Quality & Quantity (2022) 56:985–1021
https://doi.org/10.1007/s11135-021-01163-1

The role of financial development in the relationship between income inequality and economic growth: an empirical approach using cross-country panel data

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Accepted: 3 May 2021 / Published online: 28 May 2021

Abstract
The study complements the existing literature on the role of credit constraints in the interplay between income inequality and economic growth. The question "what type of financial development matters for inequality-growth relationship" is answered empirically by adopting a multi-dimensional index of financial development. The analysis covers 35 OECD member countries and 34 non-OECD economies starting from the year 1980 with varying coverage across countries. The results of the panel estimation techniques suggest that in the non-OECD countries, income inequality is positively associated with subsequent growth of per capita GDP under sufficiently developed financial markets. If the markets are poorly developed, the partial correlation between inequality and growth is statistically insignificant. For OECD countries, the association seems to be non-existent although weak evidence for growth-dampening inequality is found if both the level of inequality is high and the financial markets are highly developed. The results imply that promoting the development of financial markets – rather than institutions – may alleviate the adverse effects of income inequality on economic growth in under-developed countries.

Keywords Economic growth · Income inequality · Financial development · Panel data

JEL Classification O11 · O15 · O40

1 Introduction

A large body of economic literature has emphasized the role of credit market imperfections in how income distribution affects economic development. In short, the central argument of the branch pushed forward most notably by Galor and Zeira (1993) and Galor and Moav (2004) states that, under credit constraints, income inequality may suppress the accumulation of human capital at low income levels, which may eventually be harmful for economic

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growth. Thus, development of financial institutions and markets may alleviate the growth-dampening effects of inequality.

Moreover, setting up new firms or expanding existing ones may require sufficiently concentrated income or wealth for the entrepreneurs to cover the sunk costs associated with entrepreneurial activity. By channelling funds to the low income individual with business ideas, financial development may help to disconnect the link between economic inequality and entrepreneurial activity. Aghion et al. (1999) go even further and note that under credit frictions, inequality may be negatively associated with investment opportunities. They argue that due to decreasing returns to individual capital investment, the marginal productivity of an investment made by the rich is lower than an investment made by the poor. It is also possible that high income inequality under high financial development may hurt growth, if for example due to insufficient checks and balances, the poorer households have the possibility to over-leverage themselves, which creates an additional layer of complexity in the interplay between economic growth, inequality and financial development.

This paper adds to the existing literature by asking what type of – if any – financial development matters for the inequality-growth relationship. The question is answered empirically. A multi-dimensional index of financial development (Svirydzenka 2016) is adopted. The index not only provides an aggregate measure but also separates the institutional evolutions from the development of financial markets. Furthermore, it provides measures of depth, access and efficiency for the institutions and markets and thus follows the influential characterization of financial systems by Cihak et al. (2012).

The objective of this study is not to isolate specific mechanisms, such as the human capital channel or over-leveraging discussed above, but rather to analyze the association between income inequality and per capita growth of GDP conditional on financial development. The empirical analysis relies on a panel data set that includes 69 countries, of which 35 are the members of the OECD. The study makes use of the structure of the data by disentangling the OECD member countries from the less-developed economies. Dictated by data coverage, the analysis uses observations from 1980 to 2017 at best though many countries are observed for shorter time periods.

The findings of the empirical analysis suggest that there is a positive association between income inequality and subsequent growth of per capita GDP in the non-OECD countries given that the financial markets are sufficiently developed. The evidence for an association between inequality and growth is weak in the OECD countries: only under high inequality and highly developed financial markets there are traces of a negative relationship between inequality and growth.

Although the methodological approach of the study cannot isolate causal mechanisms, novel evidence for the role of financial markets as a mediator in the inequality-growth relationship is found. In other words, instead of analyzing financial phenomena as *causes* of inequality like for example Blau (2018) and Furceri and Loungani (2018), who study capital account liberalization and stock market liquidity, respectively, this paper investigates whether the *consequences*, namely economic growth, of inequality depend on financial development.

The findings complement the earlier studies on the role of credit constraints in the interplay between inequality and growth and the vast literature that has used reduced-form cross-country and panel growth regressions to understand whether inequality matters for economic growth.[1] First, the finding that inequality is positively associated with growth

[1] For a comprehensive review, see Neves et al. (2016), whose meta-analysis suggests that the literature suffers from publication bias: statistically significant results are more willingly reported and published following a predictable time pattern with cyclically alternating positive and negative reduced-form estimates.

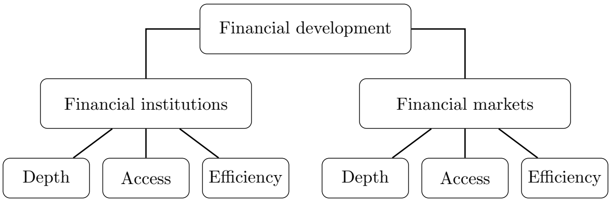


Fig. 1 Financial development index pyramid

when financial markets are sufficiently developed is compatible with the theoretical work by Galor and Zeira (1993) and Galor and Moav (2004), whose results on the adverse effects of inequality arise only when there are financial frictions. Second, in terms of the empirical studies on the inequality-growth nexus, the findings of this study suggest that the role of financial conditions should be accounted for in future work on the topic. Third, although the seminal study by Rajan and Zingales (1998) and related work on financial development and growth serve as a relevant background material, this study is essentially related to another branch of literature as financial development is considered as a mediator in the inequality-growth nexus rather than as a direct facilitator of growth.

The next section of the study introduces the data and econometric techniques while the third section presents the results of the empirical analysis. The fourth section concludes the findings. Many of the regression tables and figures are located in the appendices.

2 Data and methodology

The three key data sources of this study are the version 9.1 of the Penn World Table (Feenstra et al. 2015, PWT), the fourth version of the World Income Inequality Database (UNU-WIDER 2018, WIID) and the multi-dimensional index of financial development by Svirydzenka (2016). The coverage of these sources and the control variables narrow down the sample to include 35 OECD member economies and 34 non-OECD countries.

The aim of the multi-dimensional financial development index (Svirydzenka 2016) is to overcome the shortcomings of the use of single indicators to track financial development. Empirical studies have typically used either private credit or stock market capitalization, as ratios to GDP. However, even if financial systems were highly developed by these two measures, they may not work as the desired lubricant if they are wasteful or accessible only to few people.

As summarized in Fig. 1, the sub-indices capture the size and liquidity (depth), the ability of individuals and companies to access financial services (access) and the ability of institutions to provide the services with sustainable revenues and the activity of the capital

Footnote 1 (continued)

Their results also suggest that the estimation technique, data quality and the specification choice for the growth regression are not significant drivers of the varying estimates. Rather, cross-sectional analyses tend to find a stronger negative association than panel studies, the negative association is stronger in less developed countries, the inclusion of regional dummies soak up much of the previous finding and the concept of inequality significantly affects the results.

Table 1 The underlying variables for depth, access and efficiency measures of Fig. 1

Financial institutions	
Depth	Private sector credit to GDP
	Pension fund assets to GDP
	Mutual fund assets to GDP
	Insurance premiums, life and non-life to GDP
Access	Bank branches per 100,000 adults
	ATMs per 100,000 adults
Efficiency	Net interest margin
	Lending-deposits spread
	Non-interest income to total income
	Overhead costs to total assets
	Return on assets
	Return on equity
Financial markets	
Depth	Stock market capitalization to GDP
	Stocks traded to GDP
	International debt securities of government to GDP
	Total debt securities of financial corporations to GDP
	Total debt securities of non-financial corporations to GDP
Access	Percent of market capitalization outside of top 10 largest companies
	Total number of issuers of debt
Efficiency	Stock market turnover ratio (stocks traded to capitalization)

In access to financial markets, the total number of issuers of debt includes domestic and external and non-financial and financial corporations

markets (efficiency).[2] The sub-indices are constructed for banks, insurance companies, mutual funds and pension funds as a group (financial institutions) and for stock and bond markets (financial markets). Finally, the development of institutions and markets are gathered into the aggregate index.

Table 1 presents the variables that are used to form the sub-indices. The two largely used proxies for financial development – private sector credit to GDP and stock market capitalization to GDP – are included as the underlying variables. The former for the depth of institutions, the latter for the depth of markets. The construction of the indices follows a four-stage approach. First, the underlying variables are normalized, second, the normalized variables are aggregated into the sub-indices, third, the sub-indices are aggregated into the indices of institutional and market development, and finally, the aggregate index is constructed. In her paper, Svirydzenka (2016) offers a detailed discussion on the methodology, portrays overall trends and discusses differences between countries and country groups.

The primary data source for income inequality in this study is the fourth version of the World Income Inequality Database (WIID) maintained by the United Nations University World Institute for Development Economics Research (UNU-WIDER 2018). It is a

[2] See Fig. 1 in Svirydzenka (2016) for the original artwork.

secondary database combining information from several sources[3] and builds on the work by Deininger and Squire (1996). Each update has aimed at improving data comparability, both within countries over time and across countries, by taking seriously the issues raised in the evaluative studies by for example Atkinson and Brandolini (2001) and Jenkins (2015). The data set includes not only information on the Gini coefficient but also on the income shares of each decile. Even though the data issues cannot be fully removed, I believe that the newest version of the WIID is the best available data source for income inequality in a cross-country setting. This conclusion is founded on the well-documented choices that account for the influential critique directed to the construction of secondary databases.

The empirical studies on the linkage between income inequality and economic growth have predominantly focused on disposable income, also referred to as net or post-tax & post-transfer income. Since the aim of this study is to complement the previous empirical literature by introducing a novel measure of financial development, the same concept of inequality is adopted. Although many of the suggested mechanisms in the theoretical literature emphasize wealth inequality rather than the dispersion of income, the focus on disposable income is well-founded as our consumption, saving and investing decisions are based on income after taxes and transfers. The listed economic decisions in turn are relevant for aggregate economic activity. A detailed discussion on the general properties of inequality data, comparison of the WIID data to other alternatives and the data selection algorithm are presented in “Appendix A”.

For data on economic growth, I rely on the Penn World Table (Feenstra et al. 2015, PWT), which is a standard data source for empirical cross-country studies offering annual data on numerous variables in a global scope. Economic activity is defined as expenditure-side per capita gross domestic product (GDP) and the rate of growth corresponds to logarithmic differences.

