Tracking positive and negative effects of inequality on long-run growth

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Abstract Despite extensive research controversy remains on the effects of income inequality on economic growth. The literature proposes several transmission channels through which these effects may occur and even the existence of two different forms of inequality. However, empirical studies have not generally distinguished between these channels, nor have they considered the two forms of inequality and their separate effects on growth. In this paper, we review the theory and the evidence of the transmission channels through which inequality influences growth. We contribute to the literature by using a system of recursive equations, following a control function approach, to empirically assess the relevance of these channels and to differentiate between two forms of inequality. In a single model, we capture both a negative and a positive effect of inequality on long-run economic growth.

Keywords Inequality · Economic growth · Development · Control function approach

JEL Classification O1 · O4

1 Introduction

Much has been said about the effects of income inequality on economic growth. The ongoing debate focuses on the possible negative and positive effects of inequality on growth, characterised as working through different transmission channels and considering the complex nature of both phenomena. One question seems to be of
major relevance: whether inequality is due to available opportunities and particular socioeconomic and institutional contexts or to market dynamics and unequal outcomes and uneven success. The World Development Report (2006) differentiates between equality of opportunities and equality of outcomes. While unequal opportunities are detrimental for development, unequal outcomes generate necessary incentives for capital accumulation, innovation, and economic growth. “Inequality of opportunity is wasteful and inimical to sustainable development and poverty reduction,” but there is an “important role of income differences in providing incentives to invest in education and physical capital, to work hard, and to take risks” (WDR 2006). Similarly, Easterly (2007) refers to structural inequality, or inequality due to socio-institutional factors, and to market inequality, or inequality due to market forces. While the former relates to inefficient institutions, low human capital investment, and underdevelopment, the latter relates to uneven success in free markets. Marrero and Rodriguez (2013) follow the same argument, referring to income inequality as a composite measure of inequality of opportunity and inequality of effort, which may affect growth through opposite channels. In any case, structural inequality (or inequality of opportunity) is expected to have a negative effect on subsequent economic growth, while market inequality (or inequality of effort) is expected to have a positive effect.

The complex influence of inequality on the dynamics of economic growth attracted the attention of the scientific community after the world financial and economic crisis of 2008. Over the last decade, several authors have emphasised the role of inequalities in the growth process and the role of the dramatic rise of these inequalities in many countries as a cause of the crisis itself (Krugman 2008; Stiglitz 2009; Brescia 2010; Rajan 2010). According to these authors, high levels of inequality help to explain evident deficiencies in economic performance that accumulate over the long run.

In this paper, we conflate the literature on the effects of the transmission channels of inequality on growth and the idea of two different components of inequality. Using several variables that we relate to the different transmission channels, we decompose the variance of inequality using a system of recursive equations by means of the control function approach (CFA). Our aim and contribution is to provide empirical evidence of the opposing relationships between inequality and long-run economic growth while highlighting the relevance of the different transmission channels through which inequality operates. Our first main finding is that inequality indeed influences long-run economic growth both positively and negatively. Secondly, we argue that the negative influence accounts for roughly 80% of the total effect in the sample of 51 countries analysed. Interestingly, we have identified the proportion of mountainous land as a powerful geographical determinant of inequality levels across countries. To the best of our knowledge, this had not been considered in the literature on inequality. Finally, we find that the role that each channel plays may depend critically on the circumstances of each country, with the negative influence of inequality being significant in developing countries. These results are crucial for policy makers, as their challenge is to find out how, and not just if, inequality is affecting the process of economic growth.

The remainder of the paper is organised as follows. Section 2 briefly reviews the empirical evidence of the effects of income inequality on economic growth and the theory and evidence of the transmission channels through which these effects occur. Section 3 sets out our model and empirical strategy. Section 4 presents the database.
Section 5 displays the main results. Section 6 performs several robustness checks. Finally, Sect. 7 concludes.

2 The effects of inequality on economic growth: literature review

The traditional econometric approach to assessing the overall impact of inequality on growth has introduced a single measure of income distribution in an economic growth model.1 Along these lines, there is seemingly conflicting evidence in the literature. On the one hand, several authors support the idea of a negative effect of inequality on long-run growth (Alesina and Rodrik 1994; Persson and Tabellini 1994; Clarke 1995; Perotti 1994, 1996; Easterly 2007, among others). These results are based on cross-sectional analyses, an approach that, to the best of our knowledge, has never provided evidence of a positive effect. On the other hand, other authors have found a positive impact of inequality (Forbes 2000; Barro 2000; Chen 2003; Voitchovsky 2005, among others). However, this positive impact relies on panel data analysis and is either associated with short-term economic growth (Forbes 2000) or is dependent on countries’ income (Barro 2000), the initial income distribution (Chen 2003), the profile of inequality (Voitchovsky 2005), or the process of urbanisation (Castells-Quintana and Royuela 2014). The main argument for using panel techniques is that they allow for the control of omitted time-invariant factors and for addressing how a change in a country’s level of inequality will affect growth within that country (Forbes 2000). However, when using fixed effects, if the underlying causal factors in the growth process are persistent, the long-run cross-sectional effects will be subsumed into the fixed effects (Fallah and Partridge 2007). Indeed, as Forbes (2000) highlights, it is interesting to identify the time-invariant variables omitted in panel analysis and that could generate the negative bias in the inequality coefficient in cross-country growth regressions, and to evaluate the channels through which inequality, growth, and other variables are related. Removing time-invariant factors, which, as we will see, are precisely those to which the negative effect of inequality is related, limits the possibility of empirically assessing the role of the mechanisms behind the impact of inequality on growth.2

The literature provides theoretical justifications for both a potential beneficial and a potential adverse effect of inequality on the process of economic growth.3 In particular, while classical and neoclassical approaches have underlined a beneficial effect of inequality on growth, modern perspectives highlight potential adverse effects of

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1 The most used measures are the Gini coefficients and the Theil indices. Some authors have also worked with shares and ratios of the percentiles along the whole distribution of income. On one side, the percentage of the third quartile has been of particular interest to capture the weight of the middle class on the basis that having a strong middle class boosts economic development (Easterly 2001; Partridge 2005). On the other side, the use of different percentile ratios allows for a focus on differentiated effects depending on the specific distributional forms of income (Voitchovsky 2005).

2 In a similar vein, Davis and Hopkins (2011) argue that panel techniques are not very informative about the relationship between inequality and long-run economic growth.

3 Ferreira (1999) presents “a brief overview to theories of growth and distribution”, including a review of three mechanisms that give rise to an effect of distribution on growth: political economy channels, capital market imperfections, and social conflict channels. More recently, Ehrhart (2009) and Galor (2009) present a short, though exhaustive and comprehensive, overview of the theories and empirical evidence of
inequality (Galor 2009). However, some approaches predict a potential positive or negative effect, depending on the circumstances.4

Institutions are a main mechanism by which inequality influences long-run economic growth. Structural inequality reinforces bad institutions, low levels of human capital investment, and underdevelopment (Engermann and Sokoloff 1997; Sokoloff and Engermann 2000; Bourguignon and Verdier 2000; Acemoglu 2005; Easterly 2007). Factor endowments, according to this mechanism, are a central determinant of (structural) inequality and can be used to assess the causal inequality and development relationship (Easterly 2007).

It has also been argued that inequality affects growth due to increased sociopolitical instability and the risk of (violent) conflict, which translates into uncertainty of property rights and reduces investment (Alesina and Perotti 1996). Additionally, stability-threatening activities represent an unproductive waste of resources and reduce the overall productivity of an economy (Barro 2000).

Two other approaches highlight a potential negative effect of inequality. The domestic market size approach emphasises the relevance of the middle class and the risks of lower aggregate demand, derived from a higher proportion of population with lower purchasing power and the fact that lower income groups tend to have higher propensity to demand local products (Murphy et al. 1989; Todaro 1997).

