend to reflect shorter run reaction. Because disequilibrium among firms tends to be synchronized in response to common market forces and the business cycle, many disequilibrium effects wash out (or appear in the regression intercept) so that the higher cross-section slope estimates can be interpreted as long-run coefficients. The fully adjusted response will typically show a higher coefficient than an incompletely adjusted response. Since the cross-section data will also contain some short-run disturbances, however, these coefficients will only approximate fully adjusted long-run coefficients"*. Additionally, Baltagi and Griffin (1984) also reconfirmed the hypothesis and mentioned that *"[o]ur results reconfirm the empirical tendency for time series data to yield short-run responses and cross-sections to yield long-run responses arising from the dynamic under-specification of the lag length."*

First of all, Fixed effect models are being used broadly for longitudinal data analysis (Hill et al., 2020). It has been developed to solve omitted variable bias and unobserved heterogeneity by containing within units (Allison, 2009; Hill et al., 2020; Treiman, 2014; Wooldridge, 2010). And its reliability for using it to control for time-constant unobserved heterogeneity has been recommended (Vaisey & Miles, 2017). Furthermore, Collischon and Eberl (2020) see the cause of the popularity of the model as *"[t]he potential sources of biases in the estimations are limited in comparison to classical OLS models. In the case of OLS models, a correlation between any unobserved variable and the outcome or the treatment variable of interest results in a biased estimate of the treatment effect. In contrast, FE models limit the sources of bias to time-varying variables that correlate with the treatment as well as with the outcome over time. In most applications, this condition is far more achievable than the strong exogeneity assumption of OLS models."* And hence, the authors suggested using the model if time-constant unobserved heterogeneity is likely to be an issue, if time-varying unobserved heterogeneity is unlikely an issue and if the direction of a causal effect is theoretically pellucid (Collischon & Eberl, 2020).

Although being one of the most well-known models for panel data analysis, it has several limitations that make it undesirable to use it for all types of research. A culture of omission, limited external validity, low statistical power, measurement error, limited periods, undefined variables, time invariance, unobserved heterogeneity, inaccurate interpretations of coefficients, erroneous causal inferences, imprudent comparisons with cross-sectional models, and questionable contributions are an example of these issues (Hill et al., 2020). Besides these restrictions, group differences, reverse causality, external validity, and large standard errors are also among the potential issues of the model (Collischon & Eberl, 2020; Vaisey & Miles, 2017).

Second of all, Ordinary Least-Squares (OLS) estimator has been accepted as one of the most reasonable estimators in case of when the OLS is the best linear unbiased estimator (BLUE) (Hsiao, 2014, p.36), which *"[i]s often referred to as the Gauss-Markov theorem"* (Kennedy, 2008, p.45). It is a regression estimation technique that minimizes a weighted sum of all these residuals (Kennedy, 2008, p.13, 347). However, sometimes the results of the OLS may be biased and inconsistent (Greene, 1981). And facing multicollinearity is one of the main problems that is being faced when using OLS regression (Kennedy, 2008, p.199).

The analytical approach has been formulated based on the strategy that Forbes (2000) and Brueckner and Lederman (2015) have been tested and came to a solid conclusion. As the impact of income distribution on growth is complex and needs to be tested with several methods, all explanatory variables will be divided into one, five, and twenty-year intervals. Furthermore, a lag structure will be implemented to get an exact result as it is a usual method used by some, researchers especially when the target is income distribution. One of the advantages of lagging time is having an average of some years, making the calculation more rational. These three lags will let to learn the short, middle, and long-term effects of income distribution on sustainable and economic growth.

The data has been transferred from longitudinal to cross-sectional data to test all countries with various variables. Thus, from 118 to 138 countries (dependent on the model they will be attracted to) will be included in regressions. Additionally, to diminish the heteroscedasticity issue, some variables will be converted into logarithmic.

## 4.2 Model

### 4.2.1 Model 1. Impact of income inequality on sustainable development

$$\begin{aligned} Sustainable\ development_{i,t} = {} & \beta_1 inequality_{i,t-1} + \beta_2 FDI_{i,t-1} + \beta_3 investment_{i,t-1} + \\ & \beta_4 trade\ openness_{i,t-1} + \beta_5 consumption_{ii,t-1} + \\ & \beta_6 education_{i,t-1} + \beta_7 life\ expectancy_{i,t-1} + \\ & \beta_8 population\ growth_{i,t-1} + \beta_9 urbanization_{i,t-1} + \\ & \beta_{10} dependency_{i,t-1} + \beta_{11} institutions_{i,t-1} + \alpha_i + \eta_t + u_{i,t} \end{aligned} \quad (4)$$

where sustainable development refers to Adjusted net savings (ANS) per capita from 1970 to 2018, which is the primary explanatory variable. Inequality is income distribution that shows the Gini index in country *i* and time *t*. FDI, investment, trade openness, public consumption, education, life expectancy, population growth, urban population, dependency rate, and

democracy index are the control variables explained in the data section. $\alpha_i$ are country dummies, $\eta_t$ are period dummies, and $u_{i,t}$ is an error term.

Time dimension t expresses one, five, and twenty-year intervals from 1970 to 2018. Time has been divided into three subgroups because of having more reliable data with fewer repeats and is expected to avoid errors as much as possible by replacing a substantial amount of missing data by the mean of five and twenty years.

The model is controlled for the variables - share of Foreign Direct Investment on GDP, the share of investment on GDP, trade openness which has been calculated based on import and export outcomes of the country, the share of public consumption on GDP, the lower secondary school completion rate for both sexes measured by total years, life expectancy which also measured by total years, the annual rate of population growth, the share of urban population on the total labor force, ratio of age dependency on working-age population and the Gastil index that indicates a democratic environment of the country based on several indicators.

Control variables are lagged for one, five, and twenty-year periods based on their participation in methods. So 1 in *"t-1"* refers to the lags that will be included in the regressions related to the timeframe. So it refers to 1, 5, or 20 based on the model that will be used.

Furthermore, to run the OLS estimations, the model below will be used in the thesis:

$$\begin{aligned} \textit{Sustainable development}_i = {} & \alpha_0 + \beta_1 \textit{inequality}_i + \beta_2 \textit{FDI}_i + \beta_3 \textit{investment}_i + \beta_4 \textit{trade openness}_i + \\ & \beta_5 \textit{consumption}_i + \beta_6 \textit{education}_i + \beta_7 \textit{life expectancy}_i + \\ & \beta_8 \textit{population growth}_i + \beta_9 \textit{urbanization}_i + \beta_{10} \textit{dependency}_i + \\ & \beta_{11} \textit{institutions}_i + u_i \qquad (5) \end{aligned}$$

where sustainable development refers to Adjusted net savings (ANS) per capita from 1970 to 2018, which is the primary explanatory variable. $\alpha_0$ is a constant term which does not change across countries. Inequality is income distribution that shows the Gini index in country *i* and time *t*. FDI, investment, trade openness, public consumption, education, life expectancy, population growth, urban population, dependency rate, and democracy index are the control variables explained in the data section. And $u_i$ is an error term.

Data for income groups of countries based on their income level has been acquired from the World Bank's country classification section (World Bank, 2021). Economies have been divided into four groups based on their GNI per capita indicators: Low-income economies that have GNI per capita of $1,035 or less; lower-middle-income economies, which perform from $1,036 to $4,045; upper-middle-income economies' performance is between $4,046 and $12,535; and high-income economies who own $12,536 or more in 2019 (World Bank, 2021).

Different variants of Adjusted net saving will also be tested to investigate the effect of income inequality on various components of Adjusted net savings (education expenditure and CO2 damage):

$$ANS\_E = NNS - R - P \qquad (6)$$

$$ANS\_P = NNS + E - R \qquad (7)$$

where ANS is Adjusted net saving, NNS refers to Net national saving, R shows resource rents (depletion of energy, minerals and forest), P exhibits carbon dioxide damage, and E is the sign of current education expenditures (Gnègnè, 2009).

## 4.3 Hypothesis

The models explained in the previous section are used to test the null hypothesis of the estimated coefficient of income inequality is being statistically not different from zero. The null hypothesis will be rejected if the estimated coefficient is different from zero at a 10 percent level of significance.

For economic growth:

*$H_0$: $\beta_1 = 0$ (null hypothesis: income inequality has no significant effect on economic growth)*

*$H_1$: $\beta_1 \neq 0$ (alternative hypothesis: income inequality has a significant effect on economic growth)*

For sustainable development:

*$H_0$: $\beta_1 = 0$ (null hypothesis: income inequality has no significant effect on sustainable development)*

*$H_1$: $\beta_1 \neq 0$ (alternative hypothesis: income inequality has a significant effect on sustainable development)*

# 5 Empirical Analysis

Results of the empirical analysis will be introduced in that section. After the results are explained in section 5.1, robustness checks will be described in section 5.2, and the discussion section 5.3 will expand and check its appropriation with the methodology presented in this paper.

## 5.1 Results

### 5.1.1 The relationship between income inequality and sustainable development

The result of Pearson's correlations (Table 3) between Adjusted net saving and independent variables express the availability of a statistically significant negative relationship between sustainable development (ANS) and income inequality (Gini coefficient) in both one, five, and twenty-year intervals. However, especially for the 20-year interval, a stronger relationship is observed between the two variables.

