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The Relationship Between Income Inequality and Economic Growth: Are Transmission Channels Effective?

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Abstract
This study aims to determine whether the effect of income inequality on economic growth is realised through transmission channels theoretically expressed. This relationship is examined for 143 countries and the periods between 1980 and 2017 through positive and negative channels. These countries are divided into two groups by considering their income levels and they are analysed with panel data econometric techniques. Although the findings provide evidence that high inequality adversely affects economic growth, it can be stated that this inference cannot be generalized when countries' income levels are taken into account. Countries with higher inequality tend to have higher fertility rates and less innovative activity. The financial market imperfections in developing countries adversely affect human capital investments. On the other hand, high inequality tends to increase saving propensity in developed countries and provides evidence for the positive channel. The findings highlight the complexity of the impact of income inequality on economic growth. Therefore, indirect impact needs to be scrutinized and policy recommendations need to be carefully designed.

Keywords Income inequality · Economic growth · Transmission channels · Income classification

JEL Classification D63 · O11 · O15 · O40

1 Introduction

A fair and sustainable economic and social welfare is one of the goals of macroeconomic policies. Concerning this purpose, the primary goal of macroeconomic stabilisation policies is to achieve stable economic growth, especially as it is also a critical factor in reducing global poverty. As long as policymakers fail to achieve their sustainable economic growth goals, they reconsider their decisions towards these goals (Mijiyawa, 2008; Piece, 2012). On the other hand, it is claimed that policies aimed at reducing income inequality

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promote long-term sustainable growth effectively (Berg & Ostry, 2011; Ostry et al., 2014). The theoretical inferences between these variables are significant for policy recommendations, as encouraging economic growth and ensuring fair income distribution is at the centre of the efficiency-equity trade-off that shapes policy debates in many countries (Dominicis et al., 2008).[1] For this reason, it is necessary to scrutinise and understand the theoretical relationships between the relevant variables.[2] Studies within this scope focus on the effect of economic growth on income inequality based on the inverted-U hypothesis put forward by Kuznets (1955). The hypothesis that income inequality increases in the early stages of economic development while it decreases in later stages has been tested from different angles in many studies.

When the country data is examined as well as the theoretical view to understand the relationship between economic development and income inequality, it can be said that income inequality has been on the increase in almost every region of the world in recent years. However, the rate of increase changes from region to region (Alvaredo et al., 2018). It can be said that the level of income inequality is also different in countries with varying levels of income, but still the relationship between the two variables is not correlated. For example, while the Gini coefficient changes between 20 and 40 in high-income countries, it is around 33 in Kyrgyzstan, a lower-middle-income country. Similarly, in upper-middle-income countries, such as South-Africa and Namibia, where income inequality is dramatically high with Gini coefficients around 58 and 65, respectively; In Lesotho, a lower-middle-income, Gini reaches around 52. However, it is also remarkable that countries which are relatively low-income inequality are composed of high-income countries.[3] The fact that income inequality is so different even for countries with similar development levels shows the importance of policies and institutions on income inequality (Alvaredo et al., 2018).[4]

On the other hand, theoretical and empirical studies on the effect of income inequality on economic growth are relatively recent. Economists are increasingly focusing on the links between these variables. Several studies have predicted that the effect of income inequality on economic growth will be positive. The earliest studies concluded that income inequality promotes economic growth by increasing savings (Bourguignon, 1981; Kaldor, 1955; Keynes, 1920; Lewis, 1954). Under the linearity assumption of the saving function, the total saving behaviour in the economy is independent of income and wealth distribution, independence disappears under a non-linear saving function (Stiglitz, 1969). The marginal propensity to save from profits is greater than the propensity to save from wages, and this is the condition of stability. According to this view, known as the classical approach, the marginal propensity to save increases as wealth increases. In this case, resources are

[1] Atkinson (2015) argues that some solutions for inequality can increase efficiency, that is, efficiency and equality can also point in the same direction.

[2] Whether the issue of income inequality is a major concern for economists is debatable. Lucas (2004) 'quotes about distribution "Of the tendencies that are harmful to sound economics, the most seductive, and in my opinion the most poisonous, is to focus on questions of distribution." In contrast, Atkinson (2015) states that income distribution should be at the centre of economic discussions. Because distribution and redistribution of total income are important for individuals. Total production is affected by distribution and understanding income distribution is essential to understanding the functioning of the economy. Past economic crises show that looking at macroeconomic aggregates alone is not enough.

[3] The current data of the Gini Coefficient has been obtained from the "Standardized World Income Inequality Database (SWIID 8.2)" published by Solt (2009).

[4] In addition to the effect of income level of countries on income inequality, the effect of income volatility on inequality in the recent period is discussed and the relationship between these variables symmetrical and asymmetrical are examined. The consensus is that volatility has a positive effect on inequality (Bahmani-Oskooee, 2018; Huang et al., 2015; Aye et al., 2020).

transferred to individuals with a high marginal propensity to save, and total savings gradually increase. Therefore, a high level of economic growth can be achieved with increased investments (Kaldor, 1955). Secondly, income inequality promotes economic growth through innovation and R&D incentives. Initially, the innovation market is small, as only wealthy consumers purchase new products. The higher share of the rich in the population leads to an increase in the value of innovation. The market expands, and firms earn higher profits with increasing income. Therefore, the increase in the value of innovation encourages innovative activities and long-term growth (Foellmi & Zweimüller, 2006). Finally, differences in income distribution provide incentives for factors such as education, investment in physical capital, risk-taking, and hard work. Thus, income inequality positively affects economic growth (WDR, 2006).

On the other hand, it can be said that the studies suggesting that income inequality is harmful to economic growth are more common. Similar to the positive effects, the negative impact of income inequality on growth can occur through different channels. The modern approach, which claims that inequality in income distribution will harm economic growth, includes four different channels (Galor, 2009). The presence of credit market imperfection explains the first channel. (Aghion & Bolton, 1997; Aghion et al., 1999; Banerjee & Newman, 1993; Galor & Zeira, 1993). Due to the credit market imperfection, inequality reduces investment opportunities and the motivation of borrowers, and it creates macroeconomic volatility (Aghion et al., 1999). More generally, when individuals have unequal borrowing opportunities, the unjust income distribution under initial conditions will persist and continue for the next generations. According to this theory, which is analysed especially through the investments made in human capital, it will be inevitable that economic growth will be negatively affected since human capital is the basis for economic growth. According to the political economy approach, the second channel, a relationship is established between "inequality" and "income redistribution through taxes", and the effect of income inequality on economic growth is examined indirectly. The voting model explains the redistribution and taxation relationship (Alesina & Rodrik, 1994; Perotti, 1993; Persson & Tabellini, 1994). In democratic societies, the median voter determines the amount of tax based on income. Poor groups can benefit more if tax revenue is distributed equally to all. On the other hand, in economies with high inequality, inequality will damage economic growth as it can lead to political decisions that cause net return on investment to fall. On the other hand, Paul and Verdier (1996) object to the political economy approach on the ground that high inequality does not always require a high rate of redistributable taxation, and there may be conditions in which redistribution is not detrimental to economic growth.

Another channel is referred to as the socio-political instability approach. The basic idea of the model based on the Benhabib and Rustichini (1996), Alesina and Perotti (1996), Alesina et al. (1996) studies is that increasing income inequality will initially increase social unrest. This situation negatively affects investment by increasing coups, revolutions, and acts of violence in society, or more generally, political uncertainty and by threatening the property rights of individuals. A decrease in investments due to the deterioration of peace and stability in society will negatively affect economic growth (Alesina & Perotti, 1996).

The last channel that suggests that income inequality negatively affects economic growth is the differential fertility approach. It is claimed that income inequality determines fertility rates and indirectly affects human capital investment and economic growth negatively. In countries with high fertility rates, economic growth is expected to decline due to diminishing capital per capita. The relationship between income inequality and fertility rate is explained by education level. While low-income families have more children and low investment in education, the opposite will happen for affluent families. Therefore, it is

stated that in countries with high-income inequality, increasing fertility rates will reduce economic growth (Galor & Weil, 1996; Galor & Zang, 1997; Kremer & Chen, 2002; De La Croix and Doepke, 2003).

Considering classical and modern perspectives together, Galor and Moav (2004) developed the idea of a unified growth model. The effect of income inequality on economic growth varies depending on the country's economic development level. In the early stages of development, inequality is beneficial for economic growth since physical capital returns are higher than human capital. In the later stages of development, inequality reduces economic growth due to credit constraints as the importance of human capital increases. In more advanced stages of development, the restriction on access to credit will disappear for all individuals, and eventually, income distribution will not significantly affect economic growth.[5] This view raises an important question: Do countries' income levels matter in the impact of income inequality on economic growth?[6]

This study is expected to contribute to the literature in two aspects. While many studies in the literature examine the direct relationship between relevant variables, some focus only on bilateral relationships such as income inequality-channel variable or channel variable-economic growth. Studies that determine whether the effect of income inequality on economic growth occurs through a channel focus mainly on some of the negative channels stated in theory. The primary purpose of this study is to test whether the positive and negative channels specified in theory are valid, rather than the direct effect of income inequality on economic growth. Thus, the study is expected to provide a more comprehensive explanation of how the relationship between income inequality and economic growth emerges. Second, to understand the importance of countries' income levels in the impact of income inequality on economic growth, the 143 countries, whose data is available, are examined in two separate groups as low and lower-middle-income, upper-middle-income, and high-income according to the World Bank income classification. Since many macroeconomic variables and policy recommendations may differ between the two country groups, different consequences for subsamples are likely to occur in the relationship between income inequality and economic growth. Therefore, examining countries with varying levels of development together may cause misleading results. The analysis is conducted using the System Generalized Moments Method by taking the 5-year averages of the data for the period 1980–2017. The study consists of five sections. The second section presents the relevant literature. The third section details the method and data set. The fourth section includes the analysis results and growth estimates on the channel variable of inequality. The fifth section consists of the conclusion and evaluations.

2 Literature Review

Many studies mainly focus on reduced form, although they examined the relationship between income inequality and economic growth.[7] However, the above-mentioned theoretical transmission channels were neglected in their analyses. This section focuses only

[5] Galor and Moav (2004) only focus on the role of the credit market imperfection.

[6] Also, Barro (2000) states that the effect of income inequality on economic growth may differ for poor and rich economies.

[7] Some recent studies are Li and Zou (1998), Barro (2000), Banarjee and Duflo (2003), Voitchovsky (2005), Knowles (2005), Bengoa and Sanchez-Robles (2005), Qin et al. (2009), Castelló-Climent (2010), Herzer and Vollmer (2012), Ncube et al. (2014), Halter et al. (2014), Forbes (2000), Brueckner and Lederman (2018).

on empirical studies that analysed the role of the channel variable on income inequality and economic growth relationship. It is organised around the differences on the inequality-growth nexus between developing and developed countries, one of the main contributions of the paper as stated in the introduction section. Accordingly, each channel is evaluated within itself, but it is aimed to group them by considering the country group examined in the studies. Table 1 provides a summary of previous work conducted in this framework. The results of the studies show that there is no consensus on the impact of income inequality on economic growth. When Table 1 is examined, the differences of countries, period, method, explanatory, and dependent variables used in the studies are pretty remarkable, and it is thought that these factors may play a role in the differentiation of the main results obtained.[8]

Some empirical studies show that the financial development levels of countries play a vital role in the negative impact of income inequality on economic growth (Braun et al., 2019; Castells-Quintana & Royuela, 2017; Gründler & Scheuermeyer, 2018; Le & Nguyen, 2019; Madsen et al., 2018). On the other hand, while it has been demonstrated that inequality promotes economic growth in the short and medium-term in countries with low financial market development and this effect has disappeared in the long run (Iradian, 2005), the impact of income inequality on economic growth is not certain for the credit markets imperfections channel (Ciegis and Dilius, 2019).

In the relationship between inequality and growth, the fact that credit constraints are significant only in countries at the initial stage of development supports the theoretical view of Castells-Quintana and Royuela (2017) and Galor and Moav (2004). In less developed countries, as the contribution of physical capital to growth is more significant than human capital, inequality positively affects economic growth (in line with the Classical approach). In contrast, in developed countries, significant effects disappear due to the increase in access to credit. Thus, the fact that inequality encourages economic growth in low and middle-income countries (Iradian, 2005) can be explained by poor households' lack of access to credit. Against low-income families who do not have the resources to finance their investments, the existence of rich people, who can realise their risky projects, will increase the total savings rate and contribute to economic growth. Also, important inferences can be drawn from empirical studies for a single country, considering the country's income level. Evidence of the credit markets imperfections channel for Vietnam as a lower-middle-income economy (Le & Nguyen, 2019) shows the importance of the developed financial system in low-income countries. If poor individuals have the opportunity to invest in their human capital, economic growth will increase. Empirical evidence that the credit markets' imperfections channel is not valid (Ciegis and Dilius, 2019) is explained by the fact that the increased education level of the poor does not support economic growth, contrary to theory.[9] It can be said that the EU countries in this study are relatively developed countries and have reached a certain level of education, therefore, the level of attained education may not have a significant effect on economic growth. This result may also be due to the tertiary education indicator used to represent the education level.