The endogenous fertility approach highlights the link between higher inequality and higher fertility rates, which in turn reduce growth. In particular, this happens because as the number of children per family increases the average investment in education decreases (Barro 2000; Ehrhart 2009).

In contrast to the above-discussed mechanisms, according to classical and neoclassical theories an increase in inequality leads to higher aggregate savings, as there is greater propensity to save among the rich. Higher aggregate savings lead to higher levels of investment and growth (Kaldor 1956). This effect is less pronounced the more open the economy.

Finally, another two approaches have mixed predictions about the net effect of inequality. According to the political economy approach, either high levels of inequality lead to increased redistributive pressure, which in turn may lead to economic distortions and disincentives (Alesina and Rodrik 1994; Persson and Tabellini 1994), or to the rich to lobbying to prevent the implementation of efficient redistribution policies (e.g. public education) (Saint-Paul and Verdier 1996; Acemoglu and Robinson 1994).5 These lobbying activities represent a waste of resources related to rent seek-

Footnote 3 continued
the relationship between inequality and economic development. Neves and Silva (2013) provide a critical survey of the empirical literature to explain the sources of conflicting results.

4 Barro (2000) provides a good explanation of how some approaches can predict a negative or a positive effect on growth, depending on the circumstances. As Barro notes, even under the sociopolitical instability approach, lower inequality may not lead to higher growth: if economic resources are required for the poor to effectively threaten sociopolitical stability, then income-equalising transfers promote stability only to the extent that that they do not encourage the poor to involve themselves in disruptive actions rather than work.

5 Saint-Paul and Verdier (1996) challenge the conventional political economy approach and argue that, in fact, unequal societies redistribute less and that this in turn is detrimental to growth. More recently, Woo (2011) has suggested a fiscal volatility channel for inequality to negatively influence growth.
ing and corruption and precisely characterise what several authors have highlighted as the fundamental adverse role of inequality in the current global crisis (Stiglitz 2009; Krugman 2012).

According to the credit market imperfections approach, credit constraints reduce the capacity of many individuals to invest. This not only increases macroeconomic volatility (Aghion et al. 1999), but it also reduces average investment—especially in human capital (Galor and Zeira 1993). Both aspects reduce long-run growth. However, with high set-up costs or investment indivisibilities, higher levels of inequality can allow some individuals to reach the necessary wealth to invest, leading to greater aggregate investment (Aghion et al. 1999).

The above transmission channels have all been extensively described in the related literature. Nevertheless, given data constraints and the difficult task of separately measuring each channel, few studies have attempted to empirically and independently assess each transmission channel. Indeed, despite extensive evidence on the overall impact of inequality on growth, a comprehensive empirical analysis and joint examination of several transmission channels is still missing from the literature. Those studies that have tried to analyse the dynamics of the transmission channels have usually focused on a single theoretical approach. The aim of these studies is to identify the relationship between inequality and a given variable as a proxy for the channel under analysis and to then see the effect of this variable on growth (or variables that we know are relevant for growth, like investment). “Appendix 1” lists the main papers providing empirical evidence for the different channels, the variables they use as proxies for the channel, and the effect they find either on growth or investment.

Seminal works are Perotti (1994, 1996), Persson and Tabellini (1994), and Alesina and Perotti (1996). While the latter provides evidence of the negative role of sociopolitical instability (using several variables for social unrest), Perotti (1994) tests two other approaches, namely the capital market imperfections approach, using loan-to-value payment for mortgages as a variable, and the political economy approach, using the share of government transfers in GDP as a proxy for redistribution. However, none of these papers considers the different channels in a single model. Following Alesina and Perotti (1996), later studies have focused on liberties, institutions, and the quality of property rights as the main transmission channel within the sociopolitical instability approach (Svensson 1998; Keefer and Knack 2002). Concerning the role of the domestic market, on the one hand (Falkinger and Zweimüller 1997) consider product diversity, while on the other hand (Keefer and Knack 2002) consider variables related to population, aggregate GDP, and openness. In both studies, results do not conclusively support the domestic market approach. However, Davis (2008) revalidates the relevance of scale effects, particularly in developing countries, and several other authors provide evidence of the relevance of the size of the middle class (Easterly 2001; Partridge 2005). Regarding the endogenous fertility approach, several studies provide evidence on the positive link between inequality and fertility rates (Perotti 1996; Koo and Dennis 1999; Kremer and Chen 2002) and a negative effect of fertility rates on growth (Barro 2000). Even controlling for fertility, Barro finds a negative effect of inequality in poor countries and a positive effect in rich countries.
approach, considering welfare transfers in a small sample of 13 OECD countries for which data were available, to find non-significant results about the hypotheses that inequality increases redistribution and that redistribution reduces growth. In fact, as noted before, other authors support a different hypothesis on the relationship between inequalities and redistributive policies. Easterly (2007) tests the institutional mechanism. Using geographical variables, in particular the exogenous suitability of land for wheat versus sugarcane, as proxy for factor endowment differentials across countries and the proportion of population in tropical areas, he confirms a negative effect of inequality on long-run development.

Finally, although there is evidence of a growth-enhancing effect, related to incentives for capital accumulation (Galor 2009) and innovation, incentives to work hard and take risks (World Bank 2006), and agglomeration economies (Fallah and Partridge 2007; Castells-Quintana and Royuela 2014), we have not found in any paper an explicit assessment of the transmission channels related to this positive effect.

Unifying the classical and modern perspectives, Galor and Moav (2004) suggest a changing relationship between inequality and growth depending on the process of development. Inequality is growth enhancing in early stages of development, adverse later in that process, and irrelevant in developed economies.7 Papers such as Barro (2000), Chen (2003), Voitchovsky (2005), and Castells-Quintana and Royuela (2014) provide evidence that inequality can have both negative and positive effects on economic growth, depending on the circumstances of the country. Nevertheless, in these papers the opposing effects are not empirically related to any of the channels through which inequality might affect growth, and there is insufficient evidence of both effects happening simultaneously.8

Summing up, although theoretically the relationship between inequality and growth works through different channels, with inequality potentially having at the same time a positive and a negative effect on economic growth, empirical evidence in this sense remains scarce. To the best of our knowledge, only Marrero and Rodriguez (2013), using US states panel data, find opposing effects for two components of inequality. However, they do not consider empirically the different channels through which inequality affects growth. We contribute to the literature by providing further evidence of these different components of inequality having opposing effects on a single model of long-run economic growth, considering multiple transmission channels and using cross-country, rather than state-level, data.

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7 In particular, in early stages of development, when physical capital accumulation is the prime engine for growth, inequality can enhance the process of development by channelling resources towards individuals whose marginal propensity to save is higher, allowing for higher levels of investment. In later stages of development, when human capital accumulation becomes the prime engine for growth, and given credit constraints, increased inequality leads to a lower spread of education among individuals, handicapping the process of development due to diminishing returns of human capital. Finally, as capital markets develop and credit constraints are relaxed, inequality becomes irrelevant.

8 Voitchovsky (2005) does find parallel positive and negative effects in a single model by using different parts of the income distribution. Inequality at the top end of the distribution is positively associated with growth, while inequality lower on the distribution is negatively related to subsequent growth. However, the paper acknowledges that its empirical analysis “is not very informative regarding the different channels through which inequality might affect income.”
3 Empirical approach

Because the focus is on the long-run effects of income inequality, we follow the literature on the determinants of cross-country differences on long-run economic growth. This literature tends to rely on OLS “Barro regressions” using a cross-sectional data on growth rates and initial values of the explanatory variables. Results are interpreted as measuring the long-run effects of those variables. In the empirical literature on the effects of inequality on economic growth, most cross-sectional studies find a negative coefficient (De Dominicis et al. 2008). However, Binder and Georgiadis (2011) list up to four basic problems associated with these regressions: all cross-country heterogeneities are assumed to be fully captured by the control variables; they are subject to endogeneity bias; there is no clear distinction between short- and long-run dynamics; and nonlinearities are not considered. All of these arguments have been articulated in the literature. The classification of countries and the introduction of interactions is a first strategy to deal with problems of heterogeneities and nonlinearities (Brock and Durlauf 2001; Durlauf et al. 2005). Another strategy is the use of panel data sets and techniques. When panel data sets are considered, the negative effect of inequality disappears and even becomes positive when fixed effects or GMM methods are used. Nonetheless, Partridge (2005) criticises the use of fixed effects methods for the analysis of the relationship between inequality and growth, as inequality is a highly persistent variable over time. Similarly, Barro (2000) maintains that fixed effects estimates exacerbate the bias due to measurement error. In this paper, we take the above into account, integrating into a cross-sectional framework both the positive and negative effects of inequality on economic growth focusing on long-run dynamics (as we average growth over 37 years). In particular, we follow Sala-i-Martin et al.’s (2004) analysis on economic growth using cross-sectional data.