Following a standard convention in the literature, the baseline statistical model addresses growth of per capita GDP inside five-year non-overlapping windows. The last growth window is a three-year one (2015-2017). The aim of the choice is to (i) move away from a short-run scope influenced by business cycles (ii) and to mitigate the issues of missing observation and noisiness stemming from potential measurement error in the income inequality (*Gini*) and financial development (*Svir*, Svirydzenka (2016)) time series. The panel growth regression can be written as

$$\begin{aligned}\frac{1}{4}(lnY_{i,t+4} - lnY_{i,t}) &= \gamma lnY_{i,t-1} + \boldsymbol{\delta}'\boldsymbol{X}_{i,t} \\ &+ \beta_1\left(\frac{1}{5}\sum_{j=0}^{4} Gini_{i,t-5+j}\right) + \beta_2\left(\frac{1}{5}\sum_{j=0}^{4} Svir_{i,t-5+j}\right) \\ &+ \beta_3\left(\frac{1}{5}\sum_{j=0}^{4} Gini_{i,t-5+j} \times \frac{1}{5}\sum_{j=0}^{4} Svir_{i,t-5+j}\right) + \alpha_i + \eta_t + \varepsilon_{i,t},\end{aligned} \tag{1}$$

[3] The Organisation for Economic Co-operation and Development (OECD), The EU-Statistics on Income and Living Conditions (EU-SILC), The Luxembourg Income Study (LIS), The World Bank, The Socio-Economic Database for Latin America and the Caribbean (SEDLAC), national statistical offices and independent research papers.

Table 2 Descriptive statistics, five-year non-overlapping windows

Variable	Mean	Std. Dev.	Observations	Countries
Full sample				
Growth of per capita GDP	2.97 %	2.68 %	318	69
Level of per capita GDP (2011 USD)	21 068	15 915		
Gini coefficient	0.36	0.10		
Financial development, aggregate index	0.38	0.22		
Development of financial institutions	0.48	0.24		
Development of financial markets	0.27	0.24		
OECD				
Growth of per capita GDP	2.50 %	2.13 %	177	35
Level of per capita GDP (2011 USD)	31 369	13 938		
Gini coefficient	0.31	0.06		
Financial development, aggregate index	0.51	0.20		
Development of financial institutions	0.63	0.21		
Development of financial markets	0.38	0.25		
non-OECD				
Growth of per capita GDP	3.56 %	3.16 %	141	34
Level of per capita GDP (2011 USD)	8 137	5 170		
Gini coefficient	0.43	0.09		
Financial development, aggregate index	0.22	0.10		
Development of financial institutions	0.31	0.12		
Development of financial markets	0.13	0.14		

where α_i and η_t are the vectors of fixed country and year effects and $\varepsilon_{i,t}$ is the overall error term. $Y_{i,t}$ stands for expenditure-side real per capita GDP in country i in year t while $\boldsymbol{X}_{i,t}$ contains a set of control variables[4]. The purpose of including both the country and year fixed effects is to control for the bias stemming from both the unobservable variables that change over time but are constant over countries – such as large shifts in technology or educational attainment not captured by the years of schooling – and the factors that are different across countries but are constant over time. The latter effectively means that the empirical analysis relies on variation within countries.[5]

It is worth noting that the model does not include a lagged dependent variable, i.e. the growth rate during the previous five-year period, but the log of per capita GDP just before the growth window commences to capture convergence in growth rates. The estimates change only little and remain qualitatively intact if lagged growth rates are used instead of the chosen specification, which is standard in the literature.

[4] Investment to GDP (Feenstra et al. 2015), average years of schooling to GDP (Barro and Lee 2013), the quality of political institutions (Marshall et al. 2002), trade volume to GDP (Feenstra et al. 2015) and debt to GDP (Lane and Milesi-Ferretti 2007).

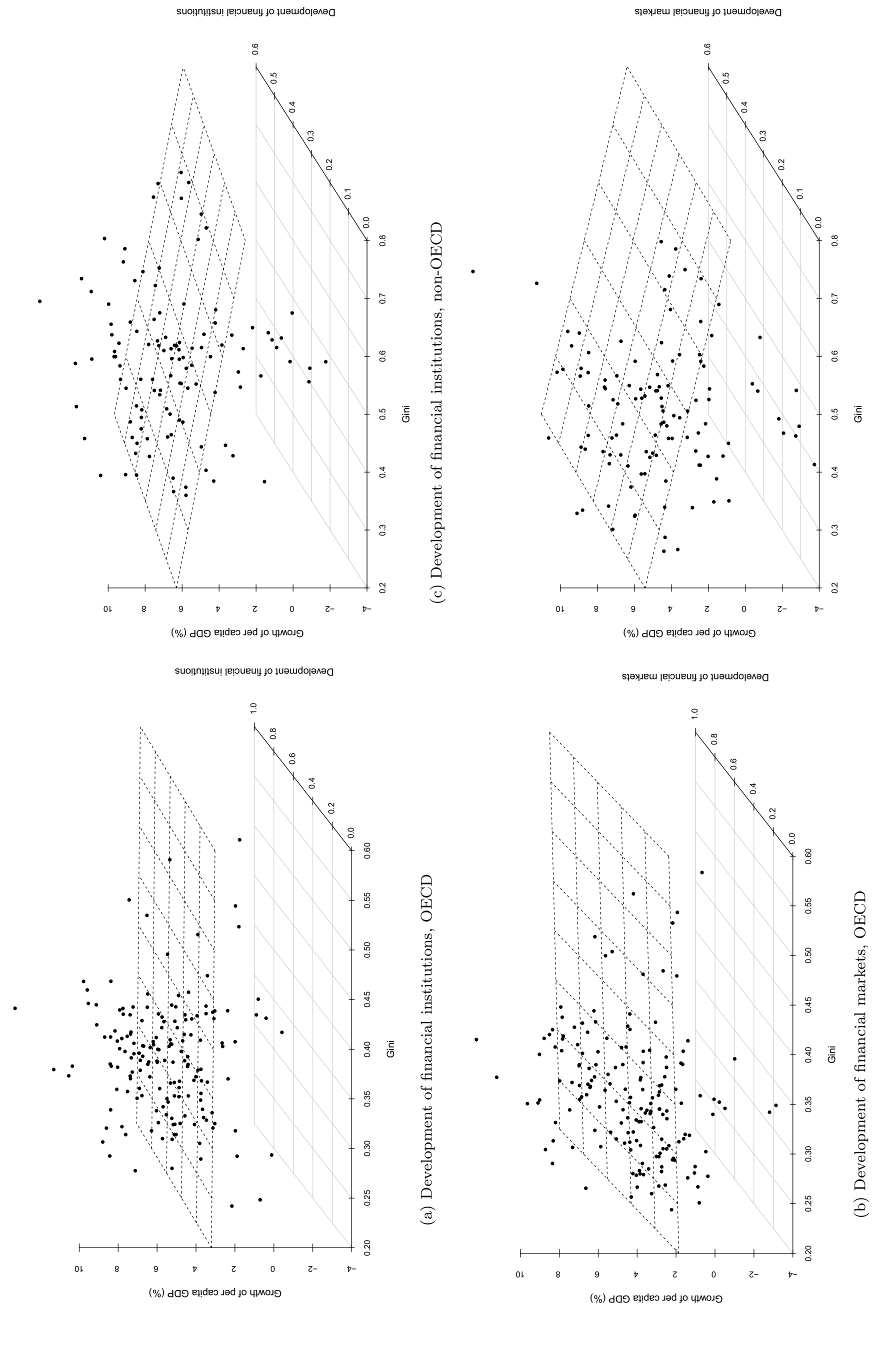
[5] As a robustness check, a widely-used system GMM estimator is also used. The properties of this panel estimation technique are briefly discussed in the next section when the results of the empirical analysis are presented.

So far, the modelling choices follow standard approaches. The novelty comes from the inclusion of the terms *Svir* and the interaction term to evaluate the dependency of the inequality-growth relationship on financial development. Moreover, the empirical analysis aims to fully utilize the richness of the financial development index (Svirydzenka 2016) introduced above. Consequently, the aggregate index, the development of financial institutions, the development of financial markets and the sub-indices (Fig. 1 and Table 1) enter the panel regressions one after another.

Table 2 shows the sample means and associated standard deviations for the focal variables of this study. Clearly, the OECD and non-OECD countries are substantially different from another, which comes as a no surprise. The higher growth rates of per capita GDP in the less developed countries depict the stylized fact of growth convergence: poorer countries tend to catch up and grow faster. The sample means for the levels of economic activity are not as informative since they have been growing over time and thus portray the level of development in the middle of the sample. Still, the large difference between the groups paints the big picture. The differences also exist for the Gini coefficients and financial development. The non-OECD countries tend to be more unequal while both the financial institutions and markets are more developed in the OECD member states. The substantial differences immediately suggest that the analysis relying in the full sample of 69 countries should be complemented by focusing on the two groups separately.

As the first step to examine the interplay between economic growth, income inequality and financial development, the observations are plotted in three-dimensional illustrations (Fig. 2) separately for the OECD and non-OECD countries. Regression planes from pooled least squares regressions, where the growth of per capita GDP is regressed on the contemporaneous Gini coefficient and either market or institutional development, are also fitted over the observations. This approach does not account for growth convergence, other growth determinants, country-specific characteristics or the time that the potential effects of inequality on growth takes to manifest themselves. Rather, the illustrations offer the first glance at the inter-dependencies between the variables under investigation.

Again, differences between the OECD and non-OECD countries emerge. In the former, the regression planes are fairly flat for the aggregate index and institutional development, whereas Fig. 2b portrays how the growth rates of per capita GDP are lowest when the contemporaneous values of the Gini coefficient and market development are low. This naïve approach thus suggests that inequality and financial market development are good for economic growth in the rich countries. In the non-OECD countries alternatively, all planes tilt towards the right indicating that the contemporaneous correlation between economic growth and the Gini is negative. As can be seen below, this finding is largely due to the fact that the least developed economies in the group of the non-OECD countries tend to be more unequal but also grow faster as they are catching up (growth convergence). The aggregate index plane tilts slightly towards high values of the index, the feature is more prevalent for the financial institutions, whereas the inclination is the opposite for the development of the financial markets. Altogether, the inter-dependencies between growth, inequality and financial development seem to be heterogeneous between the aggregate index, the development of institutions and the development of markets in both country groups.