[8] Neves et al. (2016) develops a meta-analysis of the empirical literature and they examine whether the factors such as the quality of data, chosen method effect the effect sizes about the relationship between two variables.

[9] Even in the absence of income inequality, the level of education does not promote economic growth in any country group (Ciegis and Dilius, 2019).

Table 1 Summary of empirical literature

Author(s)	Sample and period	Methodology	Channel	Dependent variables	Explanatory (control) variables	Main findings
Iradian (2005)	Panel data for 82 countries 1965–2003	Fixed Effect and GMM	Credit Market Imperfections	GDP per capita growth rate	Gini, Natural log of GDP (constant price) Gross capital formation(%GDP), inflation rate dummy for countries with high financial mediation	In the short to medium term, inequality and growth are positively related. In the long run, a negative relationship exists between inequality and growth
Castells-Quintana and Royuela (2017)	51 countries 1970–2007	Control function approach	Credit Market Imperfections Domestic Market Fertility Geography Institutions SocioPolitical Instability Political Economy	Annual average GDP per capita growth rate	Gini, initial GDP per capita, life expectancy at birth, the primary enrolment rate, openness year primary exports, average government spending and average expenditure on education (%GDP), mining (%GDP), many variable in relation to inequality	Inequality influences long-run growth both positively and negatively The negative influence of inequality is significant in developing countries, but the role of channel depends on the circumstances of each country
Madsen et al. (2018)	21 OECD countries 1870–2011	2SLS	Credit Market Imperfections	S/Y (S is gross private savings, Y is nominal GDP) I/Y (I is real non-residential gross investment) Gross enrollment rate Patent applications	Net Gini, Top 10% income shares, the domestic credit (%GDP), R&D expenditures(%GDP), age dependency ratio, life expectancy, real interest rate, communist influence, Tobin's q	Inequality has a significantly negative effect on growth in countries with low financial development Inequality has little effect on growth at advanced levels of financial development

Table 1 (continued)

Author(s)	Sample and period	Methodology	Channel	Dependent variables	Explanatory (control) variables	Main findings
Ciegis and Dilius (2019)	28 EU countries 1995–2014	OLS	Credit Market Imperfections Fiscal Policy	Real GDP per capita	Gini, Decile ratio, first decile, tenth decile, Private sector credits, social protection benefits per capita (Tertiary education indicator, government expenditure, life expectancy, volume of export)	No conclusive results on the effects of income inequality on economic growth Impact of inequality varies according to the level of development
Braun et al. (2019)	Panel data of 150 countries 1978–2012	Pooled OLS and GMM	Credit Market Imperfections	Real GDP per capita growth rate 5-year interval	Gini, patent applications, trade openness, inflation, previous level of income per capita, private credit as a percentage of GDP, general government final consumption expenditure, interaction values	Inequality has less negative impact on growth for countries with developed financial markets
Gründler and Scheuermeyer (2018)	192 countries 1960–2014	System GMM	Credit Market Imperfections Fertility Redistribution	GDP per capita 5-year averages	Inequality, redistribution (GiniMarket-GiniNet) years of schooling, investment, log of life expectancy at birth, political stability, inflation, government consumption, fertility rate, trade openness	Inequality has a negative impact on growth. Impact of inequality on redistribution varies from one country to another based on the development level

Table 1 (continued)

Author(s)	Sample and period	Methodology	Channel	Dependent variables	Explanatory (control) variables	Main findings
Le and Nguyen (2019)	61 provinces of Vietnam 1998–2016	OLS Two Stage Least Square Model Fixed Effects Model	Credit Market Imperfections Fertility Political Economy	Average GDP growth rate The average ratio of credit to GDP The average schooling years fertility rate the average ratio of total government expenditure to GDP and the average ratio of tax revenue to GDP (proxy of redistribution)	Gini, quintiles of the population, the average schooling years, Investment to GDP ratio, trade openness, initial income per capita	Inequality and growth are related through different channels (except political economy) but the direct relationship is weak
Galor and Zang (1997)	Panel data of 73 countries. 1960–1988	WLS and OLS	Fertility	Per capita GDP	Fertility rate, dependency ratio, Gini income inequality, public education expenditure	Equal distribution of income and smaller family size are conducive to economic growth

Table 1 (continued)

Author(s)	Sample and period	Methodology	Channel	Dependent variables	Explanatory (control) variables	Main findings
Odedokun and Round (2001)	Panel data of 35 African countries. 1960's to 1990's	OLS	Fertility Human Capital Political Instability Political economy	5-year average per capita GDP growth rate	Private saving ratio and private investment ratio, government consumption-GDP ratio and tax ratio, school enrolment ratios, political stability index, fertility rate, per capita income, population growth, Gini coefficient, government, consumption, income share of poorest 40% middle 40% and richest 20%	No evidence (private saving and investment channel) No evidence (political economy channel) Strong evidence (socio-political İnstability channel, credit market İmperfection-induced human capital channel, and fertility cahnnel)
De La Croix and Doepke (2003)	Panel data of 68 countries. 1960–1992	GMM	Fertility	Real per capita GDP	Fertility rate, initial GDP per capita, Investment to GDP ratio, Government expenditure to GDP ratio, Gini, Initial total fertility rate	Increase in inequality contributes to slow growth through reduction in education

Table 1 (continued)

Author(s)	Sample and period	Methodology	Channel	Dependent variables	Explanatory (control) variables	Main findings
Castelló-Climent (2010)	Panel data of 108 countries. 1960–2000	System GMM and OLS	Fertility	Per capita GDP 5-year span	Fertility rate, life expectancy at birth, human capital, Gini coefficient, distribution of education by quintiles, real GDP per capita, government spending, total trade, inflation, the stock of human capital	The effect of inequality on growth depends on the level of development of the region The effect of income and human capital inequality on economic growth is negative in the low- and middle-income countries, but it vanishes or becomes positive in the higher-income countries
Berg et al. (2018)	A group of developing and developed countries 1975 onwards for developed countries 1985 onwards for developing countries	System GMM	Fertility Human Capital Redistribuiton Socio-political instability	GDP per capita growth 5-year non-overlapping time	Initial GDP per capita, Gini, redistribution and Gini, investment/GDP, population growth, openness, average years of primary, and secondary schooling, life expectancy, political participation, fertility rate, external debt/GDP	Redistribution positively affects growth Low inequality promotes long-term growth by controlling redistribution Two channels are valid

Table 1 (continued)

Author(s)	Sample and period	Methodology	Channel	Dependent variables	Explanatory (control) variables	Main findings
Alesina and Rodrick (1994)	A group of developed and developing countries 1960–1985	OLS and TSLS	Political Economy	Average Per capita growth rate	Initial per capita GDP, primary school enrolment, Gini coefficient of income inequality, Gini coefficient of land distribution inequality, democracy dummy	Income and land inequality and have negative impact on growth
Persson and Tabellini (1994)	Panel study of 9 developed countries 1830–1850 1970–1985	OLS	Political Economy	Per capita GDP growth	Personal income of the top 20% of the population, political participation, index of schooling, level of development	Inequality negatively affects growth
Perotti (1996)	A group of developed and developing countries 1960–1985	OLS and 2SLS	Political Instability	GDP per capita	Share of income in third and fourth quantiles, Initial per capita GDP, Government expenditure on health, on social security, schooling years, investment, male school enrollment ratio, female school enrollment ratio, life expectancy, political instability index, dummy variables	A negative relationship exists between inequality and growth

Table 1 (continued)

Author(s)	Sample and period	Methodology	Channel	Dependent variables	Explanatory (control) variables	Main findings
Nel (2003)	Panel data of Sub-Saharan African states. 1986–1997	OLS	Political Instability	GDP per capita growth rate 5-year average İnstability	Inequality the squared ratio between the income shares of the richest 20% and the poorest 40%, female illiteracy, male illiteracy, purchasing power parity of investment goods, dummies	Inequality has no statistically significant effect on political instability, but there might be negative impacts on economic growth due to adverse effects on investment decisions
Mo (2009)	A group of transitional economies 1970–1985	2SLS	Political Instability	GDP growth rate 5- year	Income distribution polarization, initial per capita income, private investment to GDP, rate of population growth, political instability, average schooling years, government transfer	A negative relationship exists between income polarization and GDP growth (through socio-political instability)
Babu et al., (2016)	A group of 29 emerging economies 1980–2010 1999–2008	GMM	Political Economy	Per capita GDP growth rate	Initial per capita GDP, market inequality Gini redistribution, initial GDP growth rate, investment, log of population, tertiary education, inflation, and trade openness	Inequality has a negative impact on growth in the long run after controlling for distributive effects

Table 1 (continued)

Author(s)	Sample and period	Methodology	Channel	Dependent variables	Explanatory (control) variables	Main findings
Chletsos and Fatouros (2016)	Panel study of 126 countries 1968–2007 8 five-year period averages	Fixed Effects, GMM and 2SLS	Political Economy Human Capital	Average per capita growth rate	Average initial GDP per capita, estimated household income inequality, population growth, investment, human capital, terms of trade, inflation, government consumption, democracy	A positive and significant relationship exists between inequality and growth
Blotevogel et al. (2020)	A group of developing and developed countries 1970–2017	WALS Pooled Mean-Group Regression	Human capital Fertility Capital services (investment) Total factor productivity Political stability	Human Capital index Physical Capital Stock index TFP index government stability sub-index Fertility rate 5-year change	Gini, top 10 income shares	Net effect of inequality on growth is difficult to determine The relationships change over time Fragile countries create significant but counterintuitive empirical relations

Human capital, an important explanatory factor for the credit markets imperfections channel, is also associated with fertility. This relationship is based on the idea that low-income families have more children, low educational investments, while wealthy families have fewer children and more opportunities to get an education. Consistent with theory, some empirical evidence suggests that income inequality harms economic growth through the fertility rate channel (Galor & Zang, 1997; Odedokun & Round, 2004; De La Croix and Doepke, 2003; Castelló-Climent, 2010; Castells-Quintana & Royuela, 2017; Gründler & Scheuermeyer, 2018; Berg et al., 2018; Le & Nguyen, 2019). The fact that the effect of income inequality on differential fertility is more substantial in developing countries than developed countries (Kremer & Chen, 2002) suggests that the relationship may also change depending on the development level of the countries. Berg et al. (2018) prove that the effect of inequality on fertility differences is stronger when excluding developed countries from the analysis. On the other hand, the reason why the impact of human capital on growth is different in low and high-income countries is that the differences in fertility between individuals are more pronounced in less developed countries (Castelló-Climent, 2010). Therefore, if the number of children of the poor in low-income countries is higher than the number of children of the rich, economic growth in these countries is more likely to be adversely affected.[10]

The validity of the political economy channel is also examined in many empirical studies (Persson & Tabellini, 1994; Alesina and Rodrick, 1994; Babu et al., 2016; Chletsos & Fatouros, 2016; Castells-Quintana & Royuela, 2017; Gründler & Scheuermeyer, 2018; Le & Nguyen, 2019; Ciegis and Dilius, 2019). Against the view that high inequality will put pressure on redistribution and damage economic growth, it is also argued that higher inequality can lead to higher growth via the lower taxation and human capital channel (Chletsos & Fatouros, 2016). In this view, high inequality favours low taxation to consume more or high taxation to increase public education. As seen in the table, the differences in the results obtained in the studies suggest that countries should be grouped according to their level of development and perhaps income inequality. Gründler and Scheuermeyer (2018) show that while redistribution positively affects economic growth in the early stages of development, this positive effect disappears as income level increases.[11] Hence, the fact that redistribution does not negatively affect growth in low-income countries can be explained by the fact that redistribution encourages education, supports the investments of the poor, creates demand by expanding the middle class, and decreases the tendency to crime (Paul & Verdier, 1996). On the other hand, Ciegis and Dilius (2019) reveal that the impact of inequality on economic growth through fiscal policy varies according to countries' income and income inequality levels. In countries with relatively high income and inequality due to the increase in the income of the wealthiest population, inequality positively affects growth through fiscal policy. The negative effect of inequality on economic growth is due to increased social protection expenditures. Although redistribution positively affects growth in Vietnam, a low-middle-income country, income inequality does not affect redistribution, so this channel is not valid (Le & Nguyen, 2019).[12] Similarly, there is no evidence of the validity of this channel for African low-income countries (Odedokun

[10] Castelló-Climent (2010) shows that a low fertility rate has a positive effect on the growth rate of per capita income in all country groups except developed and European economies.

[11] The positive effect disappears when the average income level reaches approximately 15,000 USD.

[12] Unlike many studies, Le and Nguyen (2019) calculate inequality proxies using Vietnam living standard household surveys.

& Round, 2004). These consequences can result from underdevelopment of democracy in those countries. Therefore, it can be said that the specific characteristics of the countries are also important for the validity of the analysed channel.