We set a neoclassical econometric model of economic growth (Eq. 1) where growth is our dependent variable, reflecting the cumulative annual average GDP growth rate (in per capita terms), $I_{i0}$ is income inequality, and $X_i$ is a list of control variables, including the initial income, $y_{i0}$:

$$\text{growth}_i = c + X_i \Gamma + \beta I_{i0} + u_{1i}$$

OLS regressions are likely to underestimate the negative effect of inequality, possibly because of a co-occurring positive effect (Easterly 2007). In fact, reduced-form estimations for the effect of inequality on growth are likely to pick up different effects at the same time (Bourguignon 1996) related to the above-discussed transmission channels. A common strategy in the empirical literature is the use of intermediate variables as proxies for the channel under analysis. In parallel, taking into account endogeneity concerns on the effect of inequality on growth and the existence of two differentiated components of inequality, a second approach has been employed to isolate one of those components using specific instruments for inequality. Therefore,

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9 Long-run growth is a function of more than just initial conditions. Exogenous shocks will surely play a role in economic growth. But, as long as these shocks are truly exogenous, this type of econometric approach should be consistent. We acknowledge an anonymous referee for this comment.
both strategies—intermediate variables and instruments—rely on the use of alternative information to capture a particular relationship between inequality and long-run growth. In the first strategy, each channel is considered independently and no attempt is made to examine all of them in a single growth model. In fact, as we have seen, few papers consider empirically more than a single channel. Similarly, in the second strategy, while the negative effect of inequality has been identified with exogenous instruments (Easterly 2007), that has not been the case with the positive effect. Consequently, the use of alternative information has only been capable of identifying the negative impact of inequality on economic growth. This is reasonable, as the positive association refers to market dynamics intrinsic to the growth process itself, which makes it difficult (if not impossible) to find exogenous variables for the identification process.

Building on both strategies and assuming the problem of identification for the positive impact of inequality on economic growth, our goal is to disentangle, in a single model, the two possible relationships between inequality and long-run economic growth. In order to do that, we considered several variables that the literature has proposed are associated with the different transmission channels. We intend to capture the negative effect of inequality on growth. Once the negative impact of inequality on economic growth was identified, we isolated the positive association between the two variables.

Hence, following the literature, we consider inequality in Eq. (1) as endogenous, i.e. correlated with the disturbance term, \( u_{1i} \). One solution for dealing with endogeneity is to apply the so-called control function approach. Like instrumental variables (2SLS), this procedure uses instruments to break the correlation between endogenous explanatory variables and unobservable variables affecting the response. In linear models with one endogenous regressor, CFA yields identical results to those obtained with 2SLS. CFA yields consistent parameter estimates if instruments are valid (see Imbens and Wooldridge 2009; Wooldridge 2010).

Following, Wooldridge’s (2010) formalisation of the CFA, we consider a list of instruments for inequality, \( Z \), that are exogenous in model (1):

\[
E(Z'u_1) = 0 \tag{2}
\]

where \( X \) in model (1) is a strict subset of \( Z \). As in 2SLS, we consider the reduced form for inequality as:

\[
I = Z\Phi + v_2 \tag{3}
\]

\[
E(Z'v_2) = 0 \tag{4}
\]

Since \( u_1 \) is uncorrelated with \( Z \), it turns out that \( I \) is endogenous in (1) if and only if \( E(u_1v_2) \neq 0 \). The linear projection of \( u_1 \) onto \( v_2 \) in error form is:

\[
u_1 = \rho_1v_2 + e_1 \tag{5}\]
Since both \( u_1 \) and \( v_2 \) are orthogonal to \( Z \), then \( E( Z'e_1) = 0 \) and \( I \) is exogenous if and only if \( \rho_1 = 0 \). Plugging Eq. (5) into Eq. (1) transforms our growth equation into:

\[
growth = c + X \Gamma + \beta I_0 + \rho_1 v_2 + e_1
\]

(6)

where, by construction, \( e_1 \) is uncorrelated with \( X \), \( I \), and \( v_2 \). As we cannot observe \( v_2 \), the solution under the CFA is to estimate \( \hat{v}_2 \)—the residual from an OLS regression of Eq. (3). Replacing \( v_2 \) with \( \hat{v}_2 \) in (6), and estimating again by OLS, yields consistent estimates for \( \Gamma \), \( \beta \) and \( \rho_1 \). The parameter \( \rho_1 \) in (6) captures the bias that would affect \( \beta \) if we did not control for \( \hat{v}_2 \), allowing us to see the sign and magnitude of that bias.

Now, if we assume that our instrument set—\( Z \) in Eq. (2)—is only able to capture a negative form of inequality, the remaining unexplained variance of inequality, including its positive form, is captured by \( v_2 \). In other words, as far as we can capture the negative component of inequality by \( Z \), the remaining variance of inequality will most likely be an approximation of its positive component. Consequently, once the original values of \( I \) and the estimations of \( v_2 \), namely \( \hat{v}_2 \), are included, the parameter \( \rho_1 \) in an OLS estimation of Eq. (6) can help us to identify the (potential) positive association between inequality and long-run economic growth.

Alternatively, we can consider inequality as \( I = Z \Pi_1 + W \Pi_2 + \omega_2 \), where only the negative component can be captured with instrumental variables \( Z \) while the positive component can only be captured through covariates, \( W \), that are correlated with \( u_1 \). Hence, the residual of the linear projection of \( I \) on \( Z \), \( v_2 \) would equal \( W \Pi_2 + \omega_2 \), and the linear projection of \( u_1 \) onto \( v_2 \) in error form would be \( u_1 = \rho_1 (W \Pi_2 + \omega_2) + e_1 \). Consequently, the remaining estimated component \( \hat{v}_2 \) in our growth equation would include \( W \Pi_2 \) plus any unexplained variance, \( \omega_2 \). In this case, \( \beta \) would consistently estimate the negative influence of inequality on economic growth. It can happen, though, that some mechanisms of inequality are at the same time related to their positive and to their negative associations with growth, as suggested in the literature, and consequently \( E( Z'W) \neq 0 \). In such cases, the estimation of \( \Phi \) in (3) would not equal \( \Pi_1 \), being the bias linked to \( E( Z'W) \). As a consequence, our approach would be affected and we could expect a bias towards zero of both \( \beta \) and \( \rho_1 \) in (6). Subsequently, we understand that the misspecification in (3) resulting from not considering instruments of the positive channel of inequality, \( W \), that could be correlated with the instruments of negative channels, \( Z \), would be driving our estimates in (6) to be non-significant. Hence, if we find significant results for both \( \beta \) and \( \rho_1 \), we will be able to say that they are downward-bounded.10

A final aspect to take into account is a potential drawback of the strategy in practical terms. Imagine that the selected list of instruments is capable of reproducing only a small proportion of the variance of inequality in Eq. (3). The result will be that the residual of equation, \( \hat{v}_2 \) will be highly correlated with inequality. Consequently, the inclusion of \( \hat{v}_2 \) in the growth equation, together with inequality, is likely to introduce multicollinearity in the regression. Although the estimates of the second stage will