The relationship between ANS and control variables for one year period suggests the result of a statistically significant and positive relationship between them except for population growth and dependency ratio. The relationship for five-year intervals reveals a similar outcome with one-year intervals. Instead, it shows an insignificant relationship between ANS and investment ratio and ANS and government consumption. Finally, when the relationship for 20-year interval has been tested, the same result of the first model has been acquired where only FDI does not express a significant relationship.

*Table 3. Pearson's correlations*

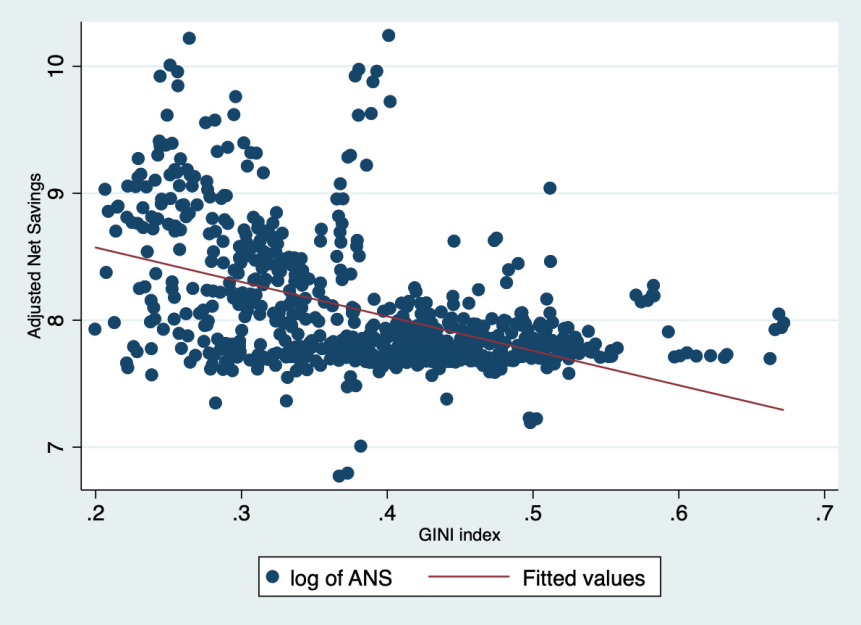
| Variables | 1-year | 5-years | 20-years |
|---|---|---|---|
| | ANS | ANS | ANS |
| Gini | -0.242* | -0.221* | -0.429* |
| | (0.000) | (0.000) | (0.000) |
| FDI | 0.063* | 0.088* | 0.093 |
| | (0.000) | (0.005) | (0.147) |
| Investment | 0.051* | 0.058 | 0.244* |
| | (0.001) | (0.066) | (0.000) |
| Trade openness | 0.136* | 0.121* | 0.245* |
| | (0.000) | (0.000) | (0.000) |
| Consumption | 0.061* | 0.060 | 0.190* |
| | (0.000) | (0.056) | (0.003) |
| Education | 0.313* | 0.144* | 0.293* |
| | (0.000) | (0.000) | (0.000) |
| Life expectancy | 0.120* | 0.234* | 0.418* |
| | (0.001) | (0.000) | (0.000) |
| Population | -0.029 | -0.083* | -0.237* |
| | (0.051) | (0.007) | (0.000) |
| Urbanization | 0.297* | 0.266* | 0.526* |

| | | | |
|---|---|---|---|
| | (0.000) | (0.000) | (0.000) |
| Dependency | -0.248* | -0.254* | -0.490* |
| | (0.000) | (0.000) | (0.000) |
| Institutions | 0.178* | 0.176* | 0.385* |
| | (0.000) | (0.000) | (0.000) |

*Note: p-values in parentheses (*** p<0.01, ** p<0.05, * p<0.1). Gini coefficient and control variables lagged for 1, 5 and 20 years.*

Figure 1 below also discloses the relationship between ANS and Gini coefficient for the whole world for 1 year period. It has been observed from the graph that the relationship between them is negative when all countries have been included. Therefore, similar graphs have been prepared for low, and middle-income economies and added to Appendix (see Appendix C: Figure 2 and Figure 3). The results are controversial: while income inequality is seen as an obstacle in front of sustainable development in high-income economies (see Appendix C, Figure 2), it may be one of the primary contributors to sustainable development for low and middle-income economies (see Appendix C, Figure 3).

*Figure 1. Relationship between Income inequality (GINI) and Sustainable development (ANS)*




*Fixed-effect methods*

The regressions have been started with testing the relationship between income inequality and genuine savings with time-variant within the estimator. First of all, the standard methods of panel estimation - Fixed-effects or Random effects, have been tested to be used in regressions. Although using fixed-effects estimations have an advantage in giving more reliable results within each country across time, random-effects estimations are more useful to have a result of combined data across countries and periods (Forbes, 2000).

Hausman test has been performed to determine the reliable estimation, and according to the result, the Fixed effect method is preferred instead of a Random effect to have more accurate results (See Appendix B, Table 14).

According to the fixed-effect models, the relationship between income inequality and sustainable economic development is statistically insignificant for the short and middle term and statistically significant at 0.1 level only for the long term. In addition, the relationship among them for both time intervals is positive (Table 4). It refers that an increase in the Gini coefficient motivates genuine savings in all years of development. Therefore, it may support income inequality's supportive role, as mentioned by Forbes (2000) in the short and middle term. (2000).

*Table 4. Fixed-effects models (GINI and ANS)*

| | 1-year | 5-years | 20-years |
|---|---|---|---|
| VARIABLES | ANS | ANS | ANS |
| Gini (t-1) | 0.207 | 0.589 | 2.618* |
| | (0.225) | (0.425) | (1.350) |
| Constant | 10.18*** | 8.770*** | 17.89*** |
| | (0.260) | (1.077) | (2.477) |
| Observations | 244 | 448 | 107 |
| R-squared | 0.114 | 0.025 | 0.937 |
| Number of countries | 95 | 118 | 91 |

Dependent variable is adjusted net savings from 1970-2018. Models are controlled for FDI, investment, trade openness, consumption, education, life expectancy, population, urbanization, dependency and institutions. Robust standard errors are in parentheses. *** p<0.01, ** p<0.05, * p<0.1

The tests above have been conducted by measuring the relationship between ANS and Gini coefficient for different periods with all control variables. When control variables have been added to the regressions based on their grouping mentioned in the Method section, it is clearer to learn how relationships change with current variables. Table 5 below describes the test of the relationship between sustainable development and income inequality with grouping strategy. A five-year interval to conduct the test has been chosen as it included more reliable data related to all variables as having mean variables for five-year intervals.

Five models have been regressed according to a group of variables. Although the first model is simple, others are being consisted of some controls. The regression results mention that the relationship is not statistically significant anymore in the case of the existence of control variables in contrast to simple regression, despite the fact that the relationship between sustainable development and inequality has been remained positive. Investment in Model 2 and government consumption in Model 3 are the two critical factors that affect sustainable development negatively. Most of the other variables in all Methods also affect negatively but without showing significance.

*Table 5. Fixed-effects models (GINI and ANS -5 years interval*

| VARIABLES | (1) Model 1 | (2) Model 2 | (3) Model 3 | (4) Model 4 | (5) Model 5 |
|---|---|---|---|---|---|
| Gini (t-1) | 0.424*** | 0.481 | 0.424 | 0.601 | 0.589 |
| | (0.151) | (0.300) | (0.298) | (0.433) | (0.425) |
| FDI (t-1) | | -0.00595 | -0.0137 | -0.0203 | -0.0201 |
| | | (0.0135) | (0.0129) | (0.0195) | (0.0194) |
| Investment (t-1) | | -0.00218* | -0.00135 | -0.00135 | -0.00139 |
| | | (0.00120) | (0.00112) | (0.00132) | (0.00135) |

| | | | | | |
|---|---|---|---|---|---|
| Trade openness (t-1) | | 0.0409 | 0.114 | 0.0893 | 0.0912 |
| | | (0.0391) | (0.102) | (0.0822) | (0.0834) |
| Consumption (t-1) | | | -0.00546*** | -0.00751 | -0.00751 |
| | | | (0.00160) | (0.00492) | (0.00493) |
| Education (t-1) | | | -0.00169 | -0.00271 | -0.00270 |
| | | | (0.00177) | (0.00251) | (0.00251) |
| Life expectancy (t-1) | | | | 0.270 | 0.272 |
| | | | | (0.266) | (0.268) |
| Population (t-1) | | | | -0.0299 | -0.0298 |
| | | | | (0.0313) | (0.0312) |
| Urbanization (t-1) | | | | -0.00113 | -0.00102 |
| | | | | (0.00282) | (0.00273) |
| Dependency (t-1) | | | | -0.00124 | -0.00119 |
| | | | | (0.00155) | (0.00152) |
| Institutions (t-1) | | | | | -0.00549 |
| | | | | | (0.0108) |
| Constant | 9.870*** | 9.732*** | 9.604*** | 8.788*** | 8.770*** |
| | (0.0588) | (0.243) | (0.337) | (1.062) | (1.077) |
| Observations | 746 | 718 | 463 | 448 | 448 |
| R-squared | 0.002 | 0.006 | 0.018 | 0.025 | 0.025 |
| Number of countries | 137 | 135 | 122 | 118 | 118 |

Dependent variable is adjusted net savings from 1970-2018. Robust standard errors are in parentheses.
*** p<0.01, ** p<0.05, * p<0.1

*OLS models*

The second method tested is the cross-country estimation - Ordinary Least Squares, which is suitable for time-invariant analysis, and the results are more suitable for measuring the long-term effect (Forbes, 2000).