Some empirical evidence shows that high inequality will adversely affect economic growth as it causes socio-political instability (Castells-Quintana & Royuela, 2017; Mo, 2009; Odedokun & Round, 2004; Perotti, 1996). On the other hand, although inequality does not have significant effects directly on political instability, it can still harm economic growth as it negatively affects investment (Nel, 2003). High inequality will cause poor individuals to turn to high-return crime rather than low-income market activities (Kelly, 2000), and it will also lead to increased political instability (Acemoglu & Robinson, 2001)[13] and activities that will disturb the peace of society and thus waste governments' resources, which could otherwise be used for productive activities (Barro, 2000).[14] The reason why low-income countries cannot save as much as the rest of the world is that their socio-political environment is not conducive to save (Venieris & Gupta, 1986). Therefore, although we do not find direct empirical evidence, it can be concluded that the negative impact of income inequality on economic growth through the socio-political instability channel may be more important in low-income countries.

There are few studies in the empirical literature questioning the positive impact of income inequality on economic growth. While income inequality positively affects human capital (Chletsos & Fatouros, 2016), contrary to the theory it can have a negative effect on savings and investments (Nel, 2003) and similarly on patents (Braun et al., 2019). As stated in the positive channel, the fact that the positive effect of income inequality on R&D and innovations cannot be determined is explained by the financial development level of the country, and developed financial systems can reduce the negative effect. Castells-Quintana and Royuela (2017) test negative and positive channels together. After testing several channels, they state that income inequality can have both positive and negative effects on economic growth, and thus the complexity of the relationship is emphasised. Moreover, this complexity is more pronounced in developing countries.

In summary, although the validity of many channels is theoretically mentioned, only one or a few of the channels are tested in the empirical literature. In particular, it can be said that positive channels are neglected. On the other hand, as stated above, since the complexity of the relations may also depend on the development level of the countries, these conditions should be taken into consideration. In this respect, the study is expected to contribute to these gaps in the literature.

[13] Acemoglu and Robinson (2001) state that inequality is a driving force that encourages the elite to contest power in democratic societies and increases social unrest in non-democratic societies.

[14] Blanco and Grier (2009) show that inequality in Latin American countries can reduce political instability after a certain threshold value (after the Gini coefficient reaches 0.45). Blotevogel et al. (2020) states that the relationship between inequality and political stability changes depending on whether or not it includes the fragile countries in the analysis and emphasizes that there may be a non-linear relationship between the two variables.

3 Method and Dataset

To understand whether the effect of inequality on economic growth occurs through the channel, in the first stage, the effect of the income inequality indicator on the channel variable is tested. The pooled OLS, Fixed or Random Effect[15] and Two-Stage Least Squares (2SLS) methods are used to predict the simple reduced model in Equation 1:

$$channel_{it} = \alpha + \beta ineq_{it} + \delta \ln (GDP)_{it} + \eta_i + \vartheta_t + \varepsilon_{it} \quad (1)$$

In this model, the $channel_{it}$ dependent variable is the proxy of channel variable and $ineq_{it}$ denotes proxy of income inequality variable, *Gini coefficient.* i represents a country, and t represents the time dimension. η_i, ϑ_t represents country-specific effects and time effects; ε_{it} describes the error terms. This study differs from other studies because the countries are divided into two groups according to their income levels. This model is preferred because it allows testing the significance of income level in the validity of the channels. In other words, the aim is not only to examine the effect of income inequality on the channel variable but also to determine whether the income level of the countries is significant on these variables.[16]

Ordinary least squares (OLS) are biased in small samples, and this bias persists in large samples. Instrumental variables (IVs) estimators, such as two-stage least squares, focus on the problem of endogeneity of explanatory variables. This problem is solved by instrumenting the endogenous regressors using exogenous variables (the instruments) in this method (Gawande & Li, 2009: 236). The instrumental variables purge the endogenous variable from the variance that overlaps with the error term, and consistent estimates are obtained for the endogenous variable. When the causal effect of one dependent variable on another is estimated, it is possible that endogeneity can arise.[17] For this reason, the 2SLS estimator has the advantage of testing mediation models to determine the causal effect of one endogenous regressor on another (stemming from the instrument/s) (Antonakis et al., 2014: 30). Therefore, the two-stage least squares method is also used to overcome a possible endogeneity of income inequality.

In this study, any effect of income inequality and channel variables on economic growth is tested with the two-staged System Generalised Method of Moments (System GMM), a dynamic panel data technique. This method was first introduced by Arellano and Bover (1995) and further developed by Blundell and Bond (1998) based on Difference Generalised Method of Moments (difference GMM) by Arellano and Bond (1991). However, it is possible that the difference GMM estimator is biased in some cases and leads to the weak instrumental variable problem. The economic growth series might lead to a problem in this context because the analysis is conducted based on 5-year averages, and the series is relatively persistent (Cojocaru et al., 2016). Therefore, the System GMM estimator, a better alternative for the difference GMM estimator, is preferred in this study. Arellano and Bover (1995) and Blundell and Bond (1998) overcame the weak estimator problem with a two-equation solution. The first one is the first difference equation formed by instrumental variables in the level, and the second is a level equation of instruments created by the first

[15] Test of overidentifying restrictions and Hausman test are controlled to choose Fixed or Random Effect Model in all estimations.

[16] Similarly, Gründler and Scheuermeyer (2018) also used this reduced model for endogenous fiscal policy channel.

[17] This endogeneity is called as *reverse causality problem* in the literature.

differences (Arellano and Bover, 1995). Also, GMM is comparatively better because when the time series is a random walk process, the instruments in the level equation are efficient estimators for endogenous variables (Blundell & Bond, 1998). The simple autoregressive dynamic model at first degree is defined as follows:

$$y_{it} = \alpha y_{i,t-1} + \beta x_{it} + u_{it} \tag{2}$$

$$u_{it} = \eta_i + \upsilon_{it} \quad i = 1, \ldots, N \quad and \quad t = 2, \ldots T \tag{3}$$

On the equation, x_{it} is the explanatory variable vector, u_{it} is the constant effect decomposition in the error term, i and t represent country and period. In this model, the disturbances for η_i and υ_{it} are not cross-correlated, and there are some assumptions for η_i and υ_{it}:

$$E(\eta_i) = 0, E(\upsilon_{it}) = 0, E(\upsilon_{it}\eta_i) = 0 \quad i = 1, \ldots, N \quad and \quad t = 2, \ldots T \tag{4}$$

and the errors are serially uncorrelated:

$$E(\upsilon_{it}\upsilon_{is}) = 0 \quad i = 1, \ldots, N \quad and \quad \forall t \neq s \tag{5}$$

Additionally, standard assumptions for initial conditions of y_{i1} satisfy:

$$E(y_{i1}\upsilon_{it}) = 0 \quad i = 1, \ldots, N \quad and \quad t = 2, \ldots T \tag{6}$$

Three conditions mean moment constraints sufficient to predict α, $T \geq 3$. Based on these given assumptions, obtained linear moment constraint is $E(y_{i,t-s}\Delta\upsilon_{it}) = 0, t = 3, \ldots T \quad and \quad s \geq 2$. The lagged two or more periods for y_{it} are valid instruments in the first-differenced equation (Arellano & Bond, 1991). $x_{i,t}$, the explanatory variable vector, are treated as endogenous variables, as assumed in recent empirical growth models. It indicates that there exist correlations between the value of these regressors.

To check the consistency of the estimates, some conditions should also be checked. The first of these conditions is that there is no correlation between successive values of error terms. Arellano-Bond developed a test to test the invalid instrument phenomenon that may arise using some lags of the variables. For this purpose, autocorrelation in the idiosyncratic disturbance term (υ_{it}) is tested. The model's error term (u_{it}) is assumed to be autocorrelated since it contains fixed effects, and the estimators are designed to overcome this problem. However, if υ_{it} are themselves serially correlated with order 1 then the selected instrument variables could be invalid. The Arellano-Bond test is applied to residual terms in differential equations to test autocorrelation. In order to test the first order autocorrelation at the level, the second order correlation in the difference equation is examined. In this case, the correlation between $\Delta\upsilon_{it-1}$ in υ_{it-1} and $\Delta\upsilon_{it-2}$ in υ_{it-2} will be determined. More generally, l. degree correlation in level is checked by examining $l + 1$. degree correlation in differences (Roodman, 2009). The AR(2) value obtained in the estimation results enables the interpretation of whether there is a second-order autocorrelation in the first difference residual values. The second condition to be checked is whether the selected instrumental variable and error terms have correlations. The validity of instruments is controlled by applying Hansen's (1982) test. Another condition is related to the number of instrument variables;

the number of determining instrument variable number must be less than or equal to the number of groups.[18]

The dynamic model used in this study to determine the relationship between income inequality and economic growth with the system GMM method is as follows:

$$y_{it} = \alpha_0 y_{it-1} + \alpha_1 ineq_{it} + \alpha_2 channel_{it} + \alpha_3 X_{it} \eta_i + \vartheta_t + \varepsilon_{it} \quad (7)$$

In this model, i represents a country, and t represents the time dimension. η_i, ϑ_t represents constant effects for unobserved countries and unobserved time effects; ε_{it} represents the error terms that depend on time and country. The y_{it} dependent variable is the GDP growth rate variable, $ineq_{it}$ denotes proxy of income inequality variable, *Gini coefficient* and $channel_{it}$ denotes proxy of channel variable.[19] X_{it} indicates an array of control variables. Control variables are selected as variables commonly used in empirical analysis in economic growth literature.

The first control variable explaining economic growth is school enrolment, which represents human capital. Since the inclusion of human capital as well as physical capital in growth models (Caballe & Santos, 1993; Lucas, 1988; Mankiw et al., 1992; Rebelo, 1991), this variable has also been frequently used as an explanatory variable in empirical analysis (Barro, 1997, 2000; Alesina and Rodrick, 1994; Perotti, 1996; Persson & Tabellini, 1994; Odedokun & Round, 2004; Mo, 2009; Castelló-Climent, 2010; Chletsos & Fatouros, 2016; Berg et al., 2018; Gründler & Scheuermeyer, 2018; Le & Nguyen, 2019). According to theoretical models, the coefficient of proxies used for human capital is expected to have a positive sign. The second control variable is investment. Investment is used both as a determinant of growth and as a channel variable in this study. In the Solow (1956) model, while the economy is in steady-state, an increase in investment rate causes a new steady-state with higher per capita capital and income. Including the investment rate as an explanatory variable in theoretical growth models is also encouraging for empirical studies (Perotti, 1996; Odedokun & Round, 2004; De La Croix and Doepke, 2003; Mo, 2009; Chletsos & Fatouros, 2016; Babu et al., 2016; Gründler & Scheuermeyer, 2018; Berg et al., 2018; Le & Nguyen, 2019). It is expected that the increase in investment rates will positively affect the economic growth. Third control variable is trade openness. Trade openness can stimulate economic growth by increasing total factor productivity through technological expansions and increased competition (Grossman & Helpman, 1991; Rivera-Batiz & Romer, 1991). Therefore, trade openness, which is frequently used in empirical analysis as a determinant of growth (Babu et al., 2016; Braun et al., 2019; Castelló-Climent, 2010; Gründler & Scheuermeyer, 2018; Le & Nguyen, 2019), could have a positive effect on growth.[20] The fourth control variable is inflation. In theoretical models, the impact of inflation on economic growth is not apparent. There are explanations about positive effects (Tobin, 1965), negative effects (Stockman, 1981) or no effects (Sidrauski, 1967). Inflation is also preferred as the explanatory variable of growth in empirical studies examining the impact of income inequality on economic growth. (Babu et al., 2016; Barro, 2000; Braun et al., 2019;

[18] When we add the control variables in growth regressions, the number of instrument variables is decreased with collapse matrixes of instrument variables by following Roodman (2009).

[19] The channel variables are selected as variables commonly used in empirical analysis in related literature. Table 1 shows all variables in detail.

[20] This relationship may change according to the development level of the countries. Spilimbergo (2000) states that trade with under developed countries negatively affects the long-term growth rate in developed countries.

Castelló-Climent, 2010; Chletsos & Fatouros, 2016; Gründler & Scheuermeyer, 2018; Iradian, 2005).

The detailed information of the variables used in the analysis for 143 countries based on the 1980–2017 period is in Table 21 in Appendix.[21] Gini coefficient is adopted from the "Standardized World Income Inequality Database (SWIID)" of Frederick Solt (2009) (version 8.1), and all other data are compiled from the World Bank database.

In the analysis, the countries are divided into two, low and lower-middle-income (LLMC) and upper-middle and high-income (UHC) based on the World Bank income classification. Thus, it is possible to identify whether the channel effect changed for country income levels. Descriptive statistics of analysed data are given in Table 2. The average, standard deviation, minimum and maximum values of the variables are shown in the table.