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10 The use of residual variation in recursive estimation to disentangle opposing dynamics has already been used in the macroeconomics literature. As far as we know, however, it is the first time it has been used for inequality.
remain consistent, the severity of such a problem in terms of efficiency is a practical issue that will depend on every situation (as we address below). In any case, if one finds significant results, despite multicollinearity, it will be a strong signal of significance.\textsuperscript{11}

4 Data

We use the following control variables in our growth model: the initial level of per capita GDP in logs (log(pcgdp)); life expectancy at birth (life exp); the primary enrolment rate (primary enrol); the number of years the economy has been open between 1950 and 1994 (yrs open); the fraction of primary exports in total exports (primary exports); and the fraction of GDP in mining (mining), this last variable in order to capture natural endowments.\textsuperscript{12} The data, aside that for income inequality, come from Sala-i-Martin et al. (2004), the Penn World Tables (PWT), and the World Bank Development Indicators database. Income inequality is measured by the Gini coefficient, and we rely on Gruen and Klasen (2008).\textsuperscript{13} A table with the variables used and their sources is annexed in “Appendix 2”. We use data as close to 1970 as possible to explain average growth rates between 1970 and 2007 in a sample of 51 countries (a list of which is annexed in “Appendix 3”).\textsuperscript{14}

Table 1 presents descriptive statistics for the variables used in the growth equation, while Table 2 presents correlations among the variables. Growth is positively correlated with initial values of life exp, primary enrol, and yrs open. By contrast, growth is negatively correlated with initial values of log(pcgdp), primary exports, mining, and inequality. In fact, the greatest negative correlation (−0.371) is of growth with inequality. Regarding inequality and the controls, inequality is positively correlated with mining and primary exports and negatively correlated with all the other variables.

Additionally, we look for variables related to inequality that we can use to identify the transmission channels that give rise to an effect on long-run economic growth. As our goal is to use these variables to disentangle different dynamics in the relationship between initial inequality and subsequent growth, we consider data as close to 1970 as possible (as with controls in the growth equation). To capture the institutional mechanism, and following Easterly (2007), we consider geographical variables: the

\textsuperscript{11} We acknowledge an anonymous referee for raising this argument.

\textsuperscript{12} Out of 67 possible explanatory variables, Sala-i-Martin et al. (2004) found 18 that were significantly related to long-run growth during 1960–1996. Results suggest that main determinants for growth include initial levels of per capita GDP—the neoclassical idea of conditional convergence—and variables for natural resource endowments, physical and human capital accumulation, macroeconomic stability. Productive specialisation also seems to negatively affect growth, with a negative and significant effect found for the fraction of primary exports in total exports.

\textsuperscript{13} These coefficients are adjusted from the WIID database for different possible objects of measure and related to households or families and for the entire population, allowing us to address concerns about international comparability of inequality data. We have previously used these adjusted coefficients, as have other authors (e.g. Atkinson and Brandolini 2010). We rely on income, rather than land or wealth inequality, because income distribution possibly reflects two sources of inequality, namely inequality of opportunities and inequality of returns, which influence economic growth in opposite directions (Neves and Silva 2013).

\textsuperscript{14} The selected countries are those for which reliable data for all variables used here have been found. The sample includes major countries from all world regions.
Table 1  Descriptive statistics: variables in growth equation

|                  | Mean | SD  | Minimum | Maximum |
|------------------|------|-----|---------|---------|
| Growth           | 2.222| 1.515| −0.903  | 7.620   |
| Inequality       | 44.108| 9.377| 26.400  | 62.400  |
| log(pcgdp)       | 8.381| 1.010| 6.332   | 9.891   |
| Life exp         | 60.206| 10.586| 40.365  | 74.649  |
| Primary enrol    | 0.799| 0.237| 0.100   | 1.000   |
| Yrs open         | 0.447| 0.357| 0.000   | 1.000   |
| Primary exports  | 0.104| 0.097| 0.009   | 0.555   |
| Mining           | 0.040| 0.047| 0.000   | 0.208   |

No. of observations included: 51

exogenous suitability of land for wheat versus sugarcane as proxy for factor endowment differentials across countries and the proportion of population in tropical areas. We add the proportion of mountainous lands, as this geographical feature seems to have significant explanatory power for inequality, as we discuss below. Using geographical variables has the additional econometric advantage of allowing us to capture exogenous variation that helps us identify the effect of (structural) inequality. For sociopolitical instability (SPI), we consider variables related to social unrest and violence, following (Alesina and Perotti 1996). We use a parsimonious strategy, and among several variables positively correlated with inequality and negatively with growth, we select three variables that yield the highest R-square in a regression on inequality. For domestic market size and the role of the middle class (DM), we use aggregate GDP and the share of the third quintile in the income distribution. Using openness as one of the controls in the growth equation captures the role of foreign markets in the total market size. For the role of fertility decisions (FER), we consider population growth rates, infant mortality rates, and the proportion of family farms, which are all highly correlated with fertility rates and inequality levels. For redistributive policies, as one main focus of the Political Economy (PE) approach, we use average government spending and average expenditure on education, both as share of GDP. Regarding the credit market imperfections (CMI) approach, we consider access to sound money and patents, as a proxy for innovation. Table 3 presents descriptive statistics for all the variables considered and their correlation with inequality.

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15 As in Easterly (2007), the considered geographical determinants appear to be highly correlated with institutional variables. However, introducing institutional variables directly is challenging given that institutions are expected to be endogenous to economic performance. More recently, Galor and Özak (2015) use soil types to build a Caloric Suitability Index that they use to predict long-run economic development. We also consider several other variables for social unrest and violence as robustness checks in the estimations described in Sect. 4. Aside from social unrest and violence, other authors consider variables related to liberties, rights, and institutions. However, data for these variables are only available from the 1980s and economic performance is expected to affect them. We therefore restrict our analysis to the selected variables, which are some of the most commonly used in the literature and help to reduce endogeneity.

16 When we regress inequality on our controls, fertility rates do not add significant explanatory power, and their use as a valid instrument for inequality is rejected by the instrument tests implemented.
|                  | Growth | Inequality | Log(pcgdp) | Life exp | Primary enrol | Years open | Primary exports |
|------------------|--------|------------|------------|----------|---------------|------------|----------------|
| Growth           | 1.000  |            |            |          |               |            |                |
| Inequality       | -0.371 | 1.000      |            |          |               |            |                |
| Log(pcgdp)       | -0.079 | -0.301     | 1.000      |          |               |            |                |
| Life exp         | 0.302  | -0.498     | 0.854      | 1.000    |               |            |                |
| Primary enrol    | 0.375  | -0.321     | 0.703      | 0.837    | 1.000         |            |                |
| Yrs open         | 0.264  | -0.337     | 0.696      | 0.707    | 0.629         | 1.000      |                |
| Primary exports  | -0.345 | 0.239      | -0.177     | -0.264   | -0.203        | -0.120     | 1.000          |
| mining           | -0.199 | 0.259      | -0.253     | -0.402   | -0.254        | -0.228     | 0.509          |