(a) Development of financial institutions, OECD

(b) Development of financial markets, OECD

(c) Development of financial institutions, non-OECD

(d) Development of financial markets, non-OECD

Fig. 2 Pooled least squares regression planes, per capita growth regressed on Gini and financial development measure (five-year non-overlapping windows)

Table 3 The association between the Gini and economic growth conditional on the level of financial development. Fixed effects panel estimation, dependent variable: growth of per capita GDP inside non-overlapping five-year growth windows. Columns (2), (4) and (6) correspond to equation (1) while columns (1), (3) and (5) correspond to specifications without an interaction term. Control variables are omitted from the table

	All		OECD		non-OECD	
	(1)	(2)	(3)	(4)	(5)	(6)
Panel A: Financial development, aggregate index (FD)						
Gini	0.0485	0.1887*	−0.1091	0.0756	0.1712**	−0.0650
	(0.0702)	(0.1126)	(0.0795)	(0.1959)	(0.0825)	(0.1616)
FD	0.0493**	0.1502***	0.0384	0.1185	−0.0694	−0.4241**
	(0.0188)	(0.0559)	(0.0234)	(0.0891)	(0.0580)	(0.1952)
Gini × FD		−0.3052*		−0.2706		0.7620*
		(0.1716)		(0.2910)		(0.3977)
Joint significance of Gini and FD (*p* values)	0.036		0.064		0.109	
Joint significance of Gini and Gini × FD (*p* values)		0.195		0.353		0.007
Joint significance of FD and Gini × FD (*p* values)		0.002		0.178		0.095
Joint significance of Gini, FD and Gini × FD (*p* values)		0.006		0.115		0.017
Observations	318	318	177	177	141	141
Number of countries	69	69	35	35	34	34
Panel B: Development of financial institutions (FI)						
Gini	0.0355	0.2055*	−0.1146	0.1178	0.1775**	0.0678
	(0.0694)	(0.1111)	(0.0773)	(0.2326)	(0.0849)	(0.1678)
FI	0.0124	0.1267**	0.0089	0.1011	−0.0382	−0.1583
	(0.0176)	(0.0531)	(0.0204)	(0.0937)	(0.0393)	(0.1887)
Gini × FI		−0.3092**		−0.3073		0.2630
		(0.1436)		(0.3035)		(0.3793)
Joint significance of Gini and FI (*p* values)	0.674		0.298		0.100	
Joint significance of Gini and Gini × FI (*p* values)		0.104		0.282		0.138
Joint significance of FI and Gini × FI (*p* values)		0.062		0.556		0.583
Joint significance of Gini, FI and Gini × FI (*p* values)		0.131		0.417		0.230
Observations	318	318	177	177	141	141
Number of countries	69	69	35	35	34	34
Panel C: Development of financial markets (FM)						
Gini	0.0537	0.1190	−0.1026	0.0139	0.1679**	0.0646
	(0.0711)	(0.0996)	(0.0808)	(0.1375)	(0.0810)	(0.1059)
FM	0.0446***	0.1009*	0.0321**	0.0901	−0.0544	−0.2840**
	(0.0122)	(0.0540)	(0.0142)	(0.0679)	(0.0526)	(0.1124)

Table 3 (continued)

	All		OECD		non-OECD	
	(1)	(2)	(3)	(4)	(5)	(6)
Gini × FM		−0.1822		−0.1941		0.5416*
		(0.1773)		(0.2291)		(0.3061)
Joint significance of Gini and FM (*p* values)	0.002		0.025		0.127	
Joint significance of Gini and Gini × FM (*p* values)		0.477		0.415		0.010
Joint significance of FM and Gini × FM (*p* values)		0.001		0.050		0.014
Joint significance of Gini, FM and Gini × FM (*p* values)		0.002		0.042		0.004
Observations	318	318	177	177	141	141
Number of countries	69	69	35	35	34	34

Robust standard errors in parantheses. *, ** and *** indicate statistical significance at 10 %, 5 % and 1 % levels, respectively. Joint significance tested using a Wald test

3 Results

This section presents the results of the empirical analysis, which builds on the panel growth regression laid out in Eq. (1). Results corresponding to a linear functional form and further extensions are also considered. The extensions include introducing alternative measures of income inequality, incorporating the potential effect of the extent of inequality on the results and using a panel estimation technique that can under certain conditions mitigate the potential issues stemming from omitted variables and reverse causality. Finally, instead of the multi-dimensional index, private credit to GDP and stock market capitalization to GDP are taken as the proxies of financial development.

Table 3 displays the estimates of specification (1) for the aggregate index, the development of financial institutions and the development of financial markets. Because of large differences in economic development, income inequality and financial development between the OECD and non-OECD countries and the rudimentary correlational evidence of Fig. 2, the panel regressions are run for the full sample and the two sub-samples separately to investigate whether the relationship is dependent on the country coverage. Moreover, this distinction seems important based on the findings of previous studies. In their meta-analysis, Neves et al. (2016) document that the association between inequality and growth seems to be negative and more pronounced in less developed countries than in rich countries. The table – not the statistical specifications themselves – excludes the estimates for the other growth determinants while "Appendix B" provides the full regression tables with controls. Moreover, the results for the sub-indices depth, access and efficiency are also located in the "Appendix".

In a linear form, the association between income inequality and growth of per capita GDP is statistically insignificant in the full sample (column (1)) and in the sub-sample of OECD countries (column (3)). In the non-OECD countries however, the Gini coefficient is positively related with subsequent economic growth (column (5)). The patterns hold irrespective of whether the set of control variables include the aggregate index of financial development, the development of markets, the development of institutions or whether the level of economic development is the only control alongside the country and year fixed effects (Table 7 in “Appendix B”). Institutions and growth seem to be unrelated while a positive and significant association emerges between the markets and growth in the full sample and in the OECD countries. Moreover, the aggregate index is positively related with growth in the full sample.

Columns (2), (4) and (6) of Table 3 correspond to the statistical model of equation (1). Panels A and C show evidence that overall financial development and the development of markets play a role in the inequality-growth relationship in the full sample and in the non-OECD countries as many of the coefficients are individually and jointly statistically significant. This does not hold for institutions (Panel B) or in the sub-sample of OECD countries for any of the measures of financial development.

Yet, based on the parameter estimates, standard errors and tests of joint significance in Table 3, it is difficult to interpret the results in terms of the relationship between the Gini coefficient and subsequent economic growth conditional on the financial development index. To visualize the interplay between income inequality, economic growth and financial development, interaction plots, which display the point estimate of $Gini + Gini \times Svir$ along with the 95 % confidence intervals for different values of financial development, are introduced (Fig. 4). Again, the interest not only lies in the aggregate index but instead the richness of the data source (Svirydzenka 2016) is allowed to flourish. Moreover, the OECD and non-OECD countries are separated, which seems essential given the results of Table 3.

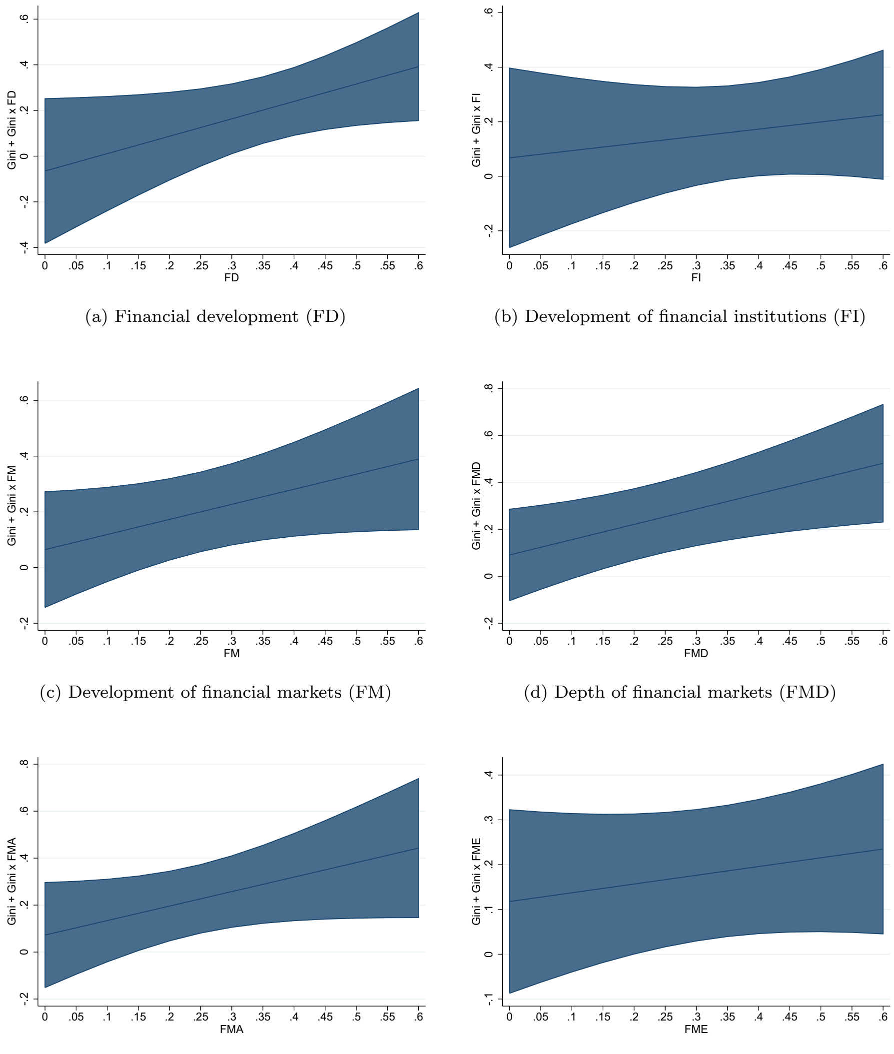
The results for the sample of OECD countries are blunt: there is no evidence for a statistically significant association between the Gini coefficient and subsequent economic growth in the quadratic specifications conditional on any of the measures of financial development. The interaction plots for OECD countries, in which zero is included in the confidence intervals for all cases, are omitted.