4 Empirical Results

4.1 The Effect of Income Inequality on the Channel Variables

The impact of income inequality on economic growth is analysed in terms of both positive and negative channels. The estimates mainly focus on the impact of inequality on the channel variable. In this way, the effects on economic growth will be discussed in the second stage. In addition to the proxies of channel variables used in this step, estimates are also made with different proxies, except for the fertility channel, in order to test the robustness of estimations, and these results are presented in Tables 4, 6, 8, 10, 12, and 14.[22]

Table 3 presents the results of the political stability, political economy and fertility channel in low and lower-middle-income countries. Contrary to expectations, it is observed that the effect of inequality on the political stability index is positive in all estimations. The effect of inequality on the redistribution variable is insignificant except for the pooled OLS estimate. These results indicate that inequality in low-income countries does not significantly affect redistribution as theoretically stated (Le & Nguyen, 2019; Odedokun & Round, 2004). It can be argued that low-income countries do not have the level of democracy to support the median voter theory, so the results are not surprising. Finally, the effect of inequality on the fertility rate is consistent with theory and is significantly positive in all estimations. As seen in Table 4, while robust results are obtained for the political instability channel, the results for the political economy channel are different; however, the effect is not significant for most models.

Table 5 shows the results of the credit markets imperfections channel.[23] The effects of income inequality and credits on education are analysed with two-stage estimations. The impact of inequality and credits on education is significantly negative (except column 2) and significantly positive (except column 6), respectively. These results indicate that as income inequality increases, human capital will decrease, but as financial development

[21] The countries used in this analysis are listed in Table 22 in Appendix.

[22] The proxies used for the channel variable are selected from the frequently used variables as indicated in Table 1. The literature does not suggest any other proxy for the fertility channel. A table with the proxies used for other channel variables and their sources is annexed in Table 23 in Appendix.

[23] The proxy credmark is defined as Domestic credit to private sector by banks (% of GDP) and used to represent the development of financial markets. This indicator is used in many studies in the literature, such as Ciegis and Dilius (2019), Le and Nguyen (2019), Braun et al., (2019), Madsen et al. (2018).

Table 2 Descriptive statistics of 5-year span data

Variables	Observation	Mean	SD	Min	Max
Growthrate	1079	3.370897	3.933624	− 42.45112	33.86945
Gdp	842	15,341.56	16,799.61	373.7136	124,658
Gini	933	37.73301	8.524845	17.8	62.5
School	1062	99.37691	17.76769	20.20399	165.6454
Investment	677	2.938591	2.803435	− 4.574632	18.9183
Trade	1,050	80.03632	51.5965	4.296569	425.1579
Politicalstability	714	− .0778694	.9436302	− 2.840591	1.696236
Inflation	980	31.89336	195.9157	− 9.691091	3373.76
Redistribution	709	8.05e + 12	6.78e + 13	4.727273	1.29e + 15
Lifexp	1,142	67.8212	9.932195	28.6524	84.39512
Credmark	964	42.95687	38.92973	.1858528	246.4564
Fertility	1143	3.274354	1.772785	.9454	8.810801
Patent	778	9758.107	58,871.42	1	1,139,647
Domestic saving	902	20.87678	9.770229	− 9.898586	77.00212

increases, human capital will increase. Thus, it provides evidence to the validity of the first stage of the credit markets imperfections channel. On the other hand, only the effect of inequality on human capital (columns 1–4) shows that the positive channel is not valid. Increasing inequality in low-income countries does not provide incentives for education. In Table 6, the dependent variable *tertiary* is used for the credit market imperfections channel and human capital channel, and it is approved that the results are robust.

Finally, Table 7 shows the effect of inequality, a positive channel, on patent and saving rates. Contrary to the theory stated above, inequality has a significant adverse effect on the patent, similar to Braun et al. (2019) (except column 2). In contrast, its effect on saving rate is insignificant in all estimates similar to Odedokun and Round (2004). The underdeveloped financial systems in low-income countries may also be the cause of the negative effect (Braun et al., 2019). Therefore, evidence of the validity of these positive channels in these countries cannot be obtained. In addition, the coefficients of the GDP per capita variable used in the estimation of all channels have the expected sign in almost all of them and are significant. These results indicate that the income level of countries is essential to interpret the relationship between variables. These results obtained for the innovation and saving channel are also supported by different proxies, as seen in Table 8.

Table 9 shows the estimation results for UHC similarly for all channels. The effect of inequality on political stability is significantly negative (except column 2), unlike LLMC, and these results are consistent with the theoretical view. Considering together with the results obtained for LLMC, it can be said that the relationship between income inequality and instability is not linear. Blanco and Grier (2009) stated that inequality can reduce political instability after a certain threshold. Considering that low-income countries have relatively high levels of inequality, it can be said that the results support Blanco and Grier (2009) study, as these countries may have exceeded this threshold. Second, the effect of inequality on redistribution is also different from LLMC. The relationship between inequality and redistribution in these countries is significantly positive (except column 6). These results show that the relationship depends on the development level of the countries, and the first stage of the political economy channel is supported at UHC (Gründler &

Table 3 Effects of income inequality on channel variables in LLMC (political ınstability, political economy, and fertility channel)

Variables	Political stability				Lnredistribution				lnfertility			
	(1)	(2)[b]	(3)	(4)	(5)	(6)[a]	(7)	(8)	(9)	(10)[b]	(11)	(12)
Gini	0.023***	0.026*	0.030***	0.030***	− 0.061*	0.014	− 0.053	− 0.053	0.015***	0.007*	0.017***	0.018***
	[0.008]	[0.014]	[0.009]	[0.008]	[0.034]	[0.028]	[0.038]	[0.033]	[0.003]	[0.004]	[0.004]	[0.004]
lngdp	0.111	0.289***	0.124*	0.137*	0.835**	1.196**	0.819**	0.519	− 0.414***	− 0.176***	− 0.414***	− 0.406***
	[0.069]	[0.111]	[0.072]	[0.073]	[0.363]	[0.477]	[0.382]	[0.357]	[0.020]	[0.048]	[0.021]	[0.022]
Constant	− 2.483***	− 3.860***	− 2.867***	− 3.034***	20.911***	13.473***	20.804***	24.782***	4.041***	2.665***	3.945***	3.796***
	[0.599]	[1.038]	[0.634]	[0.665]	[3.539]	[3.538]	[3.823]	[3.528]	[0.178]	[0.419]	[0.196]	[0.205]
Observations	233	233	225	225	160	160	150	150	278	278	255	255
R-squared	0.038	0.039	0.041	0.045	0.050	0.878	0.043	0.142	0.508	0.485	0.507	0.522

Table reports regressions using Pooled OLS (Columns 1–5–9), Fixed[a]/Random[b] effect with time-dummies (2–6–10), and 2SLS without (3–7–11) and with time-dummies (4–8–12) estimations. Robust standard errors in parantheses

***$p<0.01$, **$p<0.05$, *$p<0.1$

Table 4 Effects of income inequality on channel variables in LLMC (Political instability, political economy)

Variables	Ruleoflaw				Govcons			
	(1)	(2)[b]	(3)	(4)	(5)	(6)[b]	(7)	(8)
Gini	0.013***	0.017*	0.014***	0.014***	0.149	0.144	0.289**	0.221*
	[0.005]	[0.010]	[0.005]	[0.005]	[0.101]	[0.134]	[0.128]	[0.115]
lngdp	0.204***	0.308***	0.203***	0.206***	− 0.942	− 1.750**	− 1.172*	− 1.575*
	[0.035]	[0.090]	[0.036]	[0.038]	[0.672]	[0.829]	[0.707]	[0.824]
Constant	− 2.834***	− 3.717***	− 2.839***	− 2.847***	7.320	8.032	3.754	10.798
	[0.327]	[0.866]	[0.355]	[0.369]	[7.205]	[8.937]	[8.540]	[9.091]
Observations	233	233	225	225	217	217	206	206
R-squared	0.116		0.116	0.121	0.011		0.014	0.087

Table reports regressions using Pooled OLS (Columns 1–5), Fixed[a]/Random[b] effect with time-dummies (2–6), and 2SLS without (3–7) and with time-dummies (4–8) estimations. Robust standard errors in parantheses

*** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$

Scheuermeyer, 2018). The effect of income inequality on fertility is significantly positive in all estimates, so the prerequisite for the validity of the bi fertility channel supports the Kremer and Chen (2002) study for both country groups. The sensitivity analysis results for political instability and political economy channel at UHC are presented in Table 10. The results are consistent with the results in Table 9.

The results of the credit markets imperfection channel in Table 11 are similar to the results in LLMC. The effect of inequality and credits on education is significantly negative (except column 2) and positive (except columns 6 and 10), respectively. These results provide evidence of the validity of the first stage of the credit markets imperfections channel. On the other hand, the effect of inequality on human capital (columns 1–4) shows that the positive channel stated in theory does not apply here as in LLMC. Furthermore, as in LLMC, the *tertiary* as the dependent variable is used to examine credit markets defects and human capital channels. All results indicate that the findings are robust as seen in Table 12. Lastly, Table 13 shows the effect of inequality on patent and savings rates. Results for patent are similar to LLMC; contrary to theory, the effect of inequality on the patent is significantly negative in all estimates. Therefore, income inequality does not support innovative activities contrary to expectations, but the same interpretation cannot be made for the saving rate, and the results are different from LLMC. As income inequality rises, saving rates increase (except column 6), these results support the Classical approach. The marginal propensity to save for the rich people in UHC is higher, so total savings increase as inequality increases. As seen in Table 14, while the results are robust for the innovation channel, the negative effect of *fixed capital* variable on income inequality does not support the Classical approach.

4.2 The Effect of Income Inequality and Channel Variables on Economic Growth

In this section, after estimating the effect of income inequality on proxies used as channel indicators in the first stage, the effect of these variables on economic growth is examined in the second stage. Here, the model that excludes the control variables and the more

Table 5 Effects of income inequality on channel variables in LLMC (credit market ımperfections and human capital channel)

Variables	lnlifexp				lnlifexp				lnlifexp			
	(1)	(2)[b]	(3)	(4)	(5)	(6)[a]	(7)	(8)	(9)	(10)[a]	(11)	(12)
Gini	− 0.006***	− 0.001	− 0.006***	− 0.006***								
	[0.001]	[0.003]	[0.001]	[0.001]								
Lngdp	0.158***	0.108***	0.158***	0.147***	0.117***	0.035	0.119***	0.111***	0.118***	0.038	0.119***	0.111***
	[0.009]	[0.016]	[0.010]	[0.010]	[0.010]	[0.040]	[0.011]	[0.010]	[0.010]	[0.040]	[0.011]	[0.010]
Credmark					0.003***	− 0.001	0.003***	0.002***				
					[0.000]	[0.001]	[0.000]	[0.000]				
credmark2									0.002***	− 0.001	0.002***	0.002***
									[0.000]	[0.001]	[0.000]	[0.000]
Constant	3.085***	3.248***	3.100***	3.252***	3.115***	3.753***	3.093***	3.205***	3.110***	3.729***	3.099***	3.210***
	[0.094]	[0.219]	[0.109]	[0.108]	[0.072]	[0.308]	[0.081]	[0.075]	[0.073]	[0.308]	[0.081]	[0.076]
Observations	278	278	255	255	308	308	297	297	308	308	297	297
R-squared	0.538		0.532	0.566	0.554	0.554	0.570	0.608	0.549	0.555	0.565	0.604

Table reports regressions using Pooled OLS (Columns 1–5–9), Fixed[a]/Random[b] effect with time-dummies (2–6–10), and 2SLS without (3–7–11) and with time-dummies (4–8–12) estimations. Robust standard errors in parantheses

*** $p<0.01$, ** $p<0.05$, * $p<0.1$

Table 6 Effects of income inequality on channel variables in LLMC (credit market ımperfections and human capital channel)

Variables	Tertiary				Tertiary				Tertiary			
	(1)	(2)[a]	(3)	(4)	(5)	(6)[b]	(7)	(8)	(9)	(10)[b]	(11)	(12)
Gini	− 0.726***	− 0.005	− 0.807***	− 0.852***								
	[0.147]	[0.165]	[0.146]	[0.150]								
lngdp	13.108***	10.218***	13.260***	12.416***	12.271***	8.971***	13.211***	12.524***	12.030***	8.479***	12.979***	12.261***
	[0.873]	[3.062]	[0.917]	[0.891]	[1.059]	[1.781]	[1.399]	[1.356]	[1.059]	[1.796]	[1.411]	[1.374]
credmark					0.083*	0.128**	0.016	0.002				
					[0.043]	[0.065]	[0.060]	[0.060]				
credmark2									0.092**	0.142**	0.029	0.021
									[0.046]	[0.062]	[0.058]	[0.058]
Constant	− 59.917***	− 69.337***	− 57.641***	− 43.835***	− 84.830***	− 62.990***	− 90.887***	− 82.748***	− 83.252***	− 59.575***	− 89.381***	− 81.302***
	[6.375]	[24.251]	[7.262]	[8.046]	[7.537]	[13.694]	[9.617]	[9.497]	[7.472]	[13.788]	[9.709]	[9.601]
Observations	236	236	217	217	256	256	246	246	256	256	245	245
R-squared	0.538	0.575	0.537	0.555	0.485		0.496	0.518	0.488		0.498	0.520

Table reports regressions using Pooled OLS (Columns 1–5–9) Fixed[a]/Random[b] effect with time-dummies (2–6–10), and 2SLS without (3–7) and with time-dummies (4–8–12) estimations. Robust standard errors in parantheses