No. of observations included: 51
Table 3  Descriptive statistics: variables for the inequality equation

| Considered variables                          | Mean   | SD    | Min   | Max    | Corr. with inequality |
|-----------------------------------------------|--------|-------|-------|--------|------------------------|
| Geography-institutions                        |        |       |       |        |                        |
| Wheat/sugar                                   | 0.079  | 0.182 | −0.393| 0.442  | −0.625                 |
| Tropical pop                                  | 0.197  | 0.315 | 0.000 | 1.000  | 0.339                  |
| Mountains                                     | 17.587 | 18.651| 0.000 | 73.700 | 0.412                  |
| Socio political instability (SPI)             |        |       |       |        |                        |
| Assassinations                                | 0.005  | 0.021 | 0.000 | 0.138  | 0.254                  |
| Death                                         | 12.102 | 4.365 | 5.678 | 23.500 | 0.173                  |
| War dummy                                     | 0.392  | 0.493 | 0.000 | 1.000  | 0.265                  |
| Domestic market                               |        |       |       |        |                        |
| Q3                                            | 13.979 | 3.187 | 7.700 | 18.720 | −0.792                 |
| Log(GDP1970)                                  | 10.470 | 0.780 | 8.740 | 12.573 | −0.412                 |
| Fertility                                     |        |       |       |        |                        |
| Pop growth                                    | 1.969  | 1.068 | −0.584| 4.458  | 0.512                  |
| Mortality                                     | 76.691 | 51.507| 11.200| 193.000| 0.460                  |
| Political economy                             |        |       |       |        |                        |
| kg702007                                      | 8.593  | 4.264 | 2.221 | 20.918 | 0.020                  |
| Exp edu                                       | 15.070 | 4.403 | 6.187 | 24.478 | 0.358                  |
| Credit market imperfections (CMI)             |        |       |       |        |                        |
| Access to money                               | 7.017  | 1.608 | 2.518 | 9.647  | −0.029                 |
| Innovation                                    | 74.704 | 124.992| 0.000 | 539.986| −0.492                 |
| Family farms                                  | 46.843 | 25.808| 2.000 | 94.000 | −0.435                 |

5 Estimation and results

We implement our empirical strategy by recursive estimation. Hence, in a first equation we relate income inequality to different variables according to transmission channel (as in Eq. 3). From this first estimation, we generate an estimated residual term, $\hat{v}_2$, for each set of variables, capturing the unexplained variance in inequality. The aim here is simply to decompose the variance in inequality. In a second equation, and again for each set of variables, we introduce inequality and the estimated residual from the first equation along with control variables in order to estimate our model of long-run economic growth. By introducing both terms, i.e. inequality and the estimated residual, we are able to assess two differentiated effects on economic growth. By using different sets of variables, we can analyse which factors need to be controlled for our residual to capture a long-run growth-enhancing component of inequality. This is something that is not done in panel data analysis, which suggests a positive effect of inequality on growth.

Table 4 presents the results from estimating Eq. (3), our inequality equation, including controls from the growth equation. We report standardised (beta) coefficients and Shea’s Partial R-square to measure the relevance of the considered variables excluded.
Table 4 Results for the inequality equation

| Channel                | 1 Geography-institutions | 2 SPI | 3 Domestic market | 4 Fertility | 5 Political economy | 6 CMI | 7 All “negative” channels |
|------------------------|--------------------------|-------|-------------------|-------------|---------------------|-------|--------------------------|
| Wheat/sugar            | −0.481 ***               |       |                   |             |                     |       | −0.124                   |
| Tropical pop           | 0.123                    |       |                   |             |                     |       | −0.101                   |
| Mountains              | 0.298 ***                |       |                   |             |                     |       | 0.249 **                 |
| Assassinations         |                          | 0.187 *** |                   |             |                     |       | 0.196 ***               |
| Deaths                 |                          | −0.956 *** |                   |             |                     |       | −0.566 **               |
| War dummy              |                          | 0.024 |                   |             |                     |       | −0.054                  |
| Q3                     |                          |       | −0.727 ***        |             |                     |       | −0.518 ***              |
| Log(GDP_{1970})        |                          |       | −0.164            |             |                     |       | −0.016                 |
| Pop growth             |                          |       |                   | 0.400 *     |                     |       | −0.170                 |
| Mortality              |                          |       |                   | −0.135      |                     |       | −0.089                 |
| Family farms           |                          |       |                   | −0.286 *    |                     |       | −0.038                 |
| kg702007               |                          |       |                   |             | 0.044               |       |                         |
| exp edu                |                          |       |                   |             | 0.345 **            |       |                         |
| Access to money        |                          |       |                   |             |                     |       | 0.035                  |
| Innovation             |                          |       |                   |             |                     |       | −0.453 ***             |
| R²                     | 0.670                    | 0.612 | 0.666             | 0.843       | 0.447               |       | 0.454 0.825            |
| Shea’s Partial R²      | 0.489                    | 0.399 | 0.483             | 0.199       | 0.143               |       | 0.155 0.728            |

First-stage estimations using robust standard errors and small-sample correction. *p < 0.10, **p < 0.05, ***p < 0.01. OLS coefficients have been standardised to ease comparability. Controls from the growth equation (log(pcgdp), life exp, primary enrol, yrs open, primary exports and mining) are also included. Shea’s partial R² measures the relevance of the instruments not included in the growth equation. Column 7 excludes instruments for PE and CMI channels rejected by the Hansen test.
from the growth equation. All channels report significant parameters. The channel with the highest partial R-square (0.489) corresponds to the geography-institutions (column 1). These variables are time-invariant factors that are cancelled out in the panel data analysis with fixed effects or first differences. This can explain why a positive effect of inequality is found in this type of analysis. The proportion of mountainous land deserves special attention. Although not considered before in the literature as an instrument for inequality, it has a high correlation with inequality and remains highly significant even when controlling for other proxies for structural inequality. Finally, in column (7) we consider all factors associated in the empirical literature with a negative effect of inequality, and consequently we exclude variables associated with PE and CMI approaches, which report significant parameters for the positive side of these two channels. The exclusion of these variables is reinforced by the performed Hansen tests (as we further explain below). All of these factors explain about 80% of the variance in inequality.

Before we assess two components of inequality in the growth equation, we test the extent to which they capture negative and positive dynamics in the growth process based on the theory revised in Sect. 2. A simple and straightforward way is to see how the two components correlate with long-run growth as well as with physical and human capital accumulation, innovation, and institutional quality. On the one hand, our estimated inequality, using all factors considered in column 7 of Table 4, has a significant negative correlation with growth, $-0.462$, as well as with the average investment during the whole period ($ki$), $-0.247$, and with the total average years of schooling in 2005 ($schooling$), $-0.429$. Correlations with innovation and institutional quality ($icrg_qog$) are also negative, $-0.517$ and $-0.578$, respectively. On the other hand, our second component (the remaining variance in inequality) has a positive correlation with growth, 0.117, as well as with physical capital accumulation, 0.191.

Figure 1 plots our two orthogonal components and their relationship to long-run growth. Both components have been standardised to split the sample of countries into four quadrants. Countries with lower estimated negative inequality have higher growth rates (represented with larger bubbles in the graph). Furthermore, the highest average growth rates are found in the top left quadrant of the figure. In this quadrant, we find countries with low estimated negative inequality but high estimated residual (our positive component), e.g. Denmark, Hungary, Ireland, South Korea, and the USA. By contrast, the lowest average growth rates were found in countries with high estimated negative inequality but low estimated residual (the bottom right quadrant, including mostly Latin American countries like Peru and El Salvador, but also other countries like Zambia and Côte d’Ivoire).

Table 5 presents results for the impact of inequality on long-run growth. Column 1 shows the results from the OLS estimation of model 1. Columns 2 to 6 present the results of our 2SRI (Two-Stage Residual Inclusion) estimations based on the CFA. 18 2SRI estimations were conducted using bootstrap standard errors to adjust for the

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18 See Terza et al. (2008) for a good explanation of 2SRI and the requisites or its consistency.
generated regressor bias from the first equation. We report the Kleibergen-Paap LM test probability to check for under-identification and the Hansen probability test to check for the validity of our approach.\footnote{We test for the relevance and validity of our approach in different ways. For relevance, we look at the F statistic and the Partial-R-squared of the first regression and perform under-identification tests. For validity, we perform tests of over-identifying restrictions.} In columns 2 to 6, we introduce as a further control in the growth equation the residual from the first set of estimations for inequality (as suggested by the CFA) for each considered channel. Hence, column 2 only considers geographical variables as instruments for inequality. Finally, column 8 includes all factors considered in column 7 of Table 4.