According to the result of the OLS model, the effect of income inequality on sustainable development is negative and statistically significant at 0.01 for all timeframes (Table 6). In contrast to the fixed-effect model, the coefficient of income inequality for all periods is negative the relationship is stronger.

*Table 6. OLS models (GINI and ANS)*

| | 1-year | 5-years | 20-years |
|---|---|---|---|
| VARIABLES | ANS | ANS | ANS |
| Gini | -0.456*** | -0.643*** | -0.461*** |
| | (0.0796) | (0.144) | (0.0844) |
| Constant | 9.819*** | 10.63*** | 10.27*** |
| | (0.386) | (0.661) | (0.363) |
| Fixed time effects | Yes | Yes | Yes |
| Observations | 260 | 484 | 213 |
| R-squared | 0.479 | 0.176 | 0.417 |

Dependent variable is adjusted net savings from 1970-2018. Models are controlled for FDI, investment, trade openness, consumption, education, life expectancy, population, urbanization, dependency and institutions. Robust standard errors are in parentheses. *** p<0.01, ** p<0.05, * p<0.1

Five-year intervals have been tested with a grouping of control variables that have been used in the Fixed Effect methods. Inequality expresses a strong relationship with sustainable development at 0.01 level in case of all models (Table 7). It is worthwhile to mention that government consumption plays an important role in limiting sustainable development besides with income inequality. Investment and life expectancy is also seen as a constraint in front of development, however there is no strong relationship between them has been presented. However, it may be seen from the table that, FDI, education and institutions are the main contributors of ensuring sustainable development.

*Table 7. OLS models (GINI and ANS - 5 year interval)*

| VARIABLES | (1)<br>ANS | (2)<br>ANS | (3)<br>ANS | (4)<br>ANS | (5)<br>ANS |
|---|---|---|---|---|---|
| Gini | -0.500*** | -0.473*** | -0.370*** | -0.556*** | -0.643*** |
| | (0.0785) | (0.0792) | (0.135) | (0.146) | (0.144) |
| FDI | | 0.0155** | 0.00908 | 0.0144 | 0.00989 |
| | | (0.00628) | (0.00903) | (0.00924) | (0.00909) |
| Investment | | -0.000194 | -0.00122 | -0.000838 | 0.000505 |
| | | (0.00108) | (0.00161) | (0.00170) | (0.00169) |
| Trade openness | | 0.0156 | 0.0121 | 0.00386 | 0.00598 |
| | | (0.0145) | (0.0240) | (0.0246) | (0.0241) |
| Consumption | | | -0.00748*** | -0.00743*** | -0.00939*** |
| | | | (0.00208) | (0.00224) | (0.00223) |
| Education | | | 0.00103** | 0.00212*** | 0.00201*** |
| | | | (0.000438) | (0.000674) | (0.000660) |
| Life expectancy | | | | 0.00335 | -0.104 |
| | | | | (0.140) | (0.139) |
| Population | | | | 0.0489*** | 0.0597*** |
| | | | | (0.0109) | (0.0109) |
| Urbanization | | | | 9.86e-05 | -5.12e-05 |
| | | | | (0.000720) | (0.000705) |
| Dependency | | | | 0.000128 | 7.05e-06 |
| | | | | (0.00126) | (0.00123) |
| Institutions | | | | | 0.0784*** |
| | | | | | (0.0168) |
| Constant | 10.26*** | 10.20*** | 10.26*** | 10.21*** | 10.63*** |
| | (0.0709) | (0.0936) | (0.254) | (0.669) | (0.661) |
| Fixed time effects | Yes | Yes | Yes | Yes | Yes |
| Observations | 785 | 779 | 501 | 484 | 484 |
| R-squared | 0.065 | 0.079 | 0.088 | 0.137 | 0.176 |

Dependent variable is adjusted net savings from 1970-2018. Robust standard errors are in parentheses.
*** p<0.01, ** p<0.05, * p<0.1

### 5.1.2 The relationship between income inequality and components of sustainable development

The impact of inequality on sustainable development with components that form ANS has been tested based on the formulas mentioned above (Formula – 4,6,7). All control variables have been used in both models. A positive relationship between inequality and sustainable development shows itself for both NNS and variants of ANS, which is not statistically significant (Table 8). Only one control variable - public consumption, presents a significant connection (See Appendix, Table 24).

*Table 8. Fixed-effects models (GINI and ANS variants - 5 year interval)*

| VARIABLES | (1) ANS | (2) NNS | (3) ANS_E | (4) ANS_P |
|---|---|---|---|---|
| Gini (t-1) | 0.589 | 0.698 | 0.579 | 1.040 |
| | (0.425) | (0.611) | (0.428) | (0.638) |
| Constant | 8.770*** | 8.348*** | 8.600*** | 7.902*** |
| | (1.077) | (1.564) | (0.443) | (0.588) |
| Observations | 448 | 451 | 451 | 451 |
| R-squared | 0.025 | 0.024 | 0.117 | 0.112 |
| Number of countries | 118 | 118 | 118 | 118 |

Dependent variable is adjusted net savings, net national saving, ANS_E and ANS_P from 1970-2018. Models are controlled for FDI, investment, trade openness, consumption, education, life expectancy, population, urbanization, dependency and institutions. Robust standard errors are in parentheses. *** p<0.01, ** p<0.05, * p<0.1

It may be seen from the Table 8 that education expenditure that is one of the main components of the genuine saving has affected slightly to the relationship between income inequality and sustainable development. Which means that adding education expenditure results with a slightly bigger coefficient. On the other hand, carbon dioxide damage plays a role to balance the relationship between inequality and sustainable development. When it subtracted from the model, an increase in relationship is being observed.

In contrast to the fixed-effects estimations, OLS presents the opposite result with negative and statistically significant relationship (Table 9). Although, CO2 damage plays a balanced role with reducing inequality effect substantially, adding education expenditure decreases the impact of inequality index to sustainable development when the relationship is negative.

*Table 9. OLS models (GINI and ANS variants - 5 year interval)*

| VARIABLES | (1) ANS | (2) NNS | (3) ANS_E | (4) ANS_P |
|---|---|---|---|---|
| Gini | -0.643*** | -0.666*** | -0.542*** | -1.175*** |
| | (0.144) | (0.209) | (0.106) | (0.166) |
| Constant | 10.63*** | 11.35*** | 8.944*** | 7.622*** |
| | (0.661) | (0.905) | (0.461) | (0.719) |
| Observations | 484 | 491 | 491 | 491 |
| R-squared | 0.176 | 0.147 | 0.388 | 0.510 |

Dependent variable is adjusted net savings, net national saving, ANS_E and ANS_P from 1970-2018. Models are controlled for FDI, investment, trade openness, consumption, education, life expectancy, population, urbanization, dependency and institutions. Robust standard errors are in parentheses. *** p<0.01, ** p<0.05, * p<0.1

### 5.1.3 The relationship between income inequality and economic growth

The impact of income inequality on economic growth has also been tested based on the same model 4 and 5, where sustainable development indicator (ANS) has been replaced by economic growth indicator (GDP).

The result is suitable with the result of the relationship between inequality and sustainable development for both fixed-effects and OLS estimations.

*Table 10. Fixed-effects models (GINI and GDP)*

| | 1-year | 5-years | 20-years |
|---|---|---|---|
| VARIABLES | GDP | GDP | GDP |
| Gini (t-1) | 3.714** | 3.680*** | 6.026*** |
| | (1.514) | (0.882) | (2.045) |
| Constant | 2.743 | 4.539*** | -0.759 |
| | (2.750) | (1.223) | (4.201) |
| Observations | 296 | 475 | 109 |
| R-squared | 0.603 | 0.661 | 0.920 |
| Number of countries | 105 | 120 | 92 |

Dependent variable is Gross Domestic Product from 1970-2018. Models are controlled for FDI, investment, trade openness, consumption, education, life expectancy, population, urbanization, dependency and institutions. Robust standard errors are in parentheses. *** p<0.01, ** p<0.05, * p<0.1

While a positive and statistically significant results has been observed according to the fixed-effects model (Table 10), an opposite conclusion has been presented in OLS estimations (Table 11).