***$p<0.01$, **$p<0.05$, *$p<0$

Table 7 Effects of income inequality on channel variables in LLMC (innovation and saving channel)

Variables	lnpatent				Domestic saving			
	(1)	(2)[a]	(3)	(4)	(5)	(6)[b]	(7)	(8)
Gini	− 0.104***	0.062*	− 0.130***	− 0.127***	− 0.141	− 0.285	− 0.233	− 0.163
	[0.019]	[0.036]	[0.020]	[0.019]	[0.159]	[0.403]	[0.177]	[0.167]
lngdp	1.708***	0.581	1.696***	1.801***	6.920***	10.254***	6.761***	7.278***
	[0.144]	[0.522]	[0.162]	[0.164]	[0.802]	[1.782]	[0.852]	[0.875]
Constant	− 5.805***	− 3.642	− 4.656***	− 5.905***	− 36.389***	− 53.160***	− 31.362***	− 39.299***
	[1.495]	[4.882]	[1.719]	[1.690]	[9.767]	[17.318]	[10.802]	[11.015]
Observations	168	168	160	160	260	260	240	240
R-squared	0.428	0.249	0.407	0.423	0.165	0.185	0.154	0.190

Table reports regressions using Pooled OLS (Columns 1–5), Fixed[a]/Random[b] effect with time-dummies (2–6), and 2SLS without (3–7) and with time-dummies (4–8) estimations. Robust standard errors in parantheses

***$p < 0.01$, **$p < 0.05$, *$p < 0.1$

Table 8 Effects of income inequality on channel variables in LLMC (innovation and saving channel)

Variables	lnR&D				Fixed capital			
	(1)	(2)[b]	(3)	(4)	(5)	(6)[b]	(7)	(8)
Gini	− 0.088***	− 0.072***	− 0.088***	− 0.089***	− 0.051	0.013	− 0.031	− 0.040
	[0.014]	[0.020]	[0.014]	[0.015]	[0.084]	[0.121]	[0.090]	[0.088]
lngdp	1.314***	1.254***	1.317***	1.337***	3.697***	3.356***	3.642***	3.073***
	[0.097]	[0.161]	[0.098]	[0.095]	[0.560]	[0.955]	[0.596]	[0.599]
Constant	− 2.338**	− 2.606*	− 2.349**	− 2.619***	− 5.861	− 5.141	− 6.132	0.908
	[0.989]	[1.487]	[1.015]	[0.970]	[5.956]	[9.030]	[6.266]	[6.814]
Observations	91	91	90	90	258	258	238	238
R-squared	0.653		0.651	0.657	0.132		0.121	0.164

Table reports regressions using Pooled OLS (Columns 1–5), Fixed[a]/Random[b] effect with time-dummies (2–6), and 2SLS without (3–7) and with time-dummies (4–8) estimations. Robust standard errors in parantheses

***$p<0.01$, **$p<0.05$, *$p<0.1$

comprehensive model are analysed together to estimate the full effect of inequality and channel variables on economic growth, as done by Gründler and Scheuermeyer (2018). The idea that the only way to determine the impact of income inequality on growth is to exclude some controls is not ignored (Galor, 2009). Thus, the problem of "bad control" can be avoided.[24]

Table 15 presents the effects of political instability on growth in LLMC from columns (1) to columns (2a). The political instability negatively affects economic growth in reduced models (columns 1 and 2) for both indicators, so it can be said that the increase in instability causes a waste of resources in line with the theory. This evidence for LLMC is not surprising and supports results from many studies in the empirical literature (Aisen & Veiga, 2013; Alesina et al., 1996; Barro, 1991; Barro & Lee, 1994; Fosu, 1992). However, when these results are evaluated together with the findings from the channel estimates for LLMC (Table 3), it can be considered that the political instability channel is not valid, even if there is evidence for the second stage. It is seen that significant coefficients are positive in estimates for redistribution from columns (3) to columns (4a). There is no evidence of the validity of the channel in the first stage. However, as redistribution increases, economic growth improves in LLMC. These results, which lend support to Paul and Verdier (1996), who oppose the political economy channel, can be explained by the fact that redistribution can increase economic growth as it allows the poor to invest in human capital. These results are supported since human capital stimulates economic growth in these countries. Columns 5 and 6 show the effect of fertility on economic growth. It was previously stated that income inequality in LLMC increases the fertility rate. Therefore, according to the results here, the fact that the increasing fertility rate harms the economic growth supports both the theory and numerous studies in the literature, showing that the channel is valid.

[24] More control may not be always better. Bad controls are variables that are themselves outcome variables in the conceptual experiment at hand. That is, bad controls can also be dependent variables. The core of the bad control problem is a version of selection bias (for more detailed explanations see Angrist and Pischke, 2008: 47–48).

Table 9 Effects of income inequality on channel variables in UHC (political ınstability, political economy, and fertility channel)

Variables	Political stability				lnredistribution				lnfertility			
	(1)	(2)[a]	(3)	(4)	(5)	(6)[b]	(7)	(8)	(9)	(10)[b]	(11)	(12)
Gini	− 0.011**	− 0.009	− 0.017***	− 0.013***	0.074***	− 0.031	0.090***	0.073***	0.015***	0.020***	0.015***	0.016***
	[0.005]	[0.015]	[0.004]	[0.004]	[0.024]	[0.043]	[0.024]	[0.023]	[0.002]	[0.003]	[0.002]	[0.002]
lngdp	0.588***	0.372***	0.544***	0.626***	1.534***	1.682***	1.629***	1.266***	− 0.160***	− 0.027	− 0.151***	− 0.129***
	[0.046]	[0.127]	[0.042]	[0.042]	[0.330]	[0.616]	[0.325]	[0.316]	[0.024]	[0.037]	[0.025]	[0.026]
Constant	− 5.049***	− 2.828*	− 4.414***	− 5.501***	7.497*	8.660	6.029	11.084***	1.708***	0.406	1.595***	1.293***
	[0.570]	[1.461]	[0.519]	[0.520]	[3.960]	[7.154]	[3.906]	[3.846]	[0.282]	[0.398]	[0.288]	[0.303]
Observations	400	400	390	390	388	388	382	382	473	473	459	459
R-squared	0.336	0.088	0.347	0.383	0.074	0.054	0.081	0.115	0.402	0.392	0.397	0.422

Table reports regressions using Pooled OLS (Columns 1–5–9), Fixed[a]/Random[b] effect with time-dummies (2–6–10), and 2SLS without (3–7–11) and with time-dummies (4–8–12) estimations. Robust standard errors in parantheses

***$p < 0.01$, **$p < 0.05$, *$p < 0.1$

Table 10 Effects of income inequality on channel variables in UHC (political instability, political economy)

Variables	ruleoflaw				govcons			
	(1)	(2)[b]	(3)	(4)	(5)	(6)[b]	(7)	(8)
Gini	− 0.004	0.007	− 0.009*	− 0.005	0.061*	0.048	0.081**	0.078**
	[0.004]	[0.007]	[0.005]	[0.004]	[0.034]	[0.050]	[0.033]	[0.033]
lngdp	1.037***	0.704***	0.998***	1.097***	− 0.168	− 0.011	0.071	0.073
	[0.063]	[0.111]	[0.062]	[0.067]	[0.553]	[0.690]	[0.548]	[0.563]
Constant	− 9.578***	− 6.539***	− 9.013***	− 10.314***	2.199	0.691	− 0.962	− 1.507
	[0.745]	[1.273]	[0.739]	[0.808]	[6.611]	[8.481]	[6.520]	[6.773]
Observations	401	401	391	391	426	426	419	419
R-squared	0.595	0.6212	0.598	0.633	0.034	0.0764	0.029	0.076

Table reports regressions using Pooled OLS (Columns 1–5), Fixed[a]/Random[b] effect with time-dummies (2–6), and 2SLS without (3–7) and with time-dummies (4–8) estimations. Robust standard errors in parantheses

***$p<0.01$, **$p<0.05$, *$p<0.1$

Table 16 presents the effects of human capital (columns 1–2a) and financial markets (coulmns 3–4a) on growth in LLMC. Empirical evidence shows that human capital has positive and significant effects on economic growth (except column 2a). The positive contribution of human capital to economic growth in LLMC is in line with expectations.[25] Contrary to expectations, the effect of financial development on economic growth is insignificant.[26] However, when evaluated together with the channel results analysed in the first stage, it is not accurate to say that the imperfect financial markets in these countries are invalid. Because, as we previously stated, while income inequality negatively affects human capital, financial development positively affects human capital. Therefore, the finding that human capital supports economic growth, as illustrated here, indirectly supports the credit markets imperfections channel. For this reason, as the financial market develops in developing countries, if individuals use credit opportunities to invest in their human capital, economic growth will increase.

Table 17 contains the estimation results for the impact of innovation on growth from columns (1) to columns (2a), which is a positive channel for LLMC. The effects of patent and R&D on economic growth (except column 2a) is positive. These results are in line with growth theories (Romer, 1990), the technology, as a driver of economic growth, promotes economic growth in LLMC. In the first stage, we provided evidence for LLMC that income inequality negatively affected innovation, so the positive channel associated with innovation is not valid. The effects of variables on economic growth are positive in the investment channel in saving and physical capital (except column 3a). Since there is no evidence that income inequality increases savings in LLMC, it can be said that this positive

[25] Since the second-order autocorrelation problem can not be solved in the model, the result may not be reliable. Since the human capital channels act mainly through investments in education, a sensitivity analysis is provided with a different proxy (*Barro-Lee: Average years of tertiary schooling is compiled from WDI database*) and is presented in Table 24 in Appendix.

[26] The literature on financial development and economic growth is extensive. The results here may support the demand-pull hypothesis that economic growth can lead to financial development (Robinson, 1952), not the supply-side hypothesis that financial development causes economic growth (Schumpeter, 1912).

Table 11 Effects of income inequality on channel variables in UHC (credit market ımperfections and human capital channel)

Variables	lnlifexp				lnlifexp				lnlifexp			
	(1)	(2)[a]	(3)	(4)	(5)	(6)[a]	(7)	(8)	(9)	(10)[a]	(11)	(12)
Gini	− 0.002***	− 0.001	− 0.002***	− 0.002***								
	[0.001]	[0.001]	[0.001]	[0.001]								
lngdp	0.065***	0.027***	0.067***	0.058***	0.057***	0.031***	0.055***	0.052***	0.062***	0.030***	0.061***	0.057***
	[0.004]	[0.006]	[0.004]	[0.004]	[0.004]	[0.007]	[0.004]	[0.005]	[0.005]	[0.007]	[0.006]	[0.006]
credmark					0.001***	0.000	0.001***	0.001***				
					[0.000]	[0.000]	[0.000]	[0.000]				
credmark2									0.000***	0.000	0.000***	0.000***
									[0.000]	[0.000]	[0.000]	[0.000]
Constant	3.744***	4.050***	3.725***	3.842***	3.710***	3.976***	3.726***	3.782***	3.672***	3.980***	3.680***	3.741***
	[0.050]	[0.069]	[0.050]	[0.052]	[0.039]	[0.067]	[0.041]	[0.043]	[0.048]	[0.067]	[0.051]	[0.053]
Observations	473	473	459	459	461	461	428	428	458	458	424	424
R-squared	0.525	0.702	0.526	0.555	0.485	0.651	0.474	0.493	0.461	0.648	0.448	0.470

Table reports regressions using Pooled OLS (Columns 1–5–9), Fixed[a]/Random[b] effect with time-dummies (2–6–10), and 2SLS without (3–7–11) and with time-dummies (4–8–12) estimations. Robust standard errors in parantheses

***$p < 0.01$, **$p < 0.05$, *$p < 0.1$

Table 12 Effects of income inequality on channel variables in UHC (credit market imperfections and human capital channel)

Variables	Tertiary				Tertiary				Tertiary			
	(1)	(2)[a]	(3)	(4)	(5)	(6)[a]	(7)	(8)	(9)	(10)[a]	(11)	(12)
Gini	− 0.405***	0.388	− 0.367***	− 0.697***								
	[0.137]	[0.347]	[0.136]	[0.123]								
lngdp	16.966***	8.626*	16.949***	9.746***	18.102***	6.627	18.150***	15.140***	17.064***	6.725	16.998***	14.120***
	[2.237]	[4.963]	[2.230]	[2.162]	[2.417]	[5.061]	[2.662]	[2.678]	[2.439]	[5.060]	[2.689]	[2.702]
credmark					0.065**	0.076**	0.085**	0.047				
					[0.031]	[0.032]	[0.038]	[0.035]				
credmark2									0.086***	0.067*	0.103***	0.070**
									[0.030]	[0.034]	[0.036]	[0.034]
Constant	− 107.138***	− 68.636	− 108.063***	− 8.868	− 137.200***	− 39.905	− 138.682***	− 95.912***	− 128.774***	− 40.306	− 129.064***	− 87.723***
	[25.335]	[47.280]	[25.139]	[25.099]	[21.833]	[47.810]	[23.808]	[24.924]	[21.978]	[47.822]	[24.000]	[25.042]
Observations	402	402	395	395	378	378	349	349	375	375	345	345
R-squared	0.344	0.718	0.333	0.500	0.350	0.692	0.369	0.456	0.359	0.687	0.376	0.460