In the non-OECD countries, both the aggregate index (Fig. 2a) and development of financial markets (2c) seem to play a significant role in the inequality-growth relationship, whereas modelling the interaction through the development of institutions (2b) suggests that inequality and growth are not related. Furthermore, the sub-indices of market development (2d, 2e and 2f) replicate the main result of market development: under sufficiently highly developed markets, the association between the Gini coefficient and subsequent growth is positive.

The interaction plots of Fig. 3 immediately raise the question of how relevant the regions right from the cut-off, where the lower bound of the confidence interval is above zero, are. For the aggregate index, the highest quintile of the sample values is above the cut-off, whereas the corresponding share is 25 % for market development[6]. For the sub-indices depth, access and efficiency, the shares are approximately 25 %, 30 % and 23 %, respectively. If the point estimates are considered, 90 % of the sample values of the aggregate measure are above the cut-off, whereas for the measures of financial market development, the association is always positive.

The functional form of equation (1) also produces estimates for the relationship between financial development and growth conditional on the level of the Gini coefficient. In the OECD countries, under low income inequality, there is a positive association between the development of financial markets and growth, whereas in the non-OECD countries,

[6] Six of the 34 countries are always above the cut-off, 13 are both over and under during the observation period while 15 are always under.



(a) Financial development (FD)

(b) Development of financial institutions (FI)

(c) Development of financial markets (FM)

(d) Depth of financial markets (FMD)

(e) Access to financial markets (FMA)

(f) Efficiency of financial markets (FME)

Fig. 3 Estimated association (95 % level confidence interval) between the Gini coefficient and per capita growth conditional on different measures of financial development, non-OECD countries

Table 4 Correlations between per capita GDP and the measures of financial development. Panel level correlations between $lnY_{i,t-1}$ and $\frac{1}{5}\sum_{j=0}^{4} Svir_{i,t-5+j}$

OECD				non-OECD			
	FD	FI	FM		FD	FI	FM
Per capita GDP	0.23	0.40	0.05	Per capita GDP	-0.03	0.19	-0.21

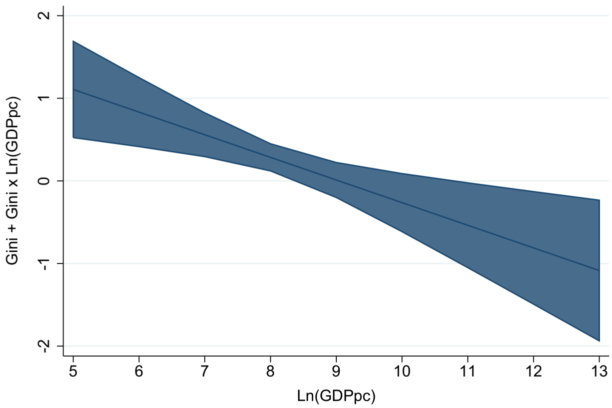


Fig. 4 Estimated association (95 % level confidence interval) between the Gini coefficient and per capita growth conditional on per capita GDP, non-OECD countries

the association is negative for low levels of the Gini coefficient. Such dependencies are not present for aggregate development or institutional development. As the emphasis of this study is to complement the previous reduced-form analysis on the interplay between income inequality and subsequent economic growth, the potential growth-promoting or growth-dampening effect of financial development is not thoroughly examined here.

The dependency of the inequality-growth relationship to the level of economic development. A potential worry over the results is whether the inequality-growth relationship in the non-OECD countries is simply conditional on the level of economic development rather than the development of financial markets. The panel level correlations reported in Table 4 mitigate this worry: there is no strong correlation between per capita GDP and the measures of financial development in either of the country samples. If the annual observations were used instead, relatively high positive correlations emerge. This is an additional benefit of using the five-year intervals.

The interaction plot (Fig. 4) shows that the upward-sloping profile of Fig. 3 does not emerge if the estimated model is the following:

$$\begin{aligned}\frac{1}{4}(lnY_{i,t+4} - lnY_{i,t}) &= \gamma lnY_{i,t-1} + \boldsymbol{\delta}'\boldsymbol{X}_{i,t} \\ &+ \beta_1\left(\frac{1}{5}\sum_{j=0}^{4} Gini_{i,t-5+j}\right) \\ &+ \beta_2\left(\frac{1}{5}\sum_{j=0}^{4} Gini_{i,t-5+j} \times lnY_{i,t-1}\right) + \alpha_i + \eta_t + \varepsilon_{i,t},\end{aligned} \tag{2}$$

where the notation follows equation (1). Rather, in the non-OECD countries, the association between the Gini coefficient and subsequent growth is positive for low levels of per capita GDP, and negative when per capita GDP is high. This result is compatible with the theoretical analysis by Galor and Moav (2004), whose main finding state that inequality enhances growth through the accumulation of physical capital at low levels of economic development, whereas in more developed economies human capital has become the prime engine for growth and inequality hurts growth.

Using top income shares. The main results are robust to considering the disposable income shares of either the highest-earning quintile or decile. First, for OECD countries, per capita GDP growth shows no dependency on the concentration of income. Second, in non-OECD countries, the association between income inequality and growth seems to depend on the development of financial markets irrespective of the measure of inequality. Figure 8 and 9 – similar to Fig. 3 – in "Appendix C" portray the results for the top income shares in the sample of non-OECD countries. The similarities in results are hardly surprising as the Gini coefficient and the top income shares follow one another closely[7]. The main results remain unchanged if the Palma ratio (top 10 % income share divided by the bottom 40 % income share) is used instead of the Gini coefficient or the top income shares.

Addressing the extent of inequality. One aspect that may affect the above-stated results, is potential dependency on the extent of income inequality. To investigate this possibility, piece-wise panel growth regressions are introduced:

$$\begin{aligned}\frac{1}{4}(lnY_{i,t+4} - lnY_{i,t}) = \gamma lnY_{i,t-1} + \boldsymbol{\delta}'\boldsymbol{X}_{i,t} \\ + \beta_1\left(\frac{1}{5}\sum_{j=0}^{4} Gini^{top25}_{i,t-5+j}\right) + \beta_2\left(\frac{1}{5}\sum_{j=0}^{4} Gini^{bottom75}_{i,t-5+j}\right) + \beta_3\left(\frac{1}{5}\sum_{j=0}^{4} Svir_{i,t-5+j}\right) \\ + \beta_4\left(\frac{1}{5}\sum_{j=0}^{4} Gini^{top25}_{i,t-5+j} \times \frac{1}{5}\sum_{j=0}^{4} Svir_{i,t-5+j}\right) \\ + \beta_4\left(\frac{1}{5}\sum_{j=0}^{4} Gini^{top75}_{i,t-5+j} \times \frac{1}{5}\sum_{j=0}^{4} Svir_{i,t-5+j}\right) \\ + \alpha_i + \eta_t + \varepsilon_{i,t},\end{aligned} \tag{3}$$

where the notation follows equation (1). This approach allows for different coefficients above and below a certain cut-off in the distribution of the Gini coefficient. The analysis uses the 75th percentile as the cut-off – the results show only little sensitivity to alternative choices. The reported one is consistent with the study by Berg et al. (2018).

Table 5 reports the piece-wise panel regression results for the OECD and non-OECD countries separately when the relationship between income inequality and subsequent growth is allowed to depend on financial market development and the extent of inequality. Again, the additional growth determinants are excluded from the table for readability. As above, the development of financial markets seems to play a role in the inequality-growth relationship while institutional development does not.

Clearly, the parameter estimates for the Gini coefficient and for the interaction term are different conditional on the level of the Gini in the OECD countries. In the less developed economies, the two coefficients for the Gini are not statistically different from one another while the null hypothesis of equality of the interaction terms is rejected.

As above, the interaction plots are more suitable than regression tables to demonstrate the inter-dependencies studied in this paper. The results for the non-OECD countries (Figs. 5b and d) are very similar between the low and high inequality cases and portray a very similar picture to Fig. 2c. In the sub-sample of OECD countries, however, the

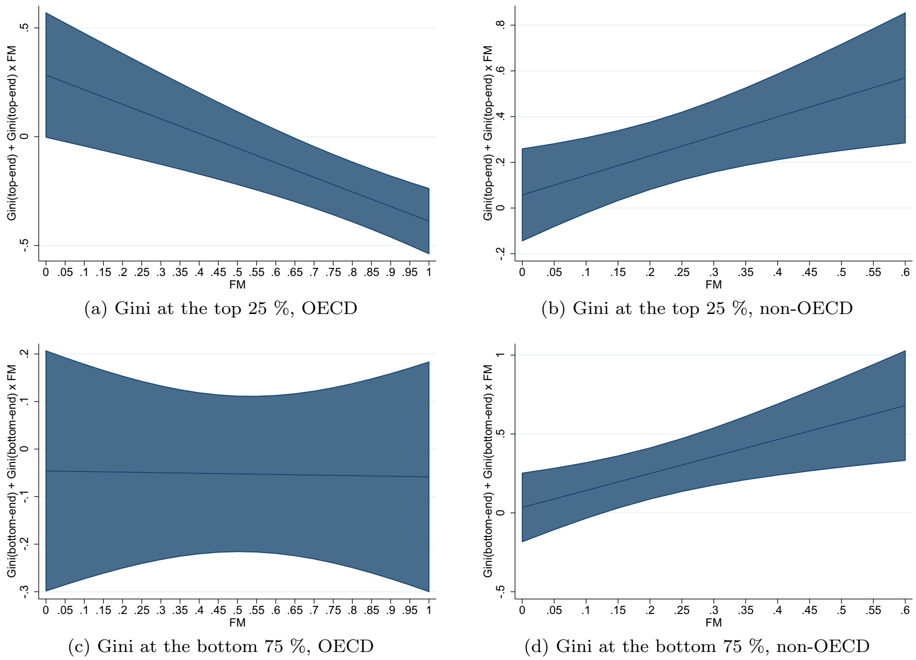
[7] In the set of countries of this study, the country-specific correlations between the Gini coefficient and the top income shares are on average above 0.97 when the five-year non-overlapping windows are considered. Although the correlations show cross-country variation, the OECD and non-OECD sub-samples share similar characteristics. Similarly to the Gini coefficient, the WIID serves as the source of data for the top income shares. Previously, Leigh (2007) studied the top incomes and broader measures of income inequality, such as the Gini, and found that the former track the latter closely.