*Table 11. OLS models (GINI and GDP)*

| | 1-year | 5-years | 20-years |
|---|---|---|---|
| VARIABLES | GDP | GDP | GDP |
| Gini | -1.447*** | -1.229*** | -1.010* |
| | (0.514) | (0.385) | (0.586) |
| Constant | 1.361 | -1.477 | -2.328 |
| | (1.907) | (1.480) | (2.350) |
| Observations | 296 | 529 | 230 |
| R-squared | 0.837 | 0.826 | 0.835 |

Dependent variable is Gross Domestic Product from 1970-2018. Models are controlled for FDI, investment, trade openness, consumption, education, life expectancy, population, urbanization, dependency and institutions. Robust standard errors are in parentheses. *** p<0.01, ** p<0.05, * p<0.1

The relationship between inequality and economic growth has been tested for the middle term with control variables by their groups (Table 12). Again, a statistically significant positive relationship is being observed from the regressions, which approve Forbes's (2000) hypothesis that inequality's role in growth for the short and middle term is undeniably positive. So that, either without any control variable or with various control variables based on the characteristics of the models, the relationship is positive and statistically significant at 0.01 and 0.5 levels.

*Table 12. Fixed-effects models (GINI and GDP - 5 year interval)*

| VARIABLES | (1) GDP | (2) GDP | (3) GDP | (4) GDP | (5) GDP |
|---|---|---|---|---|---|
| Gini (t-1) | 6.433*** | 2.711** | 2.671** | 3.678*** | 3.680*** |
| | (1.525) | (1.093) | (1.125) | (0.876) | (0.882) |
| FDI (t-1) | | 0.0837*** | 0.0457*** | 0.0192 | 0.0192 |
| | | (0.0119) | (0.0136) | (0.0130) | (0.0136) |
| Investment (t-1) | | -0.000633 | 0.00338 | 0.00258 | 0.00259 |
| | | (0.00260) | (0.00300) | (0.00256) | (0.00259) |
| Trade openness (t-1) | | 0.487*** | 0.235*** | 0.134* | 0.133* |
| | | (0.0775) | (0.0712) | (0.0727) | (0.0736) |
| Consumption (t-1) | | | -0.00465 | -0.00144 | -0.00144 |
| | | | (0.00490) | (0.00465) | (0.00466) |
| Education (t-1) | | | 0.00847*** | 0.00264 | 0.00264 |
| | | | (0.00145) | (0.00164) | (0.00164) |
| Life expectancy (t-1) | | | | 0.587** | 0.587** |
| | | | | (0.246) | (0.246) |
| Population (t-1) | | | | -0.0321** | -0.0321** |
| | | | | (0.0142) | (0.0142) |
| Urbanization (t-1) | | | | 0.000938 | 0.000923 |
| | | | | (0.00595) | (0.00612) |
| Dependency (t-1) | | | | -0.0123*** | -0.0123*** |
| | | | | (0.00348) | (0.00355) |
| Institutions (t-1) | | | | | 0.000753 |
| | | | | | (0.0356) |
| Constant | 6.015*** | 5.508*** | 5.782*** | 4.538*** | 4.539*** |
| | (0.589) | (0.536) | (0.592) | (1.222) | (1.223) |
| Observations | 849 | 791 | 490 | 475 | 475 |
| R-squared | 0.152 | 0.511 | 0.553 | 0.661 | 0.661 |
| Number of countries | 142 | 139 | 124 | 120 | 120 |

Dependent variable is GDP from 1970-2018. Robust standard errors are in parentheses.
*** p<0.01, ** p<0.05, * p<0.1

Net flows of FDI, trade openness, secondary school attainment, population growth, and age dependency are also played a more critical role besides income inequality as an influencer to the economic growth that performed 1 or 5 percent significance. Although FDI, trade openness, and education contribute to the growth for five-year intervals, population growth and age dependency constrain it with its negative effect.

### 5.1.4 Robustness checks

To check the robustness of the results, some tests have been done by replacing the type of Gini coefficient that has been used in the paper. Furthermore, in contrast to the previous regressions that have been performed with disposable income inequality, market income inequality which is calculated before taxes, will be used for robustness check.

The result of the fixed-effect models for one, five, and twenty-year periods show almost the same results with the model of Gini disposable (Table 13). No statistically significant relationship has been observed among these variables for different time variants, and coefficients of the Gini market are still positive like Gini disposable.

*Table 13. Fixed-effects models (GINI market and ANS)*

| | 1-year | 5-years | 20-years |
|---|---|---|---|
| VARIABLES | ANS | ANS | ANS |
| Gini (market, t-1) | 0.0274 | 0.470 | 0.0142 |
| | (0.0578) | (0.331) | (0.0114) |
| Constant | 10.66*** | 8.817*** | 17.65*** |
| | (0.294) | (1.040) | (2.693) |
| Observations | 189 | 448 | 107 |
| R-squared | 0.330 | 0.025 | 0.928 |
| Number of countries | 89 | 118 | 91 |

Dependent variable is adjusted net savings from 1970-2018. Models are controlled for FDI, investment, trade openness, consumption, education, life expectancy, population, urbanization, dependency and institutions. Robust standard errors are in parentheses. *** p<0.01, ** p<0.05, * p<0.1

A new regression has been performed to check the relationship by adding control variables based on their characteristics for five-year intervals (see Appendix G, Table 20). Following the result, inequality's impact on sustainable development is decreasing by adding more control variables. So that, when the first group of control variables has been added, it could save its significance level but at 0.05 level. However, adding the second, third, and fourth groups still has positive relation but not statistically significant. Besides that, public consumption played the most crucial role in that relationship with a negative sign and at 0.01 level in model 3.

The OLS estimations presented the similar relationship that have been observed in case of the Gini disposable (Table 14). A negative and statistically significant relationship have been observed according to the regressions.

*Table 14. OLS models (GINI market and ANS)*

| | 1-year | 5-years | 20-years |
|---|---|---|---|
| VARIABLES | ANS | ANS | ANS |
| Gini (market) | -0.456*** | -0.643*** | -0.461*** |
| | (0.0796) | (0.144) | (0.0844) |
| Constant | 9.819*** | 10.63*** | 10.27*** |
| | (0.386) | (0.661) | (0.363) |
| Observations | 260 | 484 | 213 |
| R-squared | 0.479 | 0.176 | 0.417 |

Dependent variable is adjusted net savings from 1970-2018. Models are controlled for FDI, investment, trade openness, consumption, education, life expectancy, population, urbanization, dependency and institutions. Robust standard errors are in parentheses. *** p<0.01, ** p<0.05, * p<0.1

## 5.2 Discussion

The result of the analysis compared with the literature mentioned above will be interpreted in that chapter. First of all, the discussion related to the relationship between income inequality and sustainable development will be explained. Variants of sustainable development will also be discussed in the same context to show how components of Adjusted net saving are being affected by income inequality. Secondly, the impact of income inequality on economic growth will be evaluated based on the literature and empirical analysis.

It has been expected that there would be a positive impact of reducing income inequality on sustainable development. Because reducing inequality is only possible by constructive and reliable policies, democratic institutions, legal empowerment that ensure property rights, and sometimes with a harmful way – system change (for example, transition to communism). In that case, if inequality decreases healthily, it will conclude with the growth and development of the country in a sustainable manner in all fields, from economic growth to social protection, from improving healthcare and education to poverty elimination. In that case, there should be an opposite direction between income inequality and sustainable development, which means that as income inequality results from poor governance, an increase in sustainable development in parallel does not sound persuasive.

If we come back to the results, two opposite results have been obtained according to the estimations that have been used. First of all, a weak relationship between two variables is observed for the short, middle, and long term when within-country estimations have been performed. It is critical to mention that control variables played an essential role in reducing the effect of income inequality, such as when only simple regressions have been done to learn the connection, a positive and statistically significant relationship has been observed for one and five-year intervals. However, adding control variables weaken the significance of the primary explanatory variable.

Second of all, cross-country observation (OLS) estimations represented an opposite result of fixed-effects estimation and presented a negative relationship between inequality and sustainable development, which is statistically significant at 1 percent.

So, two opposite results have been acquired. Which is more reliable to the literature? According to Forbes (2000), using fixed-effects result estimations for the short and middle term is more reliable. Furthermore, Baltagi and Griffin (1984) also recommended using within variation as it is more reflective for the short term. So the result is more relevant to explain how changes in inequality affect growth within a country during the mentioned time frame. In addition, authors have also used OLS for examining long-term impact for cross-country relationships, which is also relevant to the approach of Kuh (1959) and Baltagi and Griffin (1984).

If the same approach would be implemented to that thesis, it could be argued that income inequality positively impacts sustainable development for the short and middle term; however, the relationship is negative for the long run.

In case of components of adjusted net savings for five-year intervals, a similar result has been acquired. In order to the regressions, education expenditures that cover wages and salaries affected the relationship between income inequality and sustainable development negatively. It

has been shown that adding education expenditures to the regression resulted in a higher Gini coefficient due to fixed-effects methods and a smaller coefficient in OLS regressions which is statistically significant. An opposite result has been obtained in case of testing the effect of CO2 damage. Adding CO damage indicator to the ANS resulted in a decrease in fixed-effects where the relationship is positive. However, the Gini coefficient has decreased by including the CO2 damage indicator in the formula.

What about the GDP? How has it been influenced by income distribution? The results of the regressions show that the relationship between income inequality and economic development are positive and statistically significant at 0.1 and 0.5 level when within-country estimations have been performed.