Table reports regressions using Pooled OLS (Columns 1–5–9), Fixed[a]/Random[b] effect with time-dummies (2–6–10), and 2SLS without (3–7–11) and with time-dummies (4–8–12) estimations. Robust standard errors in parantheses

***$p < 0.01$, **$p < 0.05$, *$p < 0.1$

Table 13 Effects of income inequality on channel variables in UHC (ınnovation and saving channel)

Variables	lnpatent				Domestic saving			
	(1)	(2)[b]	(3)	(4)	(5)	(6)[b]	(7)	(8)
Gini	− 0.066***	− 0.053*	− 0.075***	− 0.068***	0.136**	− 0.009	0.139**	0.162**
	[0.015]	[0.032]	[0.016]	[0.016]	[0.067]	[0.131]	[0.069]	[0.071]
lngdp	0.966***	0.796	0.885***	0.995***	8.458***	11.461***	8.499***	9.048***
	[0.239]	[0.542]	[0.239]	[0.255]	[1.215]	[2.059]	[1.247]	[1.327]
Constant	− 1.023	− 0.243	0.117	− 1.171	− 64.256***	− 86.029***	− 64.785***	− 72.446***
	[2.697]	[5.941]	[2.703]	[2.958]	[14.075]	[21.577]	[14.457]	[15.639]
Observations	396	396	392	392	462	462	450	450
R-squared	0.164	0.164	0.158	0.165	0.212	0.208	0.217	0.224

Table reports regressions using Pooled OLS (Columns 1–5), Fixed[a]/Random[b] effect with time-dummies (2–6), and 2SLS without (3–7) and with time-dummies (4–8) estimations. Robust standard errors in parantheses

***$p < 0.01$, **$p < 0.05$, *$p < 0.1$

Table 14 Effects of income inequality on channel variables in UHC (innovation and saving channel)

Variables	lnR&D				Fixed capital			
	(1)	(2)[b]	(3)	(4)	(5)	(6)[b]	(7)	(8)
Gini	− 0.067***	− 0.077***	− 0.073***	− 0.074***	− 0.117***	− 0.056	− 0.118***	− 0.121***
	[0.007]	[0.012]	[0.007]	[0.007]	[0.035]	[0.075]	[0.035]	[0.035]
lngdp	1.088***	0.652***	1.017***	0.984***	− 1.234**	0.872	− 1.244***	− 1.253**
	[0.115]	[0.164]	[0.111]	[0.113]	[0.481]	[0.907]	[0.475]	[0.496]
Constant	− 1.411	2.952	− 0.490	0.058	39.207***	16.902	39.345***	38.917***
	[1.340]	[1.820]	[1.295]	[1.340]	[5.735]	[10.764]	[5.670]	[5.999]
Observations	284	284	281	281	459	459	447	447
R-squared	0.701	0.6825	0.702	0.705	0.034	0.008	0.039	0.055

Table reports regressions using Pooled OLS (Columns 1–5), Fixed[a]/Random[b] effect with time-dummies (2–6), and 2SLS without (3–7) and with time-dummies (4–8) estimations. Robust standard errors in parantheses

***$p < 0.01$, **$p < 0.05$, *$p < 0.1$

Table 15 The impact of inequality and transmission channels on economic growth in LLMC (political instability, political economy and fertility channel)

Variables	(1) Model	(2) Model	(1a) Model	(2a) Model	(3) Model	(4) Model	(3a) Model	(4a) Model	(5) Model	(6) Model
L.lngdp	− 1.793	− 3.752**	0.340	− 0.801	− 0.909	0.098	− 1.534	0.486	− 6.962***	− 6.097**
	[1.404]	[1.553]	[2.667]	[2.293]	[0.844]	[1.343]	[1.704]	[1.930]	[1.437]	[2.617]
Gini	− 0.299***	− 0.521***	− 0.273**	− 0.414**	− 0.337**	− 0.161	− 0.343**	− 0.190**	0.114	0.214
	[0.103]	[0.143]	[0.131]	[0.179]	[0.139]	[0.118]	[0.173]	[0.093]	[0.171]	[0.156]
Political stability	1.675***		0.696							
	[0.554]		[1.465]							
ruleoflaw		5.021***		1.310						
		[1.236]		[2.029]						
lnredistribution					0.515*		− 0.147			
					[0.290]		[0.573]			
govcons						0.169**		0.128*		
						[0.081]		[0.077]		
lnfertility									− 9.762***	− 11.241***
									[2.483]	[3.124]
School			0.180**	0.122**			0.125*	0.163***		− 0.075
			[0.078]	[0.057]			[0.070]	[0.057]		[0.057]
Investment			− 0.365	− 0.536			− 0.548	− 0.462		− 0.007
			[0.475]	[0.492]			[0.381]	[0.324]		[0.432]
Trade			− 0.031	− 0.022			− 0.039	− 0.026*		− 0.034**
			[0.028]	[0.028]			[0.025]	[0.015]		[0.017]
Inflation			− 0.138**	− 0.099*			− 0.098**	− 0.159***		− 0.024
			[0.070]	[0.059]			[0.042]	[0.035]		[0.050]
Constant	29.610**	56.182***	− 1.349	19.737	11.186	7.372	26.573	− 5.329	64.716***	68.404***
	[13.080]	[15.474]	[24.327]	[23.620]	[8.151]	[13.067]	[19.675]	[22.466]	[12.263]	[23.190]
Observations	232	232	127	127	140	188	110	113	232	127
Countries	54	54	44	44	42	50	38	42	54	44

Table 15 (continued)

Variables	(1) Model	(2) Model	(1a) Model	(2a) Model	(3) Model	(4) Model	(3a) Model	(4a) Model	(5) Model	(6) Model
AR(1) *p*-val	0.0493	0.137	0.266	0.518	0.156	0.0284	0.201	0.689	0.0281	0.114
Hansen *p*-val	0.296	0.575	0.137	0.436	0.553	0.254	0.385	0.171	0.192	0.279
Instruments	44	44	28	35	40	44	32	39	40	42
AR(2) *p*-val	0.674	0.566	0.565	0.571	0.288	0.214	0.433	0.320	0.852	0.800

The dependent variable is the GDP growth rate

Robust standard errors are used and given in parentheses

***$p < 0.01$, **$p < 0.05$, *$p < 0.1$ represent significance levels. L. denotes the lag of the corresponding variable. The lagged dependent variable is assumed to be predetermined and the control variables are regarded as endogenous. All regressions include time dummies

Table 16 The impact of inequality and transmission channels on economic growth in LLMC (credit market ımperfections and human capital channel)

Variables	(1) Model	(2) Model	(1a) Model	(2a) Model	(3) Model	(4) Model	(3a) Model	(4a) Model
L.lngdp	− 3.104***	− 2.967***	− 6.494***	− 0.737	− 0.784	− 0.804	1.445	1.757
	[1.080]	[1.110]	[2.477]	[1.160]	[0.741]	[0.792]	[2.740]	[2.304]
Gini	− 0.085	− 0.028	0.074	− 0.212*	− 0.216*	− 0.225*	− 0.379*	− 0.385**
	[0.122]	[0.149]	[0.274]	[0.118]	[0.122]	[0.129]	[0.200]	[0.169]
lnlifexp	14.228***		30.631**					
	[4.427]		[14.074]					
Tertiary		0.107**		− 0.010				
		[0.042]		[0.048]				
credmark					0.027		− 0.050	
					[0.021]		[0.070]	
credmark2						0.020		− 0.061
						[0.019]		[0.063]
School							0.143**	0.144***
							[0.056]	[0.041]
Investment			− 0.615	− 0.378**			− 0.343	− 0.354
			[0.412]	[0.164]			[0.420]	[0.377]
Trade			0.096**	0.003			− 0.018	− 0.011
			[0.044]	[0.034]			[0.026]	[0.028]
Inflation			− 0.045	− 0.061*			− 0.142*	− 0.149**
			[0.054]	[0.033]			[0.075]	[0.068]
Constant	− 28.265	25.241***	− 79.423	20.522*	17.369**	17.563**	− 2.290	− 4.586
	[18.460]	[7.159]	[58.610]	[11.224]	[7.456]	[7.648]	[32.360]	[25.634]
Observations	232	196	130	111	226	226	126	126
Countries	54	53	44	41	53	53	43	43
AR(1) *p*-val	0.0301	0.0336	0.827	0.219	0.0440	0.0422	0.630	0.766
Hansen *p*-val	0.216	0.223	0.226	0.332	0.172	0.190	0.360	0.372
Instruments	44	44	36	38	44	44	39	39
AR(2) *p*-val	0.820	0.0330	0.716	0.972	0.697	0.682	0.535	0.580

The dependent variable is GDP growth rate

Robust standard errors are used and given in parentheses

***$p<0.01$, **$p<0.05$, *$p<0.1$ represent significance levels. L. denotes the lag of the corresponding variable. The lagged dependent variable is assumed to be predetermined and the control variables are regarded as endogenous. All regressions include time dummies. *school* is not included in the human capital channel

channel is also not valid, similar to the innovation channel. With the findings of this last channel, it can be stated that it is not easy to determine the effects of income inequality on economic growth, especially in developing countries. The impact of income inequality on economic growth in all estimates also support this result. The relationship is negative when direct effects are significant, but these results disappear in some estimates. Also, the lag of GDP per capita is included in the estimates in LLMC as a measure of the initial stage

Table 17 The impact of inequality and transmission channels on economic growth in LLMC (innovation and saving channel)

Variables	(1) Model	(2) Model	(1a) Model	(2a) Model	(3) Model	(4) Model	(3a) Model	(4a) Model
L.lngdp	− 5.818**	− 0.810	− 2.736	− 0.596	− 2.204	− 0.868	0.910	0.185
	[2.539]	[0.794]	[1.697]	[3.064]	[1.453]	[0.867]	[1.154]	[0.930]
Gini	− 0.096	0.166**	− 0.074	0.013	− 0.305**	− 0.229**	− 0.400**	− 0.271**
	[0.138]	[0.068]	[0.161]	[0.181]	[0.129]	[0.106]	[0.192]	[0.137]
lnpatent	0.897**		0.490***					
	[0.388]		[0.155]					
lnR&D		0.816**		− 0.290				
		[0.320]		[1.114]				
domestic-saving					0.082*		− 0.013	
					[0.048]		[0.061]	
fixedcapital						0.294***		0.142**
						[0.055]		[0.072]
prim			0.102*	− 0.002			0.096***	0.082***
			[0.053]	[0.059]			[0.026]	[0.026]
Investment			− 0.215	− 0.532				
			[0.310]	[0.347]				
Trade			0.029	0.046*			0.006	0.001
			[0.029]	[0.026]			[0.019]	[0.016]
Inflation			− 0.094*	0.056			− 0.119***	− 0.088
			[0.056]	[0.097]			[0.039]	[0.055]
Constant	49.163**	− 1.230	15.005	7.164	30.982**	12.875	2.502	2.155
	[21.483]	[6.195]	[20.470]	[17.545]	[13.925]	[8.842]	[9.498]	[8.034]
Observations	142	91	91	67	218	216	196	195
Countries	42	41	33	35	53	53	51	51
AR(1) *p*-val	0.0940	0.109	0.156	0.672	0.0320	0.0462	0.0844	0.0705
Hansen *p*-val	0.433	0.466	0.602	0.485	0.306	0.134	0.233	0.119
Instruments	40	37	30	32	44	44	41	42
AR(2) *p*-val	0.182	0.873	0.460	0.680	0.708	0.893	0.700	0.0974

The dependent variable is the GDP growth rate

Robust standard errors are used and given in parentheses

***$p < 0.01$, **$p < 0.05$, *$p < 0.1$ represent significance levels. L. denotes the lag of the corresponding variable. The lagged dependent variable is assumed to be predetermined and the control variables are regarded as endogenous. All regressions include time dummies. *investment* is not included in the savings channel

of development to consider the convergence hypothesis. Negative coefficients imply the existence of convergence between countries. In models established to examine the validity of positive and negative channels, GDP per capita is significantly negative only in some models. Therefore, it can be thought that the convergence tendency in this country group is not very clear.