Table 5 The association between the Gini and economic growth conditional on financial market development and the extent of inequality. Fixed effects panel estimation (equation (3)), dependent variable: growth of per capita GDP inside non-overlapping five-year growth windows. Control variables are omitted from the table

	OECD	non-OECD
	(1)	(2)
Gini at the top 25 %	0.2831*	0.0576
	(0.1459)	(0.1027)
Gini at the bottom 75 %	− 0.0460	0.0344
	(0.1288)	(0.1110)
Development of financial markets (FM)	0.0362	− 0.4402***
	(0.0560)	(0.1365)
Gini at the top 25 % × FM	− 0.6712***	0.8530**
	(0.1586)	(0.3244)
Gini at the bottom 75 % × FM	− 0.0123	1.0760***
	(0.1890)	(0.3847)
Test for equality of the $Gini_{top}$ and $Gini_{bottom}$ coefficients (p values)	< 0.000	0.286
Test for equality of the $Gini_{top}$× FM and $Gini_{bottom}$× FM coefficients (p values)	< 0.000	0.019
Joint significance of $Gini_{top}$ and $Gini_{top}$× FM (p values)	< 0.000	0.001
Joint significance of $Gini_{bottom}$ and $Gini_{bottom}$× FM (p values)	0.820	0.001
Joint significance of FM and $Gini_{top}$× FM (p values)	< 0.000	0.004
Joint significance of FM and $Gini_{bottom}$× FM (p values)	0.109	0.006
Joint significance of $Gini_{top}$, FM and $Gini_{top}$× FM (p values)	< 0.000	0.002
Joint significance of $Gini_{bottom}$, FM and $Gini_{bottom}$× FM (p values)	0.117	0.002
Observations	177	141
Number of countries	35	34

Robust standard errors in parantheses. *, ** and *** indicate statistical significance at 10 %, 5 % and 1 % levels, respectively. Joint significance tested using a Wald test

results are dependent on the extent of income inequality as the results of Table 5 already suggested. At the bottom 75 % of the distribution of the Gini coefficient, the association between income inequality and growth seems non-existent (Fig. 5c). This holds across specifications with linear functional form and ones that incorporate non-linearities to different measures provided by Svirydzenka (2016). Under both high inequality and high financial market development, income inequality is negatively associated with subsequent growth. This non-linearity is not present for the aggregate index or the development of institutions.



(a) Gini at the top 25 %, OECD

(b) Gini at the top 25 %, non-OECD

(c) Gini at the bottom 75 %, OECD

(d) Gini at the bottom 75 %, non-OECD

Fig. 5 Estimated association (95 % level confidence interval) between the Gini coefficient at the top 25 % and at the bottom 75 % percent and per capita growth conditional on development of financial markets (FM)

The panel regressions of this analysis suggest that financial markets, rather than institutions, matter for the interplay between income inequality and per capita growth of GDP. For the non-OECD countries the relationship is found not to depend on the level of income, whereas for the OECD countries, incorporating the extent of inequality seems essential to get the right picture. However, the statistical approach used so far can only capture a partial correlation between the variables of interest despite the chosen timing convention and controlling for several other determinants of economic growth and country and year fixed effects.

Controlling for endogeneity. The limitations of simple panel estimation techniques are well-recognized in the literature. To address the identification issues caused by both omitted variables and reverse causality, researchers have increasingly started to apply generalized method of moments (GMM) estimators. The so-called system GMM or sGMM (Arellano and Bover 1995; Blundell and Bond 1998)[8] has been particularly popular. In short, the sGMM estimates equation (1) and its first-difference as a system using suitably lagged values of the regressors as instrument variables for the first-differenced equation and lagged variables of first-differences as instruments for the level equation. The estimator can therefore exploit both variation in time and across individuals since the individual-specific characteristics are not removed from the equation in levels.

[8] For the preceding work on GMM, see Hansen (1982), Holtz-Eakin et al. (1988) and Arellano and Bond (1991).

To inspect the validity of the lagged levels and differences of the regressors as instruments, the Arellano-Bond autocorrelation test, the Hansen test for overidentifying restrictions and the difference-in-Hansen tests are nowadays often reported alongside the number of instruments. This is a clear improvement on past practices, where the tractability of the choices regarding the use of the sGMM was often poor. In this study, for each sGMM estimation, Windmeijer (2005) small sample correction is used for robust standard errors; in the a priori estimate of the covariance matrix, the upper right and lower left quadrants are zeroed out; and the two-step estimator is favored over the one-step one. Moreover, the set of instruments is narrowed down to include only the observations during twice lagged windows for the regressors to reduce the risk of instrument proliferation.

Despite restricting the size of the instrument matrix, the sGMM tends to run into issues in small samples. Namely, the *p*-value of Hansen J can be suspiciously high implying that the estimator suffers from instrument proliferation, which weakens the power of testing for the validity of the instruments. Consequently, dividing the sample into OECD and non-OECD countries is out of reach. Moreover, as the instrument counts increases with the number of regressors, only the level of economic development is included as an additional growth determinant. To circumvent the problem, an approach, which uses the full sample of 69 countries together with cross-terms that indicate whether a country is a member of the OECD or not, is introduced (see equation (4) in "Appendix D"). These choices of modelling reduce the number of instruments relative to the number of countries compared to the sub-sample analysis. Still, the tests for overidentifying restrictions speak for proliferation and the number of instruments clearly exceeds the number of countries (Table 14 in "Appendix D") violating the rule of thumb provided by Roodman (2009), who offers an influential guide for the use of the sGMM.

The results of the sGMM estimations are illustrated by interaction plots familiar from above. Figure 10 in "Appendix D" replicates Fig. 5. The results for the non-OECD countries are very similar between the fixed effects estimator and the sGMM. On the contrary, the result of growth-hurting inequality under high inequality and high development of financial markets in the OECD countries is not robust to the introduction of the sGMM.

The sGMM allows for heteroskedasticity and autocorrelation within countries but not across them. The assumption of no heteroskedasticity across countries is a strong one and since the Arellano-Bond autocorrelation test and the estimation of robust standard errors make the assumption, it is not innocent. Unfortunately, testing for conditional homoskedasticity is not straight-forward in a GMM framework[9] and thus it is not clear whether the sGMM improves on the simple panel estimation techniques even if the autocorrelation test and Hansen J were to support appropriateness of the model specification. Moreover, it has been shown that the sGMM estimates tend to be associated with wide weak-instrument robust confidence intervals (Bazzi and Clemens 2013; Kraay 2015).

Although the sGMM estimator is not a remedy to isolate the effects of inequality to growth in cross-country panels, its use is also motivated by controlling for the so-called dynamic panel bias (Nickell 1981). The GMM estimators account for the correlation

[9] For simpler estimators, the nR^2 test developed by White (1980) together with the approach introduced by Breusch and Pagan (1979) is informative, whereas for GMM, the nR^2 statistic does not have the desired statistical properties (Hayashi 2000, p. 234). However, White (1982) notes that when the errors are symmetric, nR^2 is biased towards the rejection of the null hypothesis of conditional homoskedasticity. Hence, under symmetricity, the failure to reject the null is useful evidence in favor of the correctness of the specification. In practice, the test is constructed by regressing the squared residuals on a constant and second-order cross products of the instrumental variables.

between lagged dependent variables and the fixed effects in the error term, and thus from this perspective too, the similarities between the fixed effects and sGMM estimates suggest that the main findings for the non-OECD sample are not driven by any apparent source of misspecification.

4 Conclusion

This study empirically investigated the role of financial development in the interplay between income inequality and growth of per capita GDP. Although financial frictions are recognized as an integral part of the inequality-growth nexus in theoretical work and the linkages between financial development and inequality have been widely-studied empirically, previous empirical studies have not investigated whether the association between inequality and growth is conditional on the development of financial institutions or markets. The empirical analysis relied on panel data techniques and a multi-dimensional index of financial development together with survey-based evidence on the distribution of disposable income and a standard data source for overall economic activity.

A positive partial correlation was found between income inequality and subsequent growth of per capita GDP in the non-OECD countries given that the financial markets were sufficiently developed. The results were similar between standard fixed effects estimator and a technique that controls for endogeneity. The evidence for an association between inequality and growth was weak in the sample of OECD countries – irrespective of financial development. The fixed effects estimates suggested that under both high income inequality and highly developed financial markets the association between inequality and economic growth was negative. However, this finding was not robust to controlling for endogeneity.

Typically, panel growth regressions have two main limitations. First, it is not clear whether a parameter estimate corresponds to causal mechanisms or whether it is for example driven by some underlying institutional traits not captured by the controls. Second, the policy relevance of a finding that could be read as inequality *causing* a decrease or an increase in economic growth would still be limited. The policy actions aiming to affect income inequality are controlled by national policy-makers and the set of possible tools is large and associated with country-specific limitations, whereas the result necessarily relies on data that have been pooled from many countries.

The first concern is relevant in the context of this study. Even though the main result regarding the non-OECD countries was robust between different estimation techniques, the findings do not warrant a causal interpretation.

The second concern is perhaps less relevant in the context highlighted in this study as opposed to a case, where only inequality and growth are considered. The findings of this study suggest that it may be possible to focus on the development of financial markets as a tool to mitigate the potential adverse effects of income inequality on economic growth. The distinction is important if policies affecting financial markets are easier to coordinate supra-nationally than predistributive and redistributive actions.

Appendices

A Data selection for the WIID

As informatively summarized by Jenkins (2015), Atkinson and Brandolini (2001) state that non-comparability in secondary data sets may arise because of differences in the definitions of income, in the data sources or in the processing of the income data in the original source. Differences both within countries in time and across countries may emerge. Many of the differences are associated with predictable patterns on inequality if their nature is not drastically heterogeneous over time and across countries. Unfortunately, the assumption of homogeneity is unlikely to hold for the WIID despite major improvements on the earlier databases and thus the practical implications need to assessed by comparing the WIID series with other sources of at least as good a quality.