However, it has performed a negative trend based on between-country regressions with 0.01 for the short and middle run and 0.5 level for the long run. The results reminded the similar result of the difference between inequality and sustainability. So, when the same approach of Forbes (2000), Kuh (1959), and Baltagi and Griffin (1984) is being implemented to these results, an almost identical conclusion would be acquired: for a short and middle term income inequality foster economic growth, however, for the long term, it weakens growth.

However, some similarities, the results of this thesis have some differences from Forbes' (2000) findings. For example, the result of this thesis expresses the statistically insignificant relationship between inequality and sustainable development for the short and middle time frame in fixed-effects estimations. It may have several reasons.

First of all, different types of outcome variables have been used. For example, instead of economic growth, Adjusted net saving has been used in that thesis. Additionally, different time frames and sources of data may be an issue. The data that Forbes has used has covered 45 to 67 countries based on the model they have been included. Furthermore, the time frame is also limited to 25 years that cover from 1970 to 1985. Furthermore, using different explanatory variables also may result in different outcomes.

However, when the relationship between inequality and economic growth has been tested, almost the same results have been acquired. Instead of the data that have been used by Forbes (2000) was limited to only for 25 years and up to 67 countries, the similar results let to reapprove the approach of Forbes (2000) about the relationship between inequality and development and growth.

# 6 Conclusion

The primary aim of the thesis was to analyze the relationship between income inequality and sustainable development according to the literature that has been mentioned above. Two estimation methods – fixed effects and OLS, have been used to analyze the relationship from 1970 to 2018 that covers up to 139 economies worldwide.

According to the result of within-country estimation, no strong relationship has been found for the short and middle term. However, a positive and statistically significant at 10 percent result has been acquired for the long term. But, it should not be accepted as the robust result of this topic because either earlier research on that topic or econometric literature suggested that besides within variation estimation, the alternative estimations - cross-sectional between-country estimates also used to acquire relevant results for the long-term. According to these approaches, between-country estimations have also been performed and presented a negative relationship between inequality and development for the long-run period.

In addition, similar results have been acquired for the long-term by obtaining statistically significant negative relationship result when the impact of inequality on economic growth has been tested. However, the significance of the relationship for the short and middle term has also been approved.

In conclusion, if all results are being evaluated together by considering the literature, it may be claimed that there is no relationship between income inequality and sustainable development for the short and middle term. On the contrary, however, it has been proved that income inequality is a barrier to sustainable development for the long term.

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# Appendix A

*Table . Summary statistics (restricted sample) – 5 years interval*

| | N | Mean | Std. Dev. | min | max | skewness | t-value |
|---|---|---|---|---|---|---|---|
| ANS | 1071 | 10.029 | .179 | 5.335 | 10.748 | -16.166 | 1833.061 |
| NNS | 1125 | 10.035 | .239 | 2.77 | 10.963 | -24.607 | 1407.112 |
| ANS_E | 1119 | 9.1 | .206 | 8.455 | 10.666 | 3.249 | 1479.009 |
| ANS_P | 1125 | 8.588 | .361 | 7.775 | 10.64 | 2.162 | 796.981 |
| ANS_EP | 1125 | 9.091 | .211 | 8.454 | 10.686 | 3.179 | 1443.549 |
| GINI (SWIID-disp) | 971 | .385 | .091 | .199 | .672 | .221 | 132.348 |
| GINI (SWIID-mrk) | 971 | .459 | .068 | .218 | .72 | .465 | 209.957 |
| GDP | 1413 | 8.235 | 1.52 | 5.108 | 11.604 | .17 | 203.705 |
| FDI | 1384 | .077 | 1.652 | -8.026 | 5.124 | -1.146 | 1.737 |
| Investment | 1346 | 23.453 | 8.244 | 0 | 83.689 | .894 | 104.372 |
| Trade openness | 1363 | 4.143 | .614 | -1.405 | 6.029 | -1.319 | 248.992 |
| Consumption | 1330 | 15.944 | 6.431 | 1.227 | 67.25 | 1.778 | 90.415 |
| Education | 832 | 55.527 | 33.328 | .878 | 119.908 | -.079 | 48.057 |
| Life expectancy | 1430 | 4.166 | .184 | 2.673 | 4.436 | -1.316 | 855.061 |
| Population | 1605 | 1.762 | 1.39 | -3.438 | 14.907 | .999 | 50.791 |
| Urbanization | 1609 | 50.403 | 24.037 | 3.038 | 100 | .027 | 84.113 |
| Dependency | 1605 | 71.095 | 20.062 | 16.184 | 113.746 | .088 | 141.971 |
| Institutions | 1494 | .073 | .793 | -1 | 1 | -.103 | 3.573 |

Table 15. Summary statistics (restricted sample) – 20 years interval

| | N | Mean | Std. Dev. | min | max | skewness | t-value |
|---|---|---|---|---|---|---|---|
| ANS | 351 | 10.032 | .107 | 9.614 | 10.635 | 2.723 | 1760.338 |
| NNS | 375 | 10.039 | .103 | 9.509 | 10.84 | 3.625 | 1878.943 |
| ANS_E | 372 | 9.101 | .202 | 8.837 | 10.459 | 3.458 | 868.384 |
| ANS_P | 375 | 8.581 | .353 | 8.088 | 10.385 | 2.272 | 471.38 |
| ANS_EP | 375 | 9.091 | .207 | 8.839 | 10.46 | 3.392 | 849.005 |
| GINI (SWIID-disp) | 312 | .388 | .09 | .216 | .671 | .182 | 76.099 |
| GINI (SWIID-mrk) | 312 | .458 | .067 | .227 | .713 | .539 | 120.405 |
| GDP | 425 | 8.21 | 1.496 | 5.156 | 11.549 | .173 | 113.147 |
| FDI | 428 | -.027 | 1.514 | -7.231 | 3.484 | -1.103 | -.372 |
| Investment | 416 | 23.404 | 7.252 | 0 | 54.114 | .504 | 65.819 |
| Trade openness | 421 | 4.128 | .587 | .792 | 5.906 | -.697 | 144.369 |
| Consumption | 414 | 16.135 | 6.268 | 1.622 | 64.825 | 1.828 | 52.38 |
| Education | 322 | 52.86 | 33.078 | 1.063 | 111.07 | .007 | 28.676 |
| Life expectancy | 429 | 4.15 | .187 | 3.153 | 4.419 | -1.094 | 458.536 |
| Population | 482 | 1.823 | 1.27 | -1.195 | 8.407 | .677 | 31.526 |
| Urbanization | 483 | 49.038 | 24.072 | 3.397 | 100 | .068 | 44.771 |
| Dependency | 482 | 72.707 | 19.605 | 23.632 | 112.799 | -.009 | 81.419 |
| Institutions | 455 | .044 | .753 | -1 | 1 | .008 | 1.246 |

# Appendix B

*Table 16. Hausman Wu test results*

*ANS and GINI*

| | 1-year | 5-year | 20-year |
|---|---|---|---|
| Chi | 13.97 | 4.41 | 6.45 |
| p | 0.0002 | 0.0357 | 0.0111 |

*ANS variants (5 year intervals)*

| | ANS | NNS | ANS_E | ANS_P | ANS_EP |
|---|---|---|---|---|---|
| Chi | 4.56 | 1.77 | 23.83 | 33.56 | 26.42 |
| p | 0.0328 | 0.1838 | 0.0000 | 0.0000 | 0.0000 |

*Table 17. Breusch-Pagan / Cook-Weisberg test*

*ANS and GINI*

| | 1-year | 5-year | 20-year |
|---|---|---|---|
| Chi | 173.51 | 33.00 | 18.87 |
| p | 0.0000 | 0.0000 | 0.0000 |

*For ANS variants (5 year intervals)*

| | ANS | NNS | ANS_E | ANS_P | ANS_EP |
|---|---|---|---|---|---|
| Chi | 33.00 | 17.80 | 115.91 | 94.14 | 104.80 |
| p | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |

*Table 18. Modified Wald test results*

*ANS and GINI*

| | 1-year | 5-year | 20-year |
|---|---|---|---|
| Chi | 4.3e+11 | 4.9e+33 | 1.2e+31 |
| p | 0.0000 | 0.0000 | 0.0000 |