Table 18 The impact of inequality and transmission channels on economic growth in UHC (political ınstability, political economy and fertility channel)

Variables	(1) Model	(2) Model	(1a) Model	(2a) Model	(3) Model	(4) Model	(3a) Model	(4a) Model	(5) Model	(5a) Model
L.lngdp	− 5.616***	− 7.035***	− 6.217***	− 7.934***	− 4.493***	− 3.667*	− 4.280***	− 3.568***	− 4.146***	− 4.791***
	[0.768]	[1.518]	[0.833]	[1.463]	[0.660]	[1.874]	[0.743]	[0.358]	[0.552]	[0.836]
Gini	− 0.207***	− 0.226***	− 0.234***	− 0.292**	− 0.241***	− 0.202***	− 0.281***	− 0.202***	− 0.193***	− 0.244***
	[0.075]	[0.070]	[0.080]	[0.120]	[0.054]	[0.051]	[0.077]	[0.073]	[0.062]	[0.083]
Political stability	2.030**		2.338***							
	[0.918]		[0.859]							
ruleoflaw		2.236**		3.003***						
		[1.008]		[1.011]						
lnredistribution					− 0.025		0.138			
					[0.186]		[0.274]			
govcons						0.578***		0.468***		
						[0.103]		[0.066]		
lnfertility									− 2.322*	− 2.399*
									[1.220]	[1.421]
School			0.136*	0.130*			0.071*	0.023		0.102
			[0.076]	[0.072]			[0.037]	[0.057]		[0.072]
Investment			− 0.007	0.034			0.556*	− 0.163		0.067
			[0.228]	[0.315]			[0.316]	[0.201]		[0.252]
Trade			0.005	0.011			0.005	0.007**		0.009
			[0.008]	[0.009]			[0.006]	[0.003]		[0.005]
Inflation			− 0.031**	− 0.023*			− 0.035***	− 0.042**		− 0.057***
			[0.015]	[0.013]			[0.013]	[0.018]		[0.019]
Constant	64.325***	79.040***	57.384***	75.022***	55.794***	35.202***	42.398***	40.374***	51.632***	48.871***
	[8.364]	[14.940]	[10.930]	[15.644]	[8.491]	[8.585]	[9.096]	[6.965]	[6.990]	[9.162]
Observations	393	394	301	301	333	284	292	284	394	301
Countries	88	88	72	72	77	78	69	66	88	72

Table 18 (continued)

Variables	(1) Model	(2) Model	(1a) Model	(2a) Model	(3) Model	(4) Model	(3a) Model	(4a) Model	(5) Model	(5a) Model
AR(1) *p*-val	0.00704	0.00166	0.0231	0.0190	0.00339	0.0180	0.0148	0.0333	0.00317	0.00622
Hansen *p*-val	0.0833	0.0709	0.128	0.100	0.114	0.109	0.172	0.210	0.160	0.218
Instruments	63	69	62	53	60	44	62	62	68	56
AR(2) *p*-val	0.272	0.233	0.128	0.100	0.101	0.187	0.211	0.268	0.123	0.290

The dependent variable is the GDP growth rate

Robust standard errors are used and given in parentheses

***$p < 0.01$, **$p < 0.05$, *$p < 0.1$ represent significance levels. L. denotes the lag of the corresponding variable. The lagged dependent variable is assumed to be predetermined and the control variables are regarded as endogenous. All regressions include time dummies

The most significant effect of control variables on economic growth in the estimates made for LLMC emerges for primary school enrolment, which represents the level of human capital. The significantly positive variable in most models shows how important human capital is for economic growth, especially in developing countries. Similarly, the inflation rate has a significant negative effect on growth, except for a few models. The fact that a high inflation level, as an indicator of macroeconomic instability, harms the economic growth in these countries supports Stockman (1981). Similar results are obtained in other studies such as Iradian (2005), Chletsos and Fatouros (2016), Babu et al. (2016), Braun et al. (2019), using inflation as a control variable in the inequality-growth empirical literature. The effects of the other two control variables on growth are not clear, and the data scarcity problem in low-income countries limits forecasts. However, control variables do not change in either the sign of the income inequality or the channel variables, so when the results are evaluated together with the reduced model, more correct inferences can be made by considering the bad control problem.

Table 18, from column (1) to column (2a), presents the effect of political instability on economic growth in UHC. For both indicators, it can be stated that political instability affects economic growth negatively, as in LLMC, so the increase in political unrest causes waste of resources. When interpreted together with the channel results in Table 9, the rise in income inequality in these countries increases political instability, and the increasing political instability harms economic growth. Thus, it provides evidence that the channel of political instability is valid. Second, it shows the results for the redistribution from column (3) to column (4a). While the effect of inequality on redistribution is positive, the effect of redistribution on economic growth is not clear. However, in models where the redistribution is significant (columns 4 and 4a), the coefficient is positive, similar to LLMC. Paul and Verdier (1996) stated that redistribution may not always be detrimental to growth. Finally, as expected, the effect of the fertility rate on economic growth is negative (columns 5 and 5a). Income inequality increases the fertility in UHC, and as the fertility rate increases, income inequality harms economic growth. The negative impact of inequality on human capital in these countries also supports the validity of the fertility channel expressed by De La Croix and Doepke (2003). In addition, Also, a remarkable result here is that the effect of fertility on economic growth is significantly lower than LLMC. Therefore, the increase in the fertility rate in low-income countries damages to economic growth more than in UHC. These results support studies suggesting that the strength of the relationship may be different in developed and developing countries (Berg et al., 2018; Castelló-Climent, 2010; Kremer & Chen, 2002). Lastly, it is observed that the coefficients are significantly negative in all models where the direct effects of the inequality and the channel effect are examined.

Table 19 shows the effects of human capital (from column 1 to 2a) and financial development (from column 3 to 4a) on the economic growth for UHC. Empirical evidence shows that proxies used as both human capital and financial development indicators do not significantly affect economic growth. Although the first stage of the credit markets imperfections channel is confirmed in these countries, unlike LLMC, the validity of the channel cannot be proven because these variables do not have a significant effect on economic growth. The fact that the channel is not valid in these countries may be due to the fact that human capital, contrary to theory, does not increase economic growth, such as the Ciegis and Dilius (2019) study. Also, the results here differ from LLMC shows that the validity of this channel varies according to the income level of the countries, and the evidence is more substantial in developing countries. Furthermore, it is confirmed in all models, as in LLMC, that the direct effect of income inequality on economic growth is negative.

Table 19 The impact of inequality and transmission channels on economic growth in UHC (the credit market ımperfections and human capital channel)

Varıables	(1) Model	(2) Model	(1a) Model	(2a) Model	(3) Model	(4) Model	(3a) Model	(4a) Model
L.lngdp	− 3.840***	− 4.618**	− 4.289***	− 4.485***	− 4.568***	− 4.731***	− 4.001***	− 3.980***
	[0.594]	[2.100]	[0.756]	[0.740]	[0.717]	[0.697]	[0.836]	[0.823]
Gini	− 0.265***	− 0.287***	− 0.218***	− 0.180*	− 0.243***	− 0.230***	− 0.243***	− 0.227***
	[0.049]	[0.105]	[0.077]	[0.094]	[0.053]	[0.052]	[0.070]	[0.068]
lnlifexp	− 4.774		− 4.887					
	[4.488]		[7.659]					
Tertiary		− 0.051		0.009				
		[0.031]		[0.023]				
credmark					0.000		− 0.013	
					[0.008]		[0.010]	
credmark2						0.006		− 0.005
						[0.007]		[0.009]
School							0.092	0.060
							[0.068]	[0.062]
Investment			0.075	0.085			0.066	0.178
			[0.243]	[0.225]			[0.285]	[0.283]
Trade			0.017**	0.011*			0.008*	0.009*
			[0.007]	[0.007]			[0.005]	[0.005]
inflation			− 0.049***	− 0.040**			− 0.039**	− 0.038**
			[0.017]	[0.018]			[0.017]	[0.015]
Constant	70.567***	50.069***	71.954**	51.820***	55.951***	56.979***	41.268***	42.595***
	[18.235]	[10.124]	[33.204]	[9.993]	[7.862]	[7.707]	[9.069]	[8.316]
Observations	394	261	317	274	362	360	277	275
Countries	88	82	75	70	86	86	72	72
AR(1) *p*-val	0.00392	0.0619	0.00381	0.0186	0.00326	0.00301	0.00315	0.00359
Hansen *p*-val	0.165	0.0877	0.116	0.153	0.131	0.125	0.125	0.124

Table 19 (continued)

Variables	(1) Model	(2) Model	(1a) Model	(2a) Model	(3) Model	(4) Model	(3a) Model	(4a) Model
Instruments	72	56	61	54	61	65	59	59
AR(2) *p*-val	0.0683	0.162	0.466	0.261	0.0934	0.0581	0.228	0.150

The dependent variable is the GDP growth rate

Robust standard errors are used and given in parentheses

***$p<0.01$, **$p<0.05$, *$p<0.1$ represent significance levels. L. denotes the lag of the corresponding variable. The lagged dependent variable is assumed to be predetermined and the control variables are regarded as endogenous. All regressions include time dummies. *school* is not included in the human capital channel

Table 20 The impact of inequality and transmission channels on economic growth in UHC (ınnovation and domestic saving channel)

	(1)	(2)	(1a)	(2a)	(3)	(4)	(3a)	(4a)
Variables	Model	Model	Model	Model	Model	Model	Model	Model
L.lngdp	− 3.902***	− 4.867***	− 4.519***	− 5.016***	− 4.938***	− 3.244***	− 5.837***	− 4.621***
	[0.487]	[0.659]	[0.697]	[0.777]	[0.756]	[0.562]	[0.651]	[0.808]
Gini	− 0.154***	0.005	− 0.201***	0.006	− 0.249***	− 0.212***	− 0.400***	− 0.406***
	[0.051]	[0.070]	[0.068]	[0.086]	[0.057]	[0.042]	[0.068]	[0.088]
lnpatent	0.240		0.382**					
	[0.177]		[0.194]					
lnR&D		1.318***		1.277**				
		[0.453]		[0.529]				
domesticsaving					0.149***		0.148***	
					[0.030]		[0.055]	
fixedcapital						0.182***		0.196***
						[0.055]		[0.072]
School			0.071	0.052			0.195***	0.236***
			[0.059]	[0.073]			[0.062]	[0.083]
Investment			0.156	0.305				
			[0.231]	[0.332]				
Trade			0.012**	0.009*			− 0.003	0.005
			[0.006]	[0.005]			[0.009]	[0.006]
inflation			− 0.040***	− 0.052*			− 0.035**	− 0.047**
			[0.013]	[0.027]			[0.017]	[0.020]
Constant	44.857***	41.267***	43.187***	36.366***	56.035***	37.965***	50.339***	32.910***
	[5.681]	[6.485]	[7.579]	[12.344]	[9.013]	[6.733]	[9.885]	[11.308]
Observations	333	279	271	228	385	383	338	336
Countries	79	69	68	59	85	84	79	78
AR(1) *p*-val	0.0148	0.00288	0.00164	0.00933	0.000178	0.0108	0.0377	0.140
Hansen *p*-val	0.214	0.240	0.106	0.240	0.107	0.114	0.120	0.139

Table 20 (continued)

	(1)	(2)	(1a)	(2a)	(3)	(4)	(3a)	(4a)
Instruments	75	64	59	46	75	68	56	63
AR(2) *p*-val	0.0253	0.0519	0.208	0.210	0.240	0.0625	0.143	0.0931

The dependent variable is the GDP growth rate

Robust standard errors are used and given in parentheses

***$p<0.01$, **$p<0.05$, *$p<0.1$ represent significance levels. L. denotes the lag of the corresponding variable. The lagged dependent variable is assumed to be predetermined and the control variables are regarded as endogenous. All regressions include time dummies. *investment* is not included in the saving channel

Table 20 presents the impact of innovation on growth, the positive channel for UHC from column (1) to column (2a). The impact of patents and R&D on economic growth (except column 1)[27] is positive. These results are in line with the theory, as in LLMC. The technology that is the driving force of growth promotes economic growth in UHC. Thus, income inequality in UHC promotes economic growth even if it does not positively affect innovation. Even so, the positive channel is not valid as first-stage conditions are not achieved. On the other hand, when the savings channels are controlled, the effects of variables on economic growth are positive (columns 3–4a). When the income inequality is evaluated together with its effect of increasing savings in UHC, it can be said that the positive channel is valid, but this is the indirect effect. The effect of income inequality on growth is significantly negative in most models (except columns 2 and 2a). As a result, income inequality's direct effects and indirect effects may be different, especially, as it is found here, the positive effect of savings and investments on economic growth proves that the relationship can differ through this channel.

In the models for the UHC, the lag of GDP per capita is also included as a measure of the initial stage of development to take into account the convergence hypothesis. Unlike LLMC, GDP per capita has negative significance in all models. Therefore, it implies that the convergence tendency is more evident for this country group. The result of the control variables in the growth estimates for UHC is slightly different from LLMC. Unlike LLMC, trade openness has a significant positive effect on economic growth in the former country group. Trade openness is more likely to stimulate technology and increase total factor productivity in developed countries than developing countries, so the positive impact on economic growth is not surprising. The estimates for the inflation rate are similar to those of LLMC, and the effect of the inflation rate on economic growth is significant and negative in all models. This finding supports many studies in the empirical literature, as stated in the section discussing the results for LLMC. Primary school enrolment used for human capital is positive in models where it is significant, but unlike LLMC, this finding is confirmed in fewer models. Table 20 shows that the effect of different human capital channel variables on economic growth is not significant for UHC; hence, when interpreted together with the results here, the importance of human capital in developing countries is revealed. Finally, investment/GDP does not produce significant results in any model.