In the WIID, each observation is labeled as one of possible income, consumption or expenditure concepts as strongly recommended by the seminal evaluative studies. Following the assertive conclusion of Jenkins (2015), I explicitly report the data selection algorithm inspired by Jäntti et al. (2018) in "Appendix A". After separating the net income observations from the rest, two issues remain for empirical work: the observations are of varying quality and there are often multiple observations for each country-year pair. Some of the multiple observations are due to multiple surveys but predominantly the measurements come from the same survey and it is just the computation (and the statisticians in charge) that change. Helpfully, the WIID team has introduced a variable called a quality score, which ranks the observations from 3 to 13. By ranking the observations based on this score, presented in "Appendix A", and picking the highest, I can use the observations of best possible quality to form the final country panel and get rid of many of the duplicate observations. In case of observations tied on the quality score for a given country-year pair, a simple average is taken to obtain unique observations. I believe that this data selection procedure may be helpful for future researchers who need to merge the WIID into some other cross-country panel.

Many recent studies, of which some have received much attention (Ostry et al. 2014), have used the Standardized World Income Inequality Database (Solt 2016, SWIID) as their source for data on the Gini coefficients. The SWIID is based on the WIID, supplemented by other sources and all observations come from its imputation model. In his conclusions, Jenkins (2015) states that costs associated with the use of the WIID are present for the SWIID too. Additionally, he urges to set questions about the imputation model against the benefits of coverage and draws a conclusion that the WIID should be used instead of the SWIID given that the use of the WIID is accompanied by a tractable data selection algorithm.

Data selection in practice. The observation is defined as net income if the WIID4 variable resource_detailed, previously labeled as welfare definition, is one of the following: "Earnings, net", "Income, net", "Monetary income, net", "Monetary income, net (excluding property income)" or "Taxable income, net"; as consumption income if resource_detailed is "Consumption"; and as market income if resource_detailed is one of the following: "Earnings, gross", "Factor income", "Income, gross", "Market income", "Monetary income, gross", "Taxable income, gross" or "Taxable income, gross (including deductions)".

Table 6 Inequality rankings in a subset of 14 OECD countries. Countries are ranked based on the value of the Gini coefficient. The smallest Gini is marked by 1, the largest by 14

Country	2000			2010		
	WIID	SWIID	OECD	WIID	SWIID	OECD
Australia	8	9	9	11	10	10
Canada	9	8	8	8	8	8
Denmark	2	1	1	5	2	2
Finland	3	4	3	2	3	3
France	6	7	6	7	7	7
Germany	7	6	5	6	6	6
Israel	13	12	11	13	12	12
Italy	10	10	10	10	9	9
Mexico	14	14	14	14	14	14
Netherlands	5	5	7	4	5	5
Norway	4	2	4	1	1	1
Sweden	1	3	2	3	4	4
United Kingdom	11	11	12	9	11	11
United States	12	13	13	12	13	13

Based on the variable quality_score running from 3 to 13, I rank the observations and pick the highest to use the observations of best possible quality to form the final country panel and get rid of many of the duplicate observations. In case of observations tied on the quality score for a given country-year pair, a simple average is taken to obtain unique observations.

The quality score is defined in the following way by the WIID team (UNU-WIDER 2018): *We award points to the observations based on their attributes in the following way (maximum is 13 points). Gini coefficient is available (1). Resource concept: Consumption, Income (net), Income (gross), Monetary income (gross), Monetary income (net) (5), Income, Monetary income, Market income (3), Factor income, Primary income, Taxable income, Earnings (1). Equivalence scale: Per capita or equivalized (3), No adjustment (2). Area coverage: All, Urban, Rural (1). Population coverage: All (1). Distributional share information: All of d1-q5 are available (2), All of q1-q5 are available (at least one of d1-d10 is missing) (1).*

Comparative analysis between different data sources. The OECD Income Distribution Database (OECD 2019)[10] provides data on the net income Gini coefficients for its member states. All series correspond to same OECD income definitions and thus they should be more comparable across time and across the OECD countries than the WIID ones. Therefore, the OECD database offers a point of reference to evaluate whether the WIID series differ from series of likely higher quality in a subsample of OECD countries. For non-OECD countries, a comparative exercise would be a cumbersome task since the reference series would have to be gathered from various sources listed under footnote[3] and improvements on comparability relative to the WIID would be difficult to establish.

Following Atkinson and Brandolini (2001), the WIID, the OECD data and the Standardized World Income Inequality Database (Solt 2016, SWIID)[11] are used to form cross-country inequality rankings and to compare within-country inequality trends. The WIID

[10] Available at http://www.oecd.org/social/income-distribution-database.htm.

[11] The SWIID is based on the WIID, supplemented by other sources and all observations come from its imputation model. See Section 2 for further discussion.

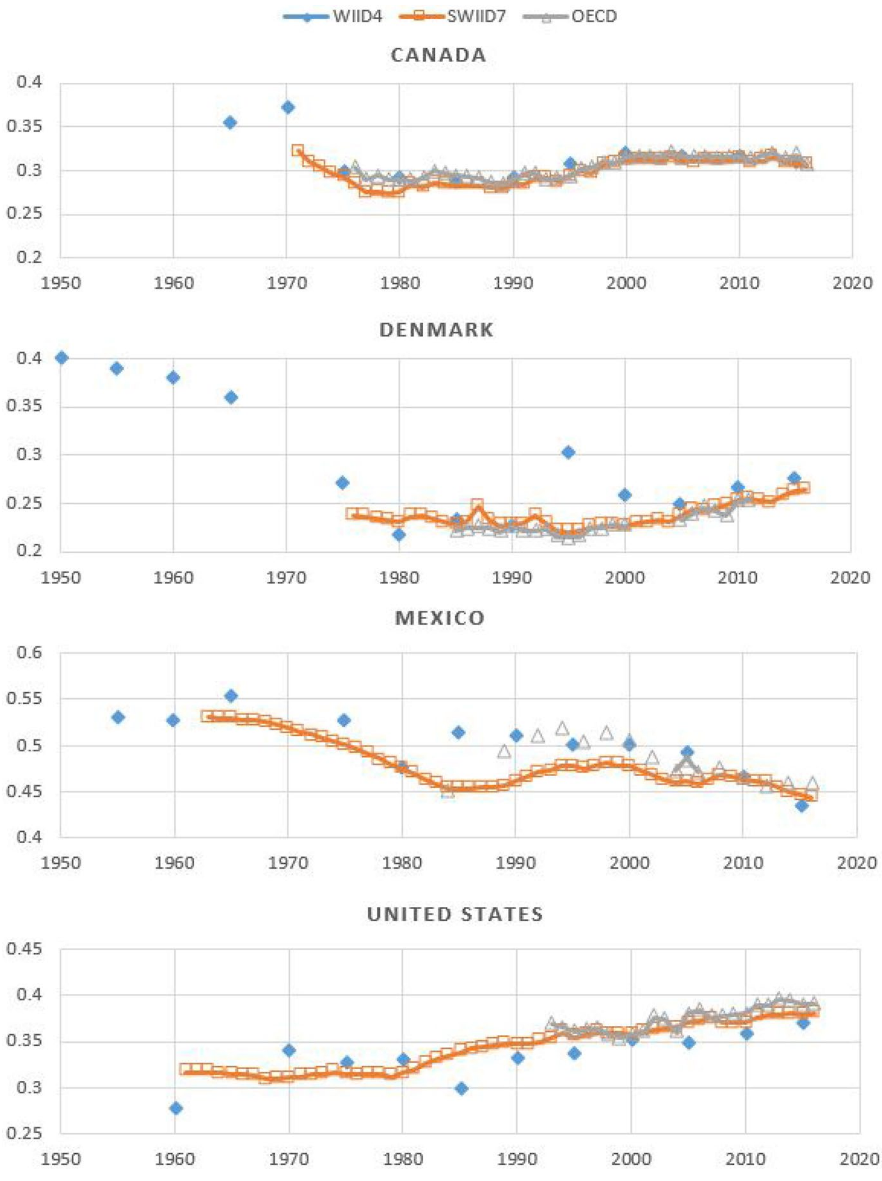


Fig. 6 The disposable income Gini coefficients in Canada, Denmark, Mexico and the United States

series correspond to the result of the above-described data selection algorithm and thus the observations are averages over the periods 2000–2004 and 2010–2014. Due to gaps in the WIID and OECD data, the comparison is restricted to 14 countries. Other choices of reference years would reduce the ranking sample even further. A single major glitch clearly emerges: the 2010 WIID ranking places Denmark as fifth while all others rank the country in the top two. As can be seen in Fig. 6, the WIID very likely overestimates the level of inequality in Denmark in 1995 and 2000. Otherwise, the rankings are fairly stable although changes occur especially within the Nordic countries who share low levels of income inequality and whose values for the Ginis are close to one another irrespective of the data source. All pairwise correlations between the rankings in a point in time are well above 0.95. (Tables 6 ,7,8,9)

Based on graphical analysis, of which Fig. 6 is an example, the WIID in general matches the data provided by the OECD modestly well although some of the time variation is undoubtedly due to differences between surveys or calculations of the income distributions. Canada is an example of a case where all three alternatives paint a similar picture, the SWIID probably underestimates the extent of inequality in Mexico while the WIID series show lower values than the OECD ones for the US (Figs. 7, 8)(Tables 10,11,12,13)

B Full fixed effects panel regression tables

See Tables 7, 8, 9, 10, 11, 12, 13.