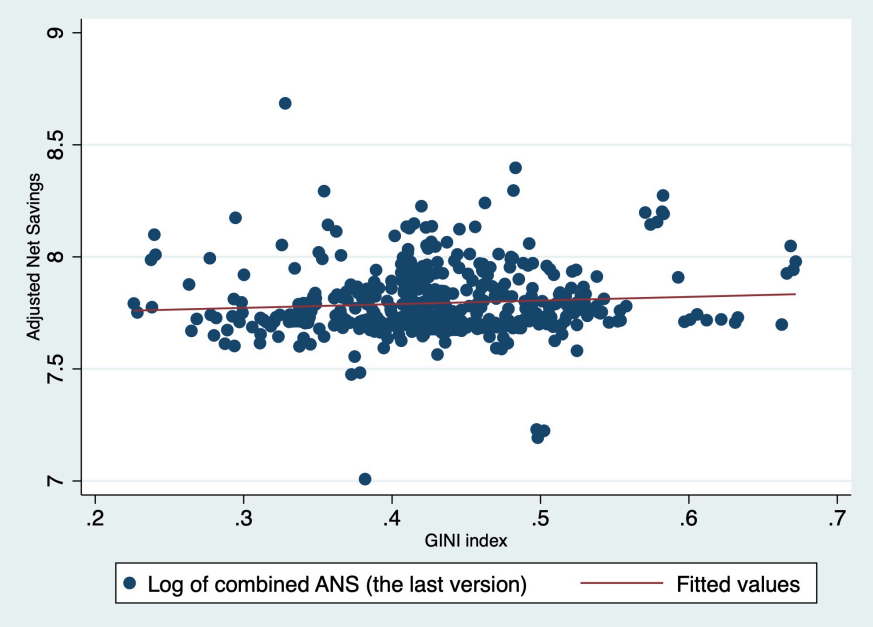
*For ANS variants (5 year intervals)*

| | ANS | NNS | ANS_E | ANS_P | ANS_EP |
|---|---|---|---|---|---|
| Chi | 4.9e+33 | 6.6e+33 | 8.5e+31 | 7.0e+30 | 2.6e+31 |
| p | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |

# Appendix C

*Figure 2. Relationship between Income inequality (GINI) and Sustainable development (ANS) for High income countries*


*Figure 3. Relationship between Income inequality (GINI) and Sustainable development (ANS) for low and middle income countries*



# Appendix E

*Table 19. VIF - OLS*

| VARIABLES | (1)<br>ANS | (2)<br>NNS | (3)<br>ANS_E | (4)<br>ANS_P | (5)<br>ANS_EP |
|---|---|---|---|---|---|
| Gini | 1.54 | 1.55 | 1.55 | 1.55 | 1.55 |
| FDI | 1.83 | 1.82 | 1.82 | 1.82 | 1.82 |
| Investment | 1.27 | 1.27 | 1.27 | 1.27 | 1.27 |
| Trade openness | 1.55 | 1.55 | 1.55 | 1.55 | 1.55 |
| Consumption | 1.41 | 1.42 | 1.42 | 1.42 | 1.42 |
| Education | 3.68 | 3.72 | 3.72 | 3.72 | 3.72 |
| Life expectancy | 3.54 | 3.59 | 3.59 | 3.59 | 3.59 |
| Population | 1.75 | 1.75 | 1.75 | 1.75 | 1.75 |
| Urbanization | 2.33 | 2.37 | 2.37 | 2.37 | 2.37 |
| Dependency ratio | 4.72 | 4.73 | 4.73 | 4.73 | 4.73 |
| Institutions | 1.41 | 1.41 | 1.41 | 1.41 | 1.41 |
| Year | | | | | |
| 1980 | 2.60 | 2.44 | 2.44 | 2.44 | 2.44 |
| 1985 | 2.84 | 2.65 | 2.65 | 2.65 | 2.65 |
| 1990 | 4.19 | 3.87 | 3.87 | 3.87 | 3.87 |
| 1995 | 5.73 | 5.24 | 5.24 | 5.24 | 5.24 |
| 2000 | 7.25 | 6.68 | 6.68 | 6.68 | 6.68 |
| 2005 | 8.47 | 7.76 | 7.76 | 7.76 | 7.76 |
| 2010 | 10.49 | 9.58 | 9.58 | 9.58 | 9.58 |
| 2015 | 10.88 | 9.94 | 9.94 | 9.94 | 9.94 |
| Mean VIF | 4.08 | 3.86 | 3.86 | 3.86 | 3.86 |

# Appendix F

*Table 20. Fixed-effects models (GINI market and ANS - 5 year interval)*

| VARIABLES | (1)<br>ANS | (2)<br>ANS | (3)<br>ANS | (4)<br>ANS | (5)<br>ANS |
|---|---|---|---|---|---|
| Gini (market, t-1) | 0.533*** | 0.570** | 0.281 | 0.483 | 0.470 |
| | (0.188) | (0.253) | (0.202) | (0.339) | (0.331) |
| FDI (t-1) | | -0.00684 | -0.0131 | -0.0196 | -0.0194 |
| | | (0.0132) | (0.0126) | (0.0191) | (0.0189) |
| Investment (t-1) | | -0.00189* | -0.00129 | -0.00122 | -0.00127 |
| | | (0.00110) | (0.00114) | (0.00127) | (0.00130) |
| Trade openness (t-1) | | 0.0358 | 0.113 | 0.0864 | 0.0885 |
| | | (0.0382) | (0.103) | (0.0813) | (0.0828) |
| Consumption (t-1) | | | -0.00550*** | -0.00766 | -0.00766 |
| | | | (0.00161) | (0.00502) | (0.00503) |
| Education (t-1) | | | -0.00171 | -0.00268 | -0.00268 |
| | | | (0.00179) | (0.00251) | (0.00250) |
| Life expectancy (t-1) | | | | 0.265 | 0.267 |
| | | | | (0.262) | (0.264) |
| Population (t-1) | | | | -0.0304 | -0.0302 |
| | | | | (0.0315) | (0.0314) |
| Urbanization (t-1) | | | | -0.00123 | -0.00110 |
| | | | | (0.00294) | (0.00283) |
| Dependency (t-1) | | | | -0.00120 | -0.00115 |
| | | | | (0.00152) | (0.00149) |
| Institutions (t-1) | | | | | -0.00610 |
| | | | | | (0.0113) |
| Constant | 9.789*** | 9.670*** | 9.649*** | 8.838*** | 8.817*** |
| | (0.0866) | (0.221) | (0.289) | (1.023) | (1.040) |
| Observations | 746 | 718 | 463 | 448 | 448 |
| R-squared | 0.003 | 0.007 | 0.017 | 0.025 | 0.025 |
| Number of countries | 137 | 135 | 122 | 118 | 118 |

Dependent variable is adjusted net savings from 1970-2018. Robust standard errors are in parentheses. *** p<0.01, ** p<0.05, * p<0.1

*Table 21. OLS models (GINI market and ANS - 5 years interval)*

| VARIABLES | (1)<br>ANS | (2)<br>ANS | (3)<br>ANS | (4)<br>ANS | (5)<br>ANS |
|---|---|---|---|---|---|
| Gini (market) | -0.0287 | -0.0264 | 0.121 | 0.192 | 0.0973 |
| | (0.111) | (0.118) | (0.174) | (0.182) | (0.193) |
| FDI | | 0.0102 | 0.00354 | 0.00260 | 0.00217 |
| | | (0.00686) | (0.00996) | (0.0104) | (0.0104) |
| Investment | | 0.000495 | 0.000388 | -0.000164 | 0.000370 |
| | | (0.00121) | (0.00175) | (0.00188) | (0.00191) |
| Trade openness | | 0.0316** | -0.000934 | 0.000835 | 0.000103 |
| | | (0.0157) | (0.0259) | (0.0274) | (0.0274) |
| Consumption | | | 0.00101 | 0.00152 | 0.00106 |
| | | | (0.00237) | (0.00258) | (0.00260) |
| Education | | | 0.000992** | 1.99e-05 | -1.25e-05 |
| | | | (0.000436) | (0.000771) | (0.000770) |
| Life expectancy | | | | 0.257* | 0.217 |
| | | | | (0.151) | (0.153) |
| Population | | | | 0.00795 | 0.0109 |
| | | | | (0.00966) | (0.00986) |
| Urbanization | | | | -0.000406 | -0.000382 |
| | | | | (0.000811) | (0.000810) |
| Dependency | | | | -0.000952 | -0.000839 |
| | | | | (0.00138) | (0.00138) |
| Institutions | | | | | 0.0294 |
| | | | | | (0.0201) |
| Fixed time effects | Yes | Yes | Yes | Yes | Yes |
| Observations | 746 | 718 | 463 | 448 | 448 |
| R-squared | 0.013 | 0.031 | 0.047 | 0.061 | 0.065 |

Dependent variable is adjusted net savings from 1970-2018. Robust standard errors are in parentheses.
*** p<0.01, ** p<0.05, * p<0.1