All controls have the expected sign in all estimations, and their coefficients are all significant (except for that of mining). Results are consistent with conditional convergence, with a negative coefficient for initial per capita GDP of around 2%, as in Sala-i-Martin (2004), and higher human capital levels increasing long-run growth (i.e. a positive coefficient for \( \text{life exp} \) and \( \text{primary enrol} \)). Openness is also positively associated with growth, while primary sector specialisation is negatively so (i.e. a negative coefficient for \( \text{primary exports} \)).

For inequality, the OLS estimation yields a negative, although non-significant, coefficient. As mentioned, this may be the result of two significant effects cancelling each other.

\begin{figure}[h]
\centering
\includegraphics[width=\textwidth]{Fig_1.png}
\caption{Two components of inequality and long-run growth. Notes: The size of each bubble is proportional to the long-run growth rates for each country. Average growth figures reported represent averages calculated for the countries in each quadrant. Standardised Negative Inequality is the standardised estimated result of Eq. (3), \( \hat{I} = \hat{Z}\Phi \). The Standardised Residual Inequality is then referred to the standardised residual of such equation, \( \hat{v}_2 \).}
\end{figure}
Table 5  Results for the growth equation

|               | 1 OLS | 2 2SRI Geography-Institutions | 3 2SRI Socio Political Instability | 4 2SRI Domestic Market | 5 2SRI Fertility | 6 2SRI Political Economy | 7 2SRI Credit Market Imperf. | 8 2SRI All “negative” channels |
|---------------|-------|--------------------------------|-----------------------------------|------------------------|-----------------|--------------------------|-------------------------------|--------------------------------|
| Inequality    | −0.015 | −0.044*                         | 0.0001                            | −0.061**               | −0.037          | −0.015                   | 0.002                         | −0.038**                        |
| SE            | −0.014 | 0.026                           | 0.027                             | 0.040                  | 0.045           | 0.046                    | 0.019                         | 0.019                           |
| Resid         | 0.057  | −0.026                          | 0.089**                           | 0.028                  | −0.0009         | −0.020                   | 0.083**                        | 0.083**                         |
| SE            | 0.037  | 0.038                           | 0.037                             | 0.049                  | 0.052           | 0.046                    | 0.040                         | 0.040                           |
| Controls:     |        |                                 |                                   |                        |                 |                          |                               |                                 |
| log(pcgdp)    | −1.940*** | −1.803***                     | −2.014***                         | −1.722***              | −1.836***       | −1.944***                 | −2.022***                     | −1.833***                       |
| Life exp      | 0.118*** | 0.088*                         | 0.134***                          | 0.070                  | 0.095           | 0.118**                  | 0.135**                       | 0.094**                         |
| Primary enrol | 2.091** | 2.512**                        | 1.867*                            | 2.756**                | 2.410**         | 2.080*                   | 1.844                         | 2.418**                         |
| Yrs open      | 1.450** | 1.374**                        | 1.490**                           | 1.331**                | 1.393**         | 1.452**                  | 1.494**                       | 1.391**                         |
| Primary exports | −4.657** | −4.318**                     | −4.834**                           | −4.121**               | −4.400**        | −4.666*                  | −4.856**                      | −4.393**                        |
| Mining        | 4.477  | 4.061                           | 4.698                             | 3.820                  | 4.162           | 4.488                    | 4.721                         | 4.154                           |
| Constant      | 10.077*** | 11.690***                     | 9.216***                           | 12.627***              | 11.299***       | 10.033***                | 9.128**                       | 11.330***                       |
| Observations  | 51     | 51                              | 51                                | 51                     | 51              | 51                       | 51                            | 51                              |
| R squared     | 0.672  | 0.692                           | 0.676                             | 0.721                  | 0.675           | 0.672                    | 0.674                         | 0.706                           |
| K-P p value   | 0.001  | 0.008                           | 0.000                             | 0.028                  | 0.024           | 0.004                    | 0.028                         |                                 |
Table 5 continued

|                | 1 OLS | 2 2SRI Geography-Institutions | 3 2SRI Socio Political Instability | 4 2SRI Domestic Market | 5 2SRI Fertility | 6 2SRI Political Economy | 7 2SRI Credit Market Imperf. | 8 2SRI All “negative” channels |
|----------------|-------|-------------------------------|-----------------------------------|------------------------|-----------------|--------------------------|----------------------------|--------------------------------|
| Hansen p value |       | 0.771                         | 0.406                             | 0.364                  | 0.178           | 0.068                    | 0.039                     | 0.368                          |
| Instruments not included in the growth equation: | Wheat–sugar, tropical pop, mountains | Death, assassinations, war dummy | Q3, log(GDP) | Pop growth, mortality, family farms | kg, exp | Access to money, innovation | Death, assassinations, war dummy, Q3, log(GDP), pop growth, mortality, family farms, wheat–sugar, tropical pop, mountains |                                |

Estimations using bootstrap standard errors (1000 repetitions). *p < 0.10, **p < 0.05, ***p < 0.01. K–P is the Kleibergen–Paap LM statistic, which tests for the null hypothesis that the matrix of the reduced-form coefficients in the first-stage regression is under-identified. The Hansen J statistic tests the null hypothesis of instrument validity under the assumption of heteroscedasticity. Column 8 excludes instruments for PE and CMI channels rejected by the Hansen test.
other out. When we further control for the two differentiated components, the coefficient for inequality becomes significant in some of the estimations. In particular, the set for geographical determinants of institutions (column 2), the sets of variables associated with domestic market (column 4), and all factors associated with a negative effect of inequality (column 8) yield, in each case, a significant and negative coefficient for inequality. In these estimations, the coefficient for our forecasted residual, which captures the remaining variance in inequality not explained by the variables considered, is positive and significant (borderline significant in column 2). As we see above, any bias in our procedure for not considering the full set of variables lowers the estimates of both components towards zero. Consequently, the results are not only significant, but also downward-bounded, reinforcing our intuition.

These results support previous results of a negative effect of inequality, in particular related to the role of the size of the domestic market and the middle class, as to geographical factors defining structural inequality and bad institutional frameworks. Furthermore, our results support the idea of two differentiated components of inequality associated with two different-signed effects. Nevertheless, these parallel effects only become evident when we appropriately control for the differentiated mechanisms for inequality. Regarding the total impact of inequality, the OLS estimation in column 1 yields a net impact of inequality of $-0.015$. By contrast, controlling for two different components of inequality yields a negative effect of $-0.038$ and a positive effect of $0.083$. However, considering that our negative component of inequality captures around 80% of the variance in inequality, with the residual capturing the remaining variance, the weighted average of the two can be approximated to $-0.017$. This is close to the value reported in column 1 and to results in previous studies, and points to an economically significant effect after considering the wide differences in the Gini coefficients among countries. The difference between the country with the highest level of inequality in 1970, Honduras, and the country with the lowest level of inequality, Hungary, can represent a difference of half a point of average annual growth.

5.1 Results by level of development

Is there always a positive effect of inequality on economic growth? According to Galor and Moav (2004), as we have seen, the relationship between inequality and growth changes with the stage of development and is expected to be positive only

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20 We test for the endogeneity of inequality. While Durbin and DWH tests reject the null hypothesis of no endogeneity, the Wooldridge test, which considers robust standard errors, does not (but with a $p$ value of 0.12 comes close to suggesting endogeneity).