Table 7 Parsimonious linear panel growth regression. Fixed effects panel estimation results with only convergence term and the Gini coefficient as explanatory variables, dependent variable: growth of per capita GDP inside non-overlapping five-year growth windows

	All (1)	OECD (2)	Non-OECD (3)
Initial per capita GDP	− 0.0692***	− 0.0752***	− 0.0817***
	(0.0136)	(0.0117)	(0.0193)
Gini	0.0579	− 0.0682	0.1889**
	(0.0740)	(0.0697)	(0.0824)
Constant	0.6491***	0.7961***	0.6175***
	(0.1388)	(0.1224)	(0.1629)
Observations	318	177	141
R-squared	0.2196	0.3840	0.4090
Number of countries	69	35	34

Robust standard errors in parantheses. *, ** and *** indicate statistical significance at 10 %, 5 % and 1 % levels, respectively

Table 8 Financial development (aggregate index). Fixed effects panel estimation, dependent variable: growth of per capita GDP inside non-overlapping five-year growth windows. Columns (2), (4) and (6) correspond to equation (1), where *Svir* is replaced with *FD*. Columns (1), (3) and (5) correspond to specifications without an interaction term

	All		OECD		Non-OECD	
	(1)	(2)	(3)	(4)	(5)	(6)
Initial per capita GDP	− 0.1007***	− 0.0989***	− 0.1045***	− 0.1040***	− 0.0984***	− 0.1111***
	(0.0130)	(0.0123)	(0.0139)	(0.0140)	(0.0235)	(0.0209)
Gini	0.0485	0.1887*	− 0.1091	0.0756	0.1712**	− 0.0650
	(0.0702)	(0.1126)	(0.0795)	(0.1959)	(0.0825)	(0.1616)
Financial development (FD)	0.0493**	0.1502***	0.0384	0.1185	− 0.0694	− 0.4241**
	(0.0188)	(0.0559)	(0.0234)	(0.0891)	(0.0580)	(0.1952)
Gini × FD		− 0.3052*		− 0.2706		0.7620*
		(0.1716)		(0.2910)		(0.3977)
Log(Investment to GDP)	0.0395***	0.0343**	0.0453**	0.0459**	0.0187	0.0265*
	(0.0136)	(0.0143)	(0.0208)	(0.0210)	(0.0145)	(0.0140)
Log(Schooling)	0.0300	0.0196	− 0.0006	− 0.0067	0.0047	0.0032
	(0.0201)	(0.0216)	(0.0263)	(0.0279)	(0.0296)	(0.0295)
Log(Political institutions)	0.0084	0.0061	0.0005	0.0013	0.0005	0.0040
	(0.0062)	(0.0057)	(0.0183)	(0.0169)	(0.0050)	(0.0050)
Log(Trade volume to GDP)	0.0176	0.0177	0.0200*	0.0179*	0.0184	0.0132
	(0.0109)	(0.0108)	(0.0102)	(0.0094)	(0.0164)	(0.0150)
Log(Debt to GDP)	− 0.0026	− 0.0015	− 0.0083	− 0.0076	0.0066	0.0064
	(0.0038)	(0.0037)	(0.0070)	(0.0070)	(0.0049)	(0.0047)
Constant	0.9129***	0.8628***	1.1281***	1.0779***	0.8475***	1.0632***
	(0.1339)	(0.1354)	(0.1639)	(0.1825)	(0.2155)	(0.2033)
Joint significance of Gini and FD (*p* values)	0.036		0.064		0.109	
Joint significance of Gini and Gini × FD (*p* values)		0.195		0.353		0.007
Joint significance of FD and Gini × FD (*p* values)		0.002		0.178		0.095
Joint significance of Gini, FD and Gini × FD (*p* values)		0.006		0.115		0.017
Observations	318	318	177	177	141	141
R-squared	0.3413	0.3541	0.5004	0.5064	0.4501	0.4749
Number of countries	69	69	35	35	34	34

Robust standard errors in parantheses. *, ** and *** indicate statistical significance at 10 %, 5 % and 1 % levels, respectively. Joint significance tested using a Wald test

Table 9 Development of financial institutions. Fixed effects panel estimation, dependent variable: growth of per capita GDP inside non-overlapping five-year growth windows. Columns (2), (4) and (6) correspond to equation (1), where *Svir* is replaced with *FI*. Columns (1), (3) and (5) correspond to specifications without an interaction term

	All		OECD		Non-OECD	
	(1)	(2)	(3)	(4)	(5)	(6)
Initial per capita GDP	− 0.0990***	− 0.0974***	− 0.1012***	− 0.1008***	− 0.0970***	− 0.0999***
	(0.0132)	(0.0125)	(0.0156)	(0.0154)	(0.0226)	(0.0228)
Gini	0.0355	0.2055*	− 0.1146	0.1178	0.1775**	0.0678
	(0.0694)	(0.1111)	(0.0773)	(0.2326)	(0.0849)	(0.1678)
Development of financial institutions (FI)	0.0124	0.1267**	0.0089	0.1011	− 0.0382	− 0.1583
	(0.0176)	(0.0531)	(0.0204)	(0.0937)	(0.0393)	(0.1887)
Gini × FI		− 0.3092**		− 0.3073		0.2630
		(0.1436)		(0.3035)		(0.3793)
Log(Investment to GDP)	0.0419***	0.0356**	0.0467**	0.0458**	0.0178	0.0210
	(0.0141)	(0.0150)	(0.0204)	(0.0203)	(0.0146)	(0.0151)
Log(Schooling)	0.0275	0.0178	− 0.0076	− 0.0103	0.0129	0.0155
	(0.0199)	(0.0208)	(0.0249)	(0.0255)	(0.0280)	(0.0286)
Log(Political institutions)	0.0097	0.0082	0.0065	0.0049	0.0006	0.0011
	(0.0069)	(0.0062)	(0.0173)	(0.0169)	(0.0049)	(0.0051)
Log(Trade volume to GDP)	0.0171	0.0191*	0.0203*	0.0196*	0.0201	0.0172
	(0.0107)	(0.0109)	(0.0105)	(0.0104)	(0.0174)	(0.0174)
Log(Debt to GDP)	− 0.0051	− 0.0040	− 0.0095	− 0.0088	0.0065	0.0063
	(0.0039)	(0.0038)	(0.0068)	(0.0069)	(0.0049)	(0.0047)
Constant	0.9227***	0.8562***	1.1196***	1.0518***	0.8180***	0.8876***
	(0.1381)	(0.1425)	(0.1800)	(0.1984)	(0.1986)	(0.2215)
Joint significance of Gini and FI (*p* values)	0.674		0.298		0.100	
Joint significance of Gini and Gini × FI (*p* values)		0.104		0.282		0.138
Joint significance of FI and Gini × FI (*p* values)		0.062		0.556		0.583

Table 9 (continued)

	All		OECD		Non-OECD	
	(1)	(2)	(3)	(4)	(5)	(6)
Joint significance of Gini, FI						
and Gini × FI (p values)		0.131		0.417		0.230
Observations	318	318	177	177	141	141
R-squared	0.3260	0.3390	0.4906	0.4964	0.4451	0.4486
Number of countries	69	69	35	35	34	34

Robust standard errors in parantheses. *, ** and *** indicate statistical significance at 10 %, 5 % and 1 % levels, respectively. Joint significance tested using a Wald test

Table 10 Development of financial markets. Fixed effects panel estimation, dependent variable: growth of per capita GDP inside non-overlapping five-year growth windows. Columns (2), (4) and (6) correspond to equation (1), where *Svir* is replaced with *FM*. Columns (1), (3) and (5) correspond to specifications without an interaction term

	All		OECD		Non-OECD	
	(1)	(2)	(3)	(4)	(5)	(6)
Initial per capita GDP	− 0.1011***	− 0.0999***	− 0.1051***	− 0.1049***	− 0.0966***	− 0.1073***
	(0.0125)	(0.0122)	(0.0139)	(0.0140)	(0.0238)	(0.0214)
Gini	0.0537	0.1190	− 0.1026	0.0139	0.1679**	0.0646
	(0.0711)	(0.0996)	(0.0808)	(0.1375)	(0.0810)	(0.1059)
Development of financial markets (FM)	0.0446***	0.1009*	0.0321**	0.0901	− 0.0544	− 0.2840**
	(0.0122)	(0.0540)	(0.0142)	(0.0679)	(0.0526)	(0.1124)
Gini × FM		− 0.1822		− 0.1941		0.5416*
		(0.1773)		(0.2291)		(0.3061)
Log(Investment to GDP)	0.0364***	0.0347**	0.0439**	0.0453**	0.0210	0.0255*
	(0.0131)	(0.0134)	(0.0200)	(0.0204)	(0.0150)	(0.0140)
Log(Schooling)	0.0305	0.0238	0.0045	− 0.0023	0.0047	0.0035
	(0.0199)	(0.0216)	(0.0263)	(0.0286)	(0.0302)	(0.0295)
Log(Political institutions)	0.0071	0.0055	− 0.0036	− 0.0017	0.0008	0.0048
	(0.0059)	(0.0057)	(0.0184)	(0.0166)	(0.0049)	(0.0049)
Log(Trade volume to GDP)	0.0175	0.0165	0.0196*	0.0170*	0.0180	0.0179
	(0.0111)	(0.0109)	(0.0102)	(0.0095)	(0.0162)	(0.0157)
Log(Debt to GDP)	− 0.0014	− 0.0010	− 0.0078	− 0.0072	0.0066	0.0066
	(0.0037)	(0.0037)	(0.0071)	(0.0069)	(0.0048)	(0.0048)
Constant	0.9189***	0.8967***	1.1359***	1.1075***	0.8252***	0.9593***
	(0.1334)	(0.1343)	(0.1603)	(0.1747)	(0.2142)	(0.1860)
Joint significance of Gini and FM (*p* values)	0.002		0.025		0.127	
Joint significance of Gini and Gini × FM (*p* values)		0.477		0.415		0.010
Joint significance of FM and Gini × FM (*p* values)		0.001		0.050		0.014
Joint significance of Gini, FM and Gini × FM (*p* values)		0.002		0.042		0.004
Observations	318	318	177	177	141	141
R-squared	0.3502	0.3560	0.5047	0.5099	0.4466	0.4699
Number of countries	69	69	35	35	34	34

Robust standard errors in parantheses. *, ** and *** indicate statistical significance at 10 %, 5 % and 1 % levels, respectively. Joint significance tested using a Wald test

Table 11 Depth of financial markets. Fixed effects panel estimation, dependent variable: growth of per capita GDP inside non-overlapping five-year growth windows. Columns (2), (4) and (6) correspond to equation (1), where *Svir* is replaced with *FMD*. Columns (1), (3) and (5) correspond to specifications without an interaction term