5 Conclusions

This study aims to explain whether the positive and negative channels expressed in the theory on the effect of income inequality on economic growth play a significant role in different income group countries. Therefore, the purpose of this study is to emphasise that income inequality might have an indirect effect on economic growth depending on the income level of countries, rather than identifying the direct effect of income inequality on economic growth. For this purpose, a two-stage estimation method is followed in the study. The first stage estimates how income inequality affects the proxies of channel variables, and the effects of these variables on economic growth are examined in the second stage. The study results indicate that the relationship between income inequality and

[27] Since the second-order autocorrelation problem can not be solved in the model, the result may not be reliable.

economic growth is quite complex. Although there is evidence that greater inequality has detrimental effects on economic growth, it appears that this inference cannot be generalised when countries' income levels are taken into account. According to the estimation results, regardless of the income level of the countries, while inequality increases the fertility rate, it affects human capital negatively, both directly and through credit market imperfections. The negative impact of these channels on economic growth is more pronounced in relatively low-income countries. Although the increase in the fertility rate negatively affects economic growth in both country groups, this effect is more significant in LLMC. Families should focus on investing more in their human capital by having fewer children instead of having more children. Therefore, especially in low-income countries, governments can raise awareness of families with various education policies. Similarly, although there are no direct effects on growth, economic growth improves in low-income countries due to the positive impact of developed financial systems on human capital. Therefore, as stated by Demirguc-Kunt (2012), these countries primarily need stable macroeconomic policies and strong legal and information systems for the development of the financial system. Implementing regulations to remove restrictions on bank activities and improving infrastructure to ensure access to financial services by large masses are some of the important roles of the government. Thus, economic growth can be improved with increased human capital investments in developing countries.

Similarly, in the political economy channel estimates, the findings differ according to the countries' income levels. While inequality does not affect redistribution in low-income countries, it positively affects developed countries. The inadequacy of democratic institutions in low-income countries can be considered one of their main problems, so achieving redistribution in these countries can be relatively difficult. Therefore, structural reforms should be implemented in these countries for the institutions that will provide democratic rights and freedoms and at the same time control the effective use of these rights and freedoms. Also, in these countries with low financial development, it may not be possible to collect taxes effectively and direct them to economic activities. Another result of the study is obtained for the political instability channel. Although the effect of political instability on economic growth is negative for both country groups, its relation to income distribution is different. When the two group estimates are interpreted together, the results imply that the relationship may not be linear, as Blanco and Grier (2009) stated. Once the inequality exceeds a certain threshold, it can reduce political instability. Considering that low-income countries also have relatively high levels of inequality, it can be said that these countries may have exceeded this threshold. The policies used to overcome the adverse effects of income inequality on political stability are not independent of those proposed by other transmission channels. Governments should reduce corruption and regulate financial markets to ensure equal education and business creation opportunities. In addition, it should implement tax policies that encourage individuals to work, not reduce their motivation. Thus, economic growth can be achieved by preventing social unrest.

Finally, the estimation results for positive channels suggest that inequality encourages growth are far from theoretical expectations regardless of the income level of countries. It is observed that income inequality does not promote human capital investment and innovative activities. Income inequality does not increase total savings in LLMC, contrary to the classical view, while significant positive effects in UHC indicate the importance of income level. The fact that the increase in savings encourages economic growth in these countries also reflects that the positive channel may be valid. However, the effect of income inequality on economic growth is positive only for this channel. The fact that inequality

does not increase the saving rate in low-income countries as in high-income countries may be related to the relatively low number of wealthy people in these countries. Moreover, this wealthiest part of the population can retain its savings so that future generations can invest in human capital.

In summary, the relationship between income inequality and economic growth is not very clear and further investigation is needed to understand this relationship more clearly. Although the robustness of the results is controlled by using panel estimation techniques and different indicators, there are also some limitations of this study. Especially in low and lower-middle income countries, there may be missing observations regarding the selected variables. Data limitations prevent detailed analysis using different variables or methods, especially in these countries. Therefore, the sample could not be divided into more subgroups such as low-income, lower-middle-income, upper-middle-income and high-income. Similarly, the Gini coefficient, used as an indicator of income inequality, is preferred because it is the largest dataset available recently. Due to data limitation, this relationship could not be tested using a different proxy for income inequality. When the results are evaluated, it can be said that for policymakers, it is becoming more challenging to control income inequality and achieve sustainable growth. However, each of the findings can be an inspiration to future studies. Finally, future studies can be extended to consider the effects of the more recently discussed the COVID-19 pandemic (Chen et al., 2021) on income inequality.

Appendix

See Tables 21, 22, 23 and 24.

Table 21 Variables and definitions

Variable (symbol)	Definition	Source
GDP growth rate *(growthrate)*	GDP growth (annual %)	World Development Indicators Database (WDI)
Gini Coefficient *(Gini)*	Inequality coefficient from net income after taxes and transfers	Standardized World Income Inequality Database (SWIID; version 8.1)
GDP per capita, PPP (constant 2011 international $, in logs) (lngdp)	GDP per capita based on purchasing power parity (PPP)	World Development Indicators Database (WDI)
School enrollment, primary (% gross) *(school)*	Gross enrollment ratio is the ratio of total enrollment, regardless of age, to the population of the age group that officially corresponds to the level of education shown	World Development Indicators Database (WDI)
Net investment in nonfinancial assets (% of GDP) *(investment)*	Net investment in government nonfinancial assets includes fixed assets, inventories, valuables, and non produced assets	World Development Indicators Database (WDI)
Trade (% of GDP) *(trade)*	Trade is the sum of exports and imports of goods and services measured as a share of gross domestic product	World Development Indicators Database (WDI)
Inflation, consumer prices (annual %) (*inflation*)	Inflation as measured by the consumer price index reflects the annual percentage change in the cost to the average consumer of acquiring a basket of goods and services that may be fixed or changed at specified intervals, such as yearly	World Development Indicators Database (WDI)
Political instability channel (negative)		Worldwide Governance Indicators Database (WDI)
Political stability/instability (*politicalstability*)	Political Stability and Absence of Violence/Terrorism; ranging from approximately − 2.5 to 2.5	
Political economy channel (negative)		World Development Indicators Database (WDI)
Tax revenue (current LCU, in logs) (*lnredistribution*)	Tax revenue refers to compulsory transfers to the central government for public purposes	
Fertility channel (negative)		World Development Indicators Database (WDI)
Fertility rate (in logs) *(lnfertility)*	Births per woman	
Human capital channel (positive)		

Table 21 (continued)

Variable (symbol)	Definition	Source
Life expectancy at birth, total (years, in logs) (*lnlifexp*)	Life expectancy at birth indicates the number of years a newborn infant would live if prevailing patterns of mortality at the time of its birth were to stay the same throughout its life	World Development Indicators Database (WDI)
Credit market imperfections channel (negative)		World Development Indicators Database (WDI)
Domestic credit (% of GDP) (*credmark*)	Domestic credit to private sector by banks (% of GDP)	
Innovation channel (positive)		
Patent applications, residents (in logs) (*lnpatent*)	Patent applications are worldwide patent applications filed through the Patent Cooperation Treaty procedure or with a national patent office	World Development Indicators Database (WDI)
Saving channel (positive)		
Gross domestic savings (% of GDP) (domestic saving)	Gross domestic savings are calculated as GDP less final consumption expenditure (total consumption)	World Development Indicators Database (WDI)

Table 22 Country classification

Low and lower-middle income Countries		Upper-middle and high-income countries		
Bangladesh	Mongolia	Algeria	Germany	Norway
Bolivia	Morocco	Argentina	Greece	Panama
Burkina Faso	Mozambique	Armenia	Grenada	Paraguay
Burundi	Nepal	Australia	Guatemala	Peru
Cambodia	Nicaragua	Austria	Guyana	Poland
Cameroon	Niger	Azerbaijan	Hong Kong SAR, China	Portugal
Central African Republic	Nigeria	Bahamas, The	Hungary	Puerto Rico
Cote d'Ivoire	Pakistan	Barbados	Iceland	Qatar
Egypt, Arab Rep	Papua New Guinea	Belarus	Iran, Islamic Rep	Romania
El Salvador	Philippines	Belgium	Iraq	Russian Federation
Ethiopia	Rwanda	Belize	Ireland	Serbia
Gambia, The	Senegal	Bosnia and Herzegovina	Israel	Seychelles
Georgia	Sierra Leone	Botswana	Italy	Singapore
Ghana	Sri Lanka	Brazil	Jamaica	Slovak Republic
Guinea	Sudan	Bulgaria	Japan	Slovenia
Guinea-Bissau	Syrian Arab Republic	Canada	Jordan	South Africa
Honduras	Tajikistan	Chile	Kazakhstan	Spain
India	Tanzania	China	Korea, Rep	St. Lucia
Indonesia	Togo	Colombia	Latvia	Sweden
Kenya	Tunisia	Costa Rica	Lebanon	Switzerland
Kyrgyz Republic	Uganda	Croatia	Lithuania	Thailand
Lesotho	Ukraine	Cyprus	Luxembourg	Tonga
Lao PDR	Uzbekistan	Czech Republic	Malaysia	Trinidad and Tobago
Madagascar	Vietnam	Denmark	Malta	Turkey
Malawi	Yemen, Rep	Dominican Republic	Mauritius	Turkmenistan
Mali	Zambia	Ecuador	Mexico	United Kingdom
Mauritania	Zimbabwe	Fiji	Namibia	United States
Moldova		Finland	Netherlands	Uruguay
		France	New Zealand	Venezuela, RB
		Gabon		

Table 23 Additional channel variables

Variables	Definition (Worldwide Governance Indicators, WDI)	Source
Political instability channel (negative)		
Rule of law: estimate (*ruleoflaw*)	Rule of law captures perceptions of the extent to which agents have confidence in and abide by the rules of society; ranging from approximately − 2.5 to 2.5	Worldwide Governance Indicators Database (WDI)
Political economy channel (negative)		
General government final consumption expenditure (annual % growth) *(govcons)*	Annual percentage growth of general government final consumption expenditure based on constant local currency	World Development Indicators Database (WDI)
Human capital channel (positive)		
School enrollment, tertiary (% gross) *(tertiary)*	Gross enrollment ratio is the ratio of total enrollment, regardless of age, to the population of the age group that officially corresponds to the level of education shown	World Development Indicators Database (WDI)
Barro-Lee: Average years of tertiary schooling, age 15+, total (in logs) *(average years of tertiary)*	Average years of tertiary schooling, 15+, total is the average years of tertiary education completed among people over age 15	World Development Indicators Database (WDI)
Credit market imperfections channel (negative)		
Domestic credit to private sector (% of GDP) *(credmark2)*	Domestic credit to private sector by financial corporations	World Development Indicators Database (WDI)
Innovation channel (positive)		
Researchers in R&D (per million people) (in logs) *(lnR&D)*	The number of researchers engaged in Research &Development (R&D), expressed as per million	World Development Indicators Database (WDI)
Saving channel (positive)		
Gross fixed capital formation (% of GDP*) (fixedcapital)*	Gross fixed capital formation includes land improvements; plant, machinery, and equipment purchases; and the construction of roads, railways, and the like, including schools, offices, hospitals, private residential dwellings, and commercial and industrial buildings	World Development Indicators Database (WDI)

Table 24 (Sensitivity analysis) The impact of inequality and transmission channels on economic growth in LLMC (1–1a) and UHC (2–2a) (human capital channel)

Variables	(1) Model	(1a) Model	(2) Model	(2a) Model
L.lngdp	− 5.753***	− 4.646***	− 4.782***	− 4.685***
	[2.136]	[1.748]	[0.724]	[0.789]
Gini	− 0.192	− 0.060	− 0.269***	− 0.207*
	[0.138]	[0.142]	[0.063]	[0.111]
ln average years of tertiary	2.688***	2.353**	− 0.473	0.145
	[0.830]	[0.952]	[0.695]	[1.001]
investment		− 0.275		0.044
		[0.226]		[0.216]
trade		0.002		0.012**
		[0.025]		[0.006]
inflation		− 0.079***		− 0.033
		[0.017]		[0.023]
Constant	60.975***	48.695***	58.761***	54.771***
	[17.165]	[16.402]	[8.344]	[10.608]
Observations	177	100	294	240
Countries	46	38	78	67
AR(1) *p*-val	0.0598	0.176	0.00484	0.0414
Hansen *p*-val	0.340	0.291	0.0584	0.0559
Instruments	34	35	55	50
AR(2) *p*-val	0.904	0.522	0.0944	0.911

The dependent variable is GDP growth rate. Proxy for education: Barro-Lee: Average years of tertiary schooling, age 15 +, total

Robust standard errors are used and given in parentheses

***$p<0.01$, **$p<0.05$, *$p<0.1$ represent significance levels. L. denotes the lag of the corresponding variable. The lagged dependent variable is assumed to be predetermined and the control variables are regarded as endogenous. All regressions include time dummies. *school* is not included in the human capital channel

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Declarations

Conflict of interest The authors declare that they have no conflict of interest.

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