# Appendix G

*Table 22. OLS models (GINI and GDP - 5 year intervals)*

| VARIABLES | (1) GDP | (2) GDP | (3) GDP | (4) GDP | (5) GDP |
|---|---|---|---|---|---|
| Gini (t-1) | -8.629*** | -8.547*** | -2.450*** | -0.606 | -0.919** |
| | (0.505) | (0.503) | (0.522) | (0.405) | (0.388) |
| FDI (t-1) | | 0.259*** | 0.135*** | 0.0545** | 0.0374 |
| | | (0.0388) | (0.0349) | (0.0256) | (0.0246) |
| Investment (t-1) | | 0.0167** | -0.00117 | -0.00865* | -0.00331 |
| | | (0.00687) | (0.00615) | (0.00464) | (0.00449) |
| Trade openness (t-1) | | 0.180* | -0.227** | -0.00766 | 0.00521 |
| | | (0.0934) | (0.0960) | (0.0715) | (0.0681) |
| Consumption (t-1) | | | 0.0664*** | 0.0501*** | 0.0429*** |
| | | | (0.00818) | (0.00628) | (0.00608) |
| Education (t-1) | | | 0.0301*** | 0.00758*** | 0.00699*** |
| | | | (0.00162) | (0.00187) | (0.00178) |
| Life expectancy (t-1) | | | | 2.420*** | 2.036*** |
| | | | | (0.338) | (0.327) |
| Population (t-1) | | | | 0.0358 | 0.0713*** |
| | | | | (0.0249) | (0.0243) |
| Urbanization (t-1) | | | | 0.0213*** | 0.0212*** |
| | | | | (0.00201) | (0.00192) |
| Dependency (t-1) | | | | -0.0155*** | -0.0148*** |
| | | | | (0.00341) | (0.00325) |
| Institutions (t-1) | | | | | 0.306*** |
| | | | | | (0.0448) |
| 1980.year | 0.0405 | 0.0493 | 0.0378 | -0.0713 | -0.0860 |
| | (0.297) | (0.289) | (0.345) | (0.246) | (0.235) |
| 1985.year | 0.0804 | 0.0127 | -0.354 | -0.327 | -0.389* |
| | (0.286) | (0.279) | (0.341) | (0.244) | (0.232) |
| 1990.year | -0.133 | -0.0116 | -0.597* | -0.442** | -0.477** |
| | (0.265) | (0.266) | (0.311) | (0.223) | (0.213) |
| 1995.year | -0.121 | -0.306 | -0.968*** | -0.656*** | -0.636*** |
| | (0.256) | (0.254) | (0.295) | (0.212) | (0.202) |
| 2000.year | -0.0207 | -0.471* | -1.137*** | -0.843*** | -0.788*** |
| | (0.253) | (0.252) | (0.293) | (0.210) | (0.200) |
| 2005.year | 0.136 | -0.436* | -1.136*** | -0.788*** | -0.751*** |
| | (0.252) | (0.254) | (0.292) | (0.210) | (0.200) |
| 2010.year | 0.170 | -0.556** | -1.073*** | -0.820*** | -0.783*** |
| | (0.250) | (0.256) | (0.293) | (0.210) | (0.200) |
| 2015.year | 0.275 | -0.447* | -1.206*** | -0.982*** | -0.913*** |
| | (0.251) | (0.255) | (0.291) | (0.209) | (0.200) |
| Constant | 11.77*** | 11.03*** | 8.337*** | -1.977 | -0.476 |
| | (0.292) | (0.486) | (0.504) | (1.512) | (1.458) |
| Observations | 849 | 791 | 490 | 475 | 475 |
| R-squared | 0.262 | 0.362 | 0.637 | 0.820 | 0.836 |

Dependent variable is GDP from 1970-2018. Robust standard errors are in parentheses. *** p<0.01, ** p<0.05, * p<0.1

# Appendix H

*Table 23. Fixed-effects models (GINI and ANS variants)*

| | 1 year | | | | 5-year | | | | 20 year | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) | (9) | (10) | (11) | (12) |
| VARIABLES | ANS | NNS | ANS_E | ANS_P | ANS | NNS | ANS_E | ANS_P | ANS | NNS | ANS_E | ANS_P |
| Gini (t-1) | 0.207 | 0.321 | 0.968 | 1.088 | 0.589 | 0.698 | 0.579 | 1.040 | 2.618* | 3.144* | 4.900** | 7.724*** |
| | (0.225) | (0.244) | (0.704) | (1.015) | (0.425) | (0.611) | (0.428) | (0.638) | (1.350) | (1.735) | (1.936) | (2.679) |
| FDI (t-1) | 0.00374 | -0.00156 | 0.00179 | 0.0124 | -0.0201 | -0.0298 | -0.00671 | -0.00484 | -0.0667** | -0.0812** | -0.103*** | -0.154*** |
| | (0.00241) | (0.00436) | (0.00804) | (0.0111) | (0.0194) | (0.0281) | (0.00533) | (0.00680) | (0.0256) | (0.0330) | (0.0356) | (0.0500) |
| Investment (t-1) | 0.00154** | 0.00134 | 0.00460* | 0.00686* | -0.00139 | -0.00184 | -0.00161 | -0.00191 | 0.0123*** | 0.0156*** | 0.0127*** | 0.0179*** |
| | (0.000733) | (0.000972) | (0.00236) | (0.00366) | (0.00135) | (0.00203) | (0.00169) | (0.00230) | (0.00175) | (0.00226) | (0.00309) | (0.00461) |
| Trade openness (t-1) | -0.0136 | 0.0108 | -0.000340 | -0.0114 | 0.0912 | 0.135 | 0.0399 | 0.0668 | -0.0175 | -0.0239 | -0.0226 | 0.104 |
| | (0.0134) | (0.0261) | (0.0508) | (0.0682) | (0.0834) | (0.124) | (0.0405) | (0.0580) | (0.100) | (0.136) | (0.0938) | (0.129) |
| Consumption (t-1) | -0.000326 | -0.00532 | -0.00972 | -0.00962 | -0.00751 | -0.00957 | -0.0117*** | -0.0148*** | 0.0334*** | 0.0409*** | 0.0123 | 0.0202* |
| | (0.00122) | (0.00425) | (0.00702) | (0.00914) | (0.00493) | (0.00674) | (0.00399) | (0.00477) | (0.00701) | (0.00918) | (0.00829) | (0.0114) |
| Education (t-1) | -0.000334 | -0.000563 | -0.00110 | -0.000971 | -0.00270 | -0.00411 | -0.000859 | -0.00111 | 0.00150 | 0.00185 | 0.00201 | 0.000725 |
| | (0.000314) | (0.000382) | (0.000850) | (0.00130) | (0.00251) | (0.00385) | (0.000606) | (0.000886) | (0.00233) | (0.00285) | (0.00383) | (0.00520) |
| Life expectancy (t-1) | -0.0364 | -0.0184 | -0.144 | -0.224 | 0.272 | 0.389 | 0.0785 | 0.0815 | -1.631** | -1.918** | -1.858** | -2.032* |
| | (0.0457) | (0.0696) | (0.137) | (0.200) | (0.268) | (0.397) | (0.100) | (0.132) | (0.695) | (0.914) | (0.841) | (1.111) |
| Population (t-1) | 0.00425 | 0.0115 | 0.0272 | 0.0367 | -0.0298 | -0.0471 | -0.00543 | -0.0101 | 0.0193 | -0.0122 | 0.172** | 0.265** |
| | (0.00922) | (0.0108) | (0.0280) | (0.0384) | (0.0312) | (0.0468) | (0.0201) | (0.0260) | (0.0482) | (0.0634) | (0.0778) | (0.107) |
| Urbanization (t-1) | 0.000501 | 0.000502 | 0.000333 | 0.00155 | -0.00102 | -0.00251 | 0.000812 | 0.00154 | -0.0267** | -0.0336* | -0.0388*** | -0.0638*** |
| | (0.00119) | (0.00101) | (0.00256) | (0.00460) | (0.00273) | (0.00414) | (0.00176) | (0.00262) | (0.0123) | (0.0178) | (0.0135) | (0.0180) |
| Dependency (t-1) | -0.000896 | -0.00101 | -0.00265 | -0.00411 | -0.00119 | -0.00201 | 0.000124 | -0.00119 | -0.0234*** | -0.0270*** | -0.0372*** | -0.0576*** |
| | (0.000804) | (0.000716) | (0.00187) | (0.00323) | (0.00152) | (0.00244) | (0.00128) | (0.00183) | (0.00482) | (0.00703) | (0.00573) | (0.00804) |
| Institutions (t-1) | 0.00462 | 0.00253 | 0.00944 | 0.0175 | -0.00549 | -0.00682 | 0.00121 | 0.00361 | 0.101*** | 0.135*** | 0.0980** | 0.144** |
| | (0.00688) | (0.00638) | (0.0165) | (0.0234) | (0.0108) | (0.0154) | (0.0113) | (0.0181) | (0.0272) | (0.0384) | (0.0414) | (0.0580) |
| Constant | 10.18*** | 10.06*** | 9.553*** | 9.315*** | 8.770*** | 8.348*** | 8.600*** | 7.902*** | 17.89*** | 19.33*** | 18.64*** | 19.57*** |
| | (0.260) | (0.338) | (0.715) | (1.044) | (1.077) | (1.564) | (0.443) | (0.588) | (2.477) | (3.195) | (3.133) | (4.300) |
| Observations | 244 | 275 | 275 | 274 | 448 | 451 | 451 | 451 | 107 | 107 | 107 | 107 |
| R-squared | 0.114 | 0.139 | 0.162 | 0.155 | 0.025 | 0.024 | 0.117 | 0.112 | 0.937 | 0.932 | 0.767 | 0.797 |
| Number of countries | 95 | 99 | 99 | 98 | 118 | 118 | 118 | 118 | 91 | 91 | 91 | 91 |

Dependent variable is adjusted net savings, net national saving, ANS_E and ANS_P from 1970-2018. Models are controlled for FDI, investment, trade openness, consumption, education, life expectancy, population, urbanization, dependency and institutions. Robust standard errors are in parentheses. *** p<0.01, ** p<0.05, * p<0.1