21 We acknowledge the potential impact of multicollinearity in some of the results. In the PE and the CMI channels, the partial R square in the first-stage regression (shown in Table 4) is relatively low, what results in high multicollinearity in the second stage. In any case, these two channels report low estimated coefficients, and consequently non-significance does not seem to be the result of multicollinearity. The other problematic channel, Fertility, on the contrary, reports a high point estimate ($-0.037$ for inequality and $0.028$ for the residual). However, the standard errors are also high. In this case, multicollinearity may be driving non-significant results.
Table 6  Growth equation by level of development

|                          | 2SRI coef. | SE   |
|--------------------------|------------|------|
| INEQUALITY*OECD          | −0.0339    | 0.033|
| INEQUALITY*nonOECD       | −0.0365*   | 0.022|
| Resid*OECD               | 0.0598     | 0.058|
| Resid*nonOCDE            | 0.0898*    | 0.048|

Controls:

|                         | 2SRI coef. | SE   |
|-------------------------|------------|------|
| log(pcgdp)              | −1.8726*** | 0.380|
| life exp                | 0.0941**   | 0.046|
| primary enrol           | 2.4309*    | 1.294|
| yrs open                | 1.4035**   | 0.601|
| primary exports         | −4.3623**  | 2.061|
| mining                  | 4.1268     | 4.005|
| Constant                | 11.5439*** | 2.577|

Observations 51
R squared 0.707

Estimations using bootstrap standard errors (1,000 repetitions). * p < 0.10, ** p < 0.05, *** p < 0.01

in the early stages and non-significant in developed economies.\(^{22}\) However, Galor and Moav’s analysis focuses on the role of credit market imperfections. We have seen that there are other channels at work. Thus, we can still have a positive effect of inequality in the early stages of development, as suggested by Galor and Moav, but also a negative effect, as suggested by other approaches. We perform structural stability tests on our sample by differentiating countries based on whether they were OECD members in 1970 or not as a proxy for stage of development.\(^{23}\) As the tests support the possibility of differentiated effects, in Table 6 we let the impact of our two components of inequality varies for countries that were OECD members in 1970 and for countries that were non-members.\(^{24}\) All controls remain significant except that of mining. Additionally, once we control for two components of inequality, the negative and positive effects of inequality are only significant in developing countries. For developed countries, the two components still have coefficients with opposing signs, although they are non-significant (in line with Galor and Moav 2004).\(^{25}\)

\(^{22}\) Indeed, the previously studied correlations of our two components of inequality with growth and capital accumulation become stronger if we consider developing and the developed countries separately.

\(^{23}\) In particular, we test parameter heterogeneity for the coefficients for our two components of inequality based on the OECD-non-OECD dichotomy.

\(^{24}\) Thus, we expect to partly control for heterogeneity across countries.

\(^{25}\) Chambers and Krause (2010) provide evidence of the second phase of Galor and Moav’s (2004) hypothesis, in particular that in countries with low educational attainment the negative effects of inequality increase with higher capital stocks.
6 Sensitivity and robustness checks

Because our procedure relies on the selection of variables to identify the transmission channels, we use a different set of variables for each channel as a further check of our results. For most channels, this is complicated because of data scarcity. However, the role of the different channels, and in particular the existence of a positive and a negative effect of inequality, appears robust to the selection of variables to capture these channels. For instance, to capture the idea of sociopolitical instability we also try the variables considered by Alesina et al. (1996, political instability dataset), although at the expense of losing 4 observations due to data availability, and we are still able to find significant coefficients (one positive and one negative) for our two components of inequality (see estimation 1 in Table 7).

Additionally, we analyse the possibility of direct effects on economic growth that are not associated with inequality of some of the channels considered. In particular, the fertility mechanism is expected to have a direct and negative effect on long-run growth associated with family decisions relevant for physical and human capital accumulation (Barro 2000), and in fact we discarded fertility rates in the inequal-

| Table 7  | Robustness checks |
|----------|-------------------|
| Dependent variable: growth | 2SRI (1) | 2SRI (2) | 2SRI (3) |
| Coef. | SE | Coef. | SE | Coef. | SE |
| Inequality | −0.0373*** | 0.018 | −0.0212* | 0.009 | 0.0597* | 0.031 |
| Resid | 0.0797*** | 0.033 | 0.0727*** | 0.015 | 0.0597* | 0.031 |
| Fertility | −0.8818*** | 0.264 | −0.8295*** | 0.307 |
| SPI_index | −0.1488 | 0.168 |
| log(GDP1970) | 0.3503 | 0.248 |
| Q3 | 0.0712 | 0.051 |
| kg702007 | −0.0338 | 0.040 |
| Controls | 0.251 | 0.366 | 0.329 |
| log(pcgdp) | 0.251 | 0.366 | 0.329 |
| Life exp | 0.0701* | 0.037 | 0.040 | 0.064 | 0.0451 | 0.056 |
| Primary enrol | 2.1799*** | 0.829 | 0.7530 | 0.412 | 0.3046 | 1.202 |
| Yrs open | 1.1894*** | 0.455 | 0.8005* | 0.360 | 0.6223 | 0.501 |
| Primary exports | −3.5561*** | 1.212 | −0.8232 | 1.147 | 0.7057 | 2.461 |
| Mining | 3.6833 | 3.014 | 4.4076 | 2.884 | 3.1386 | 2.998 |
| Constant | 9.6529*** | 1.852 | 18.7118*** | 2.046 | 14.8024*** | 3.352 |
| Observations | 47 | 51 | 51 |
| R squared | 0.619 | 0.778 | 0.818 |

Estimations using bootstrap standard errors (1000 repetitions). *p < 0.10, **p < 0.05, ***p < 0.01. The instrument set in estimation 1 replaces assassinations, death and war dummy with riots, coups, political rights, total assass, attack, democracy, execute and repress (all expressed as yearly averages for the period 1950 to 1982). The instrument set in estimation 2 excludes pop growth, mortality and family farms because fertility enters directly as a regressor.
ity equation as violating validity tests. We control for fertility rates directly in the growth equation (see estimation 2 in Table 7). The coefficient for fertility is negative and significant, as expected. However, even after controlling for fertility we find two significant effects of inequality on growth. Barro finds a non-significant effect for inequality after controlling for fertility, but does not consider, as we did, further opposing and significant effects of inequality that could be cancelling each other out.

As with fertility, we expand our analysis to the consideration of the direct (disaggregated) role of the different transmission channels in the growth equation. We follow Alesina and Perotti (1996) and construct an index as a proxy for sociopolitical instability (SPI index), using the method of principal components analysis applied to several variables of social unrest. For the role of the domestic market, we introduce the initial income ($\text{log}(GDP_{1970})$), capturing domestic market size, and to quantify the role of the middle class we include the share of the third quintile in the income distribution ($Q_3$). For redistributive policies, we introduce the variable share of government consumption over GDP ($kg_{702007}$), which captures government spending. Finally, we maintain fertility rates as a further control. Estimation 3 of Table 7 shows how our main results of two opposing effects associated with inequality holds even after the inclusion of direct effects on the growth equation.

7 Discussion and conclusions

We introduce the use of the control function approach (CFA), traditionally used to address endogeneity concerns, to analyse the relationship between inequality and economic growth. The CFA allows us to track different transmission channels of the effects of inequality on long-run economic growth by using alternative sets of variables. By considering the idea of two differentiated components of inequality (WDR 2006) and different proxies expected to relate to different transmission channels, we have empirically distinguished both negative and positive effects of inequality on long-run growth in a single model. Our results suggest, in line with the literature, that high inequality has a negative effect on long-run growth. This effect seems associated with increasing social unrest and political instability, lower aggregate demand for local goods, higher fertility rates, and bad institutional development. However, our results also support the possibility of a long-run growth-enhancing component of inequality and allow us to see the relevance of the mechanisms that need to be controlled for the positive effect of inequality to become empirically evident.

Results emphasise the complexity of the relationships between income distribution and economic growth. This complexity exists everywhere, but is more intense in developing countries. In this manner, what is interesting is not whether inequality is harmful or beneficial for growth but rather to attain a satisfactory description of the dynamics of the relationship in these countries. In order to assess the impact of inequality on economic growth in a given country, one should focus on the dynamics of inequality. When inequality is associated with political instability and social
unrest, rent seeking and distortive policies, lower capacities for investment in human capital, and a stagnant domestic market, it is mostly expected to harm long-run economic performance, as suggested by many authors. Accordingly, improving income distribution is expected to foster long-run economic growth, especially in low-income countries where the levels of inequality are usually very high. However, some degree of inequality can also be good, as has been theoretically argued in the literature and as empirically suggested in this study. A degree of inequality can play a beneficial role for economic growth when that inequality is driven by market forces and related to hard work and growth-enhancing incentives like risk taking, innovation, capital investment, and agglomeration economies. The challenge for policy makers is to control structural inequality, which reduces the country’s capacities for economic development, while at the same time keeping in place those positive incentives that are also necessary for growth. To ease this task, a broader and deeper understanding of the dynamics of the relationship between inequality and economic development will prove invaluable.