*Table 24. OLS (GINI and ANS variants)*

| | 1 year | | | | 5-year | | | | 20 year | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) | (9) | (10) | (11) | (12) |
| VARIABLES | ANS | NNS | ANS_E | ANS_P | ANS | NNS | ANS_E | ANS_P | ANS | NNS | ANS_E | ANS_P |
| Gini | -0.456*** | -0.333*** | -0.613*** | -1.265*** | -0.643*** | -0.666*** | -0.542*** | -1.175*** | -0.461*** | -0.346*** | -0.672*** | -1.325*** |
| | (0.0796) | (0.0837) | (0.181) | (0.264) | (0.144) | (0.209) | (0.106) | (0.166) | (0.0844) | (0.0872) | (0.142) | (0.230) |
| FDI | -0.00979** | -0.0165*** | -0.0273*** | -0.0273* | 0.00989 | 0.0187 | -0.0282*** | -0.0399*** | -0.00441 | -0.00609 | -0.0299*** | -0.0425*** |
| | (0.00438) | (0.00454) | (0.00984) | (0.0143) | (0.00909) | (0.0132) | (0.00669) | (0.0104) | (0.00548) | (0.00562) | (0.00911) | (0.0148) |
| Investment | -0.00110 | -0.000434 | 0.000516 | -0.000465 | 0.000505 | 0.00115 | 0.00119 | 0.00115 | 0.000622 | 0.00110 | 0.00163 | 0.00273 |
| | (0.000941) | (0.000994) | (0.00216) | (0.00314) | (0.00169) | (0.00244) | (0.00124) | (0.00193) | (0.00103) | (0.00105) | (0.00171) | (0.00277) |
| Trade openness | 0.0315** | 0.0328** | 0.0520* | 0.0438 | 0.00598 | 0.00334 | 0.0470*** | 0.0528* | 0.00994 | 0.0163 | 0.0427* | 0.0628* |
| | (0.0136) | (0.0142) | (0.0307) | (0.0447) | (0.0241) | (0.0350) | (0.0178) | (0.0278) | (0.0131) | (0.0133) | (0.0217) | (0.0352) |
| Consumption | 0.00148 | -0.000869 | -0.00158 | 0.00589 | -0.00939*** | -0.0167*** | 0.00132 | 0.00847*** | -9.27e-05 | -0.00145 | 0.000124 | 0.00301 |
| | (0.00130) | (0.00130) | (0.00283) | (0.00412) | (0.00223) | (0.00324) | (0.00165) | (0.00257) | (0.00135) | (0.00114) | (0.00186) | (0.00302) |
| Education | 0.00114*** | 0.000960** | 0.00188** | 0.00387*** | 0.00201*** | 0.00273*** | 0.000933* | 0.00203*** | 0.000436 | 0.000461 | 0.000493 | 0.000966 |
| | (0.000359) | (0.000380) | (0.000824) | (0.00120) | (0.000660) | (0.000958) | (0.000488) | (0.000761) | (0.000388) | (0.000397) | (0.000645) | (0.00105) |
| Life expectancy | 0.00934 | -0.0449 | -0.0833 | 0.0660 | -0.104 | -0.255 | 0.0166 | 0.193 | -0.0379 | -0.0748 | -0.123 | -0.0877 |
| | (0.0819) | (0.0857) | (0.186) | (0.271) | (0.139) | (0.199) | (0.101) | (0.158) | (0.0819) | (0.0821) | (0.133) | (0.216) |
| Population | 0.0514*** | 0.0514*** | 0.103*** | 0.166*** | 0.0597*** | 0.0780*** | 0.0817*** | 0.126*** | 0.0425*** | 0.0511*** | 0.107*** | 0.156*** |
| | (0.00733) | (0.00764) | (0.0166) | (0.0242) | (0.0109) | (0.0159) | (0.00809) | (0.0126) | (0.00682) | (0.00704) | (0.0114) | (0.0186) |
| Urbanization | 0.00157*** | 0.00156*** | 0.00283*** | 0.00484*** | -5.12e-05 | -0.000568 | 0.00198*** | 0.00383*** | 0.000898** | 0.000745* | 0.00244*** | 0.00488*** |
| | (0.000391) | (0.000409) | (0.000887) | (0.00129) | (0.000705) | (0.00102) | (0.000521) | (0.000813) | (0.000400) | (0.000408) | (0.000662) | (0.00108) |
| Dependency | 8.10e-05 | -0.000509 | -0.00135 | -0.00112 | 7.05e-06 | -0.000733 | -0.00250*** | -0.00287** | -0.000870 | -0.00171** | -0.00397*** | -0.00501*** |
| | (0.000768) | (0.000812) | (0.00176) | (0.00256) | (0.00123) | (0.00180) | (0.000914) | (0.00143) | (0.000710) | (0.000730) | (0.00118) | (0.00193) |
| Institutions | 0.0234** | 0.0121 | 0.0259 | 0.0622** | 0.0784*** | 0.0896*** | 0.0378*** | 0.0918*** | 0.0479*** | 0.0322*** | 0.0607*** | 0.130*** |
| | (0.00919) | (0.00968) | (0.0210) | (0.0306) | (0.0168) | (0.0245) | (0.0125) | (0.0195) | (0.0107) | (0.0111) | (0.0180) | (0.0294) |
| Year 1975 | | | | | 0.0438 | 0.0884 | 0.00781 | 0.0131 | | | | |
| | | | | | (0.232) | (0.247) | (0.126) | (0.196) | | | | |
| Year 1980 | 0.0401 | 0.0397 | 0.0864 | 0.147 | -0.0136 | 0.0258 | -0.0520 | -0.0942 | -0.0597** | -0.0647*** | -0.0924** | -0.150** |
| | (0.0456) | (0.0469) | (0.102) | (0.148) | (0.230) | (0.244) | (0.124) | (0.194) | (0.0257) | (0.0247) | (0.0400) | (0.0651) |
| Year 1985 | -0.0416 | -0.0457 | -0.0717 | -0.100 | -0.0417 | 0.0185 | -0.110 | -0.191 | | | | |
| | (0.0419) | (0.0427) | (0.0926) | (0.135) | (0.227) | (0.239) | (0.122) | (0.190) | | | | |
| Year 1990 | -0.0121 | -0.0222 | -0.0273 | -0.00783 | -0.119 | -0.120 | -0.118 | -0.193 | | | | |
| | (0.0421) | (0.0429) | (0.0930) | (0.135) | (0.226) | (0.236) | (0.120) | (0.187) | | | | |
| Year 1995 | -0.0219 | -0.0244 | -0.0383 | -0.0457 | -0.0400 | -0.00267 | -0.0787 | -0.140 | | | | |
| | (0.0419) | (0.0423) | (0.0917) | (0.134) | (0.225) | (0.235) | (0.120) | (0.187) | | | | |
| Year 2000 | -0.0283 | -0.0225 | -0.0402 | -0.0578 | -0.0652 | -0.0343 | -0.0859 | -0.154 | -0.0368 | -0.0434 | -0.0589 | -0.0873 |
| | (0.0421) | (0.0422) | (0.0914) | (0.133) | (0.225) | (0.235) | (0.120) | (0.187) | (0.0275) | (0.0267) | (0.0432) | (0.0703) |
| Year 2005 | -0.0160 | -0.0194 | -0.0353 | -0.0320 | -0.0436 | -0.0264 | -0.0576 | -0.0844 | | | | |
| | (0.0408) | (0.0411) | (0.0892) | (0.130) | (0.225) | (0.235) | (0.120) | (0.187) | | | | |

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Year 2010 | -0.00930 | -0.0203 | -0.0520 | -0.0505 | -0.0502 | -0.0240 | -0.0861 | -0.128 | | | | |
| | (0.0407) | (0.0411) | (0.0892) | (0.130) | (0.225) | (0.235) | (0.120) | (0.187) | | | | |
| Year 2015 | -0.0721 | -0.0545 | -0.109 | -0.180 | -0.0357 | -0.00397 | -0.0810 | -0.131 | | | | |
| | (0.0603) | (0.0594) | (0.129) | (0.198) | (0.226) | (0.237) | (0.121) | (0.188) | | | | |
| Constant | 9.819*** | 10.08*** | 9.181*** | 7.866*** | 10.63*** | 11.35*** | 8.944*** | 7.622*** | 10.27*** | 10.42*** | 9.656*** | 8.946*** |
| | (0.386) | (0.400) | (0.868) | (1.265) | (0.661) | (0.905) | (0.461) | (0.719) | (0.363) | (0.360) | (0.585) | (0.949) |
| Observations | 260 | 272 | 272 | 271 | 484 | 491 | 491 | 491 | 213 | 218 | 217 | 218 |
| R-squared | 0.479 | 0.387 | 0.324 | 0.438 | 0.176 | 0.147 | 0.388 | 0.510 | 0.417 | 0.373 | 0.537 | 0.590 |

Dependent variable is adjusted net savings, net national saving, ANS_E and ANS_P from 1970-2018. Models are controlled for FDI, investment, trade openness, consumption, education, life expectancy, population, urbanization, dependency and institutions. Robust standard errors are in parentheses. *** p<0.01, ** p<0.05, * p<0.1