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**Appendix 1**

See Table 8
| Persson & Tabellini (94) | SocioPolitical Instability | Political Economy | CMI | Domestic Market | Fertility | Geography-Institutions | Effect on growth or inv. |
|------------------------|---------------------------|------------------|-----|----------------|-----------|-----------------------|------------------------|
| Alesina & Perotti (96) | 1                         | Welfare transfers |     |                |           |                       | 1) Non-significant      |
| Number of assassinations |                           |                  |     |                |           |                       | 1) Negative            |
| Number of violent deaths |                           |                  |     |                |           |                       |                        |
| Number of successful coups |                          |                  |     |                |           |                       |                        |
| Number of unsuccessful coups |                        |                  |     |                |           |                       |                        |
| Dummy for democracy |                                     |                  |     |                |           |                       |                        |
| Perotti (94)            | 1                         | 2                | 3   |                |           |                       | 1) Negative; 2) Non-sig.; 3) Negative |
| Number of assassinations | 1                         | Marginal tax rate | Loan-to-value payments | 3   |            |                       |                        |
| Number of violent deaths |                           | Welfare expenditures |                  |     |                |                       |                        |
| Number of successful coups |                          |                  |     |                |           |                       |                        |
| Table 8 continued |
|-------------------|
| SocioPolitical Instability | Political Economy | CMI | Domestic Market | Fertility | Geography-Institutions | Effect on growth or inv. |
| Number of unsuccessful coups | 1 | 1 | 1 | 1 | 1 | Non-significant |
| Dummy for democracy | 1 | | | | | |

Falkinger & Zweimüller (1997)

Svensson (1998)

Keefer and Knack (2002)

Barro (2000)

Easterly (2007)

Index of product diversity

Quality of property rights

Population

Aggregate GDP

Openness

Fertility rates

Wheat-to-sugar

Tropopop
Appendix 2

See Table 9

Table 9  Variables used

| Growth model | Description | Source |
|--------------|-------------|--------|
| Growth       | Cumulative annual average per capita GDP growth rate | Constructed with data from PWT (Heston et al. 2012), using real GDP chain data (rgdpcch) |
| Inequality   | Gini coefficient. 1970 | Gruen and Klasen (2008) |
| Log(pcgdp)   | Per capita GDP (in logs) | Constructed with data from PWT (Heston et al. 2012), using real GDP chain data (rgdpcch) |
| Life exp     | Life Expectancy at birth, total years. 1970 | World Bank |
| Primary enrol| *P60: Primary enrolment rate. 1960* | Sala-i-Martin et al. (2004). From Barro and Lee (1993) |
| Yrs open     | Number of years the economy has been open between 1950 and 1994. | Sala-i-Martin et al. (2004). From Sachs and Warner (1995) |
| Primary exports | Fraction of primary exports in total exports. 1970 | Sala-i-Martin et al. (2004). From Sachs and Warner (1997) |
| Mining       | Fraction of GDP in mining. 1970 | Sala-i-Martin et al. (2004). From Hall and Jones (1999) |
| Inequality Model |  |
| Assassinations | *Assassp2: Number of political assassinations.* | Sala-i-Martin (2004)). From Barro and Lee (1993) |
| Death        | Crude death rate per 1000 people. Average between 1960 and 1990 | Constructed using 1960 (or earlier available value) to 1990. World Bank |
| War dummy    | Dummy for countries that have been involved in a war any time between 1960 and 1990. | Sala-i-Martin (2004). From Barro and Lee (1993) |
| kg702007     | Share of government consumption to real GDP. Average between 1970 and 2007 | PWT. (Heston et al.) |
| Exp edu      | Expenditure in education. | World Bank |
| Access to money | *Fi-sm: Access to sound money.* | PRS Group (2012), International Country Risk Guide |
| Innovation   | Patents per million inhabitants. Closest value to 1970 | World Bank |
| Q3           | Share of the third quintile in the income distribution. | From WIDER dataset (cross section constructed taking data for each country in the closest available year to 1970) |
| Growth model | Description | Source |
|--------------|-------------|--------|
| log(GDP$_{1970}$) | GDP (in log). 1970 | PWT. (Heston et al.) |
| Pop growth | Population growth rate. 1970 | World Bank |
| Mortality | Infant mortality rate, per 1000 live births. 1969 | World Bank* |
| Family farms | Family farms. As percentage of total cultivated area. | Vanhanen’s indicators of power resource distribution |
| Wheat/sugar | Proportion of land suitable to wheat compared to land suitable to sugar (in logs). | Easterly (2007) |
| Tropical pop | $Tropop$: Proportion of population living in tropical areas. | Easterly (2007) |
| Mountains | Proportion of mountainous land. | Collier (2009) |
| Others | Share of investment to real GDP. Average between 1970 and 2007 | PWT. (Heston et al.) |
| Ki | Fertility rate, 1970. | World Bank |
| Fertility schooling$_{2005}$ | Mean years of schooling, age 15+, total. 2005 | World Bank** |
| icrg_qog_1984 | Quality of Government Index. 1984 | PRS Group (2012), International Country Risk Guide |
| Riots | $Riotan$: Number of riots. | Alesina et al. (1996) dataset |
| Coups | $Scoup$: Number of successful coups. | Alesina et al. (1996) dataset |
| Political rights | $Polrig$: Measure of political rights. | Alesina et al. (1996) dataset |
| Total assassinations | Number of assassinations per million population per year. | Alesina et al. (1996) dataset |
| Attack | Number of armed attacks per year. | Alesina et al. (1996) dataset |
| Democracy | $Democy$: Index of democracy. | Alesina et al. (1996) dataset |
| Execute | Number of political executions per year. | Alesina et al. (1996) dataset |
| Repres | Number of repressions per year. | Alesina et al. (1996) dataset |

* Missing value for Hong Kong filled with those of China. ** Missing values for MDG and NGA filled using International Institute for Applied System Analysis and the Vienna Institute of Demography (IIASA/VID) projections.
Appendix 3

See Table 10

| Country          | isocode | Country        | isocode | Country        | isocode |
|------------------|---------|----------------|---------|----------------|---------|
| Australia        | AUS     | Honduras       | HND     | Norway         | NOR     |
| Bangladesh       | BGD     | Hong Kong      | HKG     | Pakistan       | PAK     |
| Belgium          | BEL     | Hungary        | HUN     | Panama         | PAN     |
| Bolivia          | BOL     | India          | IND     | Peru           | PER     |
| Brazil           | BRA     | Indonesia      | IDN     | Philippines    | PHL     |
| Canada           | CAN     | Ireland        | IRL     | Portugal       | PRT     |
| China            | CHN     | Italy          | ITA     | South Africa   | ZAF     |
| Colombia         | COL     | Jamaica        | JAM     | Spain          | ESP     |
| Costa Rica       | CRI     | Korea, Republic of | KOR    | Sri Lanka      | LKA     |
| Côte d’Ivoire    | CIV     | Madagascar     | MDG     | Sweden         | SWE     |
| Denmark          | DNK     | Malawi         | MWI     | Tanzania       | TZA     |
| Ecuador          | ECU     | Malaysia       | MYS     | Thailand       | THA     |
| Egypt            | EGY     | Mexico         | MEX     | Tunisia        | TUN     |
| El Salvador      | SLV     | Morocco        | MAR     | Turkey         | TUR     |
| Finland          | FIN     | Nepal          | NPL     | United Kingdom | GBR     |
| France           | FRA     | Netherlands    | NLD     | United States  | USA     |
| Greece           | GRC     | Nigeria        | NGA     | Zambia         | ZMB     |

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