	All		OECD		Non-OECD	
	(1)	(2)	(3)	(4)	(5)	(6)
Initial per capita GDP	− 0.1024***	− 0.1017***	− 0.1060***	− 0.1060***	− 0.0951***	− 0.1069***
	(0.0120)	(0.0121)	(0.0141)	(0.0141)	(0.0241)	(0.0237)
Gini	0.0538	0.0837	− 0.1010	− 0.0389	0.1789**	0.0909
	(0.0686)	(0.0868)	(0.0794)	(0.1305)	(0.0875)	(0.0993)
Depth of financial markets (FMD)	0.0506***	0.0754*	0.0298**	0.0568	− 0.0279	− 0.3068***
	(0.0120)	(0.0422)	(0.0137)	(0.0574)	(0.0575)	(0.1110)
Gini × FMD		− 0.0849		− 0.0954		0.6509**
		(0.1428)		(0.2016)		(0.2744)
Log(Investment to GDP)	0.0368***	0.0358**	0.0452**	0.0464**	0.0190	0.0234
	(0.0131)	(0.0136)	(0.0204)	(0.0208)	(0.0146)	(0.0140)
Log(Schooling)	0.0318	0.0275	0.0043	0.0007	0.0088	0.0051
	(0.0204)	(0.0221)	(0.0257)	(0.0288)	(0.0318)	(0.0299)
Log(Political institutions)	0.0077	0.0069	0.0022	0.0020	0.0006	0.0048
	(0.0058)	(0.0056)	(0.0179)	(0.0176)	(0.0047)	(0.0049)
Log(Trade volume to GDP)	0.0141	0.0139	0.0162	0.0149	0.0204	0.0193
	(0.0110)	(0.0110)	(0.0099)	(0.0097)	(0.0169)	(0.0156)
Log(Debt to GDP)	− 0.0008	− 0.0006	− 0.0083	− 0.0081	0.0064	0.0056
	(0.0037)	(0.0037)	(0.0071)	(0.0070)	(0.0048)	(0.0045)
Constant	0.9171***	0.9088***	1.1285***	1.1191***	0.7997***	0.9382***
	(0.1309)	(0.1329)	(0.1648)	(0.1738)	(0.2178)	(0.2106)
Joint significance of Gini and FMD (*p* values)	<0.000		0.027		0.137	
Joint significance of Gini and Gini × FMD (*p* values)		0.630		0.467		0.002
Joint significance of FMD and Gini × FMD (*p* values)		<0.000		0.081		0.030
Joint significance of Gini, FMD and Gini × FMD (*p* values)		0.001		0.056		0.002
Observations	318	318	177	177	141	141
R-squared	0.3629	0.3646	0.5035	0.5053	0.4404	0.4723
Number of countries	69	69	35	35	34	34

Robust standard errors in parantheses. *, ** and *** indicate statistical significance at 10 %, 5 % and 1 % levels, respectively. Joint significance tested using a Wald test

Table 12 Access to financial markets. Fixed effects panel estimation, dependent variable: growth of per capita GDP inside non-overlapping five-year growth windows. Columns (2), (4) and (6) correspond to equation (1), where *Svir* is replaced with *FMA*. Columns (1), (3) and (5) correspond to specifications without an interaction term

	All		OECD		Non-OECD	
	(1)	(2)	(3)	(4)	(5)	(6)
Initial per capita GDP	− 0.0988***	− 0.0960***	− 0.1004***	− 0.1006***	− 0.0945***	− 0.1096***
	(0.0131)	(0.0122)	(0.0163)	(0.0150)	(0.0225)	(0.0225)
Gini	0.0331	0.1345	− 0.1064	0.1304	0.1779**	0.0725
	(0.0699)	(0.0985)	(0.0738)	(0.1139)	(0.0864)	(0.1141)
Access to financial markets (FMA)	0.0167	0.1116**	− 0.0126	0.1098*	− 0.0257	− 0.3357*
	(0.0143)	(0.0522)	(0.0129)	(0.0587)	(0.0463)	(0.1716)
Gini × FMA		− 0.2865*		− 0.4117**		0.6171*
		(0.1616)		(0.1976)		(0.3636)
Log(Investment to GDP)	0.0391***	0.0358**	0.0490**	0.0519**	0.0209	0.0276*
	(0.0138)	(0.0139)	(0.0195)	(0.0192)	(0.0150)	(0.0138)
Log(Schooling)	0.0243	0.0146	− 0.0045	− 0.0117	0.0151	0.0200
	(0.0193)	(0.0203)	(0.0248)	(0.0252)	(0.0282)	(0.0290)
Log(Political institutions)	0.0094	0.0067	0.0070	0.0052	0.0005	0.0027
	(0.0067)	(0.0064)	(0.0169)	(0.0166)	(0.0046)	(0.0050)
Log(Trade volume to GDP)	0.0163	0.0156	0.0211*	0.0213**	0.0195	0.0217
	(0.0109)	(0.0106)	(0.0106)	(0.0104)	(0.0174)	(0.0162)
Log(Debt to GDP)	− 0.0044	− 0.0034	− 0.0102	− 0.0084	0.0063	0.0069
	(0.0040)	(0.0038)	(0.0070)	(0.0067)	(0.0048)	(0.0049)
Constant	0.9241***	0.8792***	1.1190***	1.0741***	0.7854***	0.9676***
	(0.1385)	(0.1352)	(0.1824)	(0.1832)	(0.1935)	(0.2063)
Joint significance of Gini and FMA (*p* values)	0.493		0.302		0.131	
Joint significance of Gini and Gini × FMA (*p* values)		0.214		0.080		0.007
Joint significance of FMA and Gini × FMA (*p* values)		0.068		0.109		0.112
Joint significance of Gini, FMA and Gini × FMA (*p* values)		0.141		0.159		0.016
Observations	318	318	177	177	141	141
R-squared	0.3280	0.3449	0.4926	0.5185	0.4400	0.4603
Number of countries	69	69	35	35	34	34

Robust standard errors in parantheses. *, ** and *** indicate statistical significance at 10 %, 5 % and 1 % levels, respectively. Joint significance tested using a Wald test

Table 13 Efficiency of financial markets. Fixed effects panel estimation, dependent variable: growth of per capita GDP inside non-overlapping five-year growth windows. Columns (2), (4) and (6) correspond to equation (1), where *Svir* is replaced with *FME*. Columns (1), (3) and (5) correspond to specifications without an interaction term

	All		OECD		Non-OECD	
	(1)	(2)	(3)	(4)	(5)	(6)
Initial per capita GDP	− 0.0999***	− 0.0998***	− 0.1048***	− 0.1049***	− 0.0959***	− 0.0984***
	(0.0127)	(0.0126)	(0.0136)	(0.0139)	(0.0227)	(0.0213)
Gini	0.0499	0.0706	− 0.0901	− 0.0976	0.1647*	0.1177
	(0.0714)	(0.0846)	(0.0788)	(0.1062)	(0.0810)	(0.1045)
Efficiency of financial markets (FME)	0.0158**	0.0338	0.0192**	0.0151	− 0.0200	− 0.0916
	(0.0077)	(0.0385)	(0.0073)	(0.0501)	(0.0168)	(0.0781)
Gini × FME		− 0.0558		0.0134		0.1952
		(0.1244)		(0.1685)		(0.2245)
Log(Investment to GDP)	0.0398***	0.0394***	0.0464**	0.0463**	0.0216	0.0225
	(0.0136)	(0.0137)	(0.0188)	(0.0190)	(0.0147)	(0.0145)
Log(Schooling)	0.0319	0.0306	0.0115	0.0122	0.0128	0.0117
	(0.0194)	(0.0199)	(0.0262)	(0.0266)	(0.0270)	(0.0277)
Log(Political institutions)	0.0075	0.0071	− 0.0091	− 0.0096	0.0014	0.0034
	(0.0064)	(0.0064)	(0.0183)	(0.0158)	(0.0049)	(0.0047)
Log(Trade volume to GDP)	0.0193*	0.0188*	0.0237**	0.0241**	0.0188	0.0187
	(0.0111)	(0.0110)	(0.0099)	(0.0088)	(0.0166)	(0.0167)
Log(Debt to GDP)	− 0.0035	− 0.0035	− 0.0081	− 0.0081	0.0066	0.0066
	(0.0037)	(0.0037)	(0.0068)	(0.0068)	(0.0048)	(0.0049)
Constant	0.9252***	0.9186***	1.1422***	1.1454***	0.8026***	0.8412***
	(0.1358)	(0.1362)	(0.1561)	(0.1609)	(0.1924)	(0.1760)
Joint significance of Gini and FME (*p* values)	0.120		0.025		0.091	
Joint significance of Gini and Gini × FME (*p* values)		0.707		0.493		0.048
Joint significance of FME and Gini × FME (*p* values)		0.070		0.039		0.196
Joint significance of Gini, FME and Gini × FME (*p* values)		0.142		0.056		0.038
Observations	318	318	177	177	141	141
R-squared	0.3364	0.3374	0.5126	0.5127	0.4444	0.4511
Number of countries	69	69	35	35	34	34

Robust standard errors in parantheses. *, ** and *** indicate statistical significance at 10 %, 5 % and 1 % levels, respectively. Joint significance tested using a Wald test

C Association between the top income shares and growth of per capita GDP

D Controlling for endogeneity: system GMM

$$
\begin{aligned}
\frac{1}{4}(lnY_{i,t+4} - lnY_{i,t}) = \gamma lnY_{i,t-1} &+ \beta_1\left(\frac{1}{5}\sum_{j=0}^{4} Gini^{top25}_{i,t-5+j}\right) + \beta_2\left(\frac{1}{5}\sum_{j=0}^{4} Gini^{bottom75}_{i,t-5+j}\right) \\
&+ \beta_3\left(\frac{1}{5}\sum_{j=0}^{4} FM_{i,t-5+j}\right) + \beta_4\left(\frac{1}{5}\sum_{j=0}^{4} Gini^{top25}_{i,t-5+j} \times OECD\right) \\
&+ \beta_5\left(\frac{1}{5}\sum_{j=0}^{4} Gini^{bottom75}_{i,t-5+j} \times OECD\right) \\
&+ \beta_6\left(\frac{1}{5}\sum_{j=0}^{4} FM_{i,t-5+j} \times OECD\right) + \beta_7\left(\frac{1}{5}\sum_{j=0}^{4} Gini^{top25}_{i,t-5+j} \times \frac{1}{5}\sum_{j=0}^{4} FM_{i,t-5+j}\right) \\
&+ \beta_8\left(\frac{1}{5}\sum_{j=0}^{4} Gini^{top75}_{i,t-5+j} \times \frac{1}{5}\sum_{j=0}^{4} FM_{i,t-5+j}\right) \\
&+ \beta_9\left(\frac{1}{5}\sum_{j=0}^{4} Gini^{top25}_{i,t-5+j} \times \frac{1}{5}\sum_{j=0}^{4} FM_{i,t-5+j} \times OECD\right) \\
&+ \beta_{10}\left(\frac{1}{5}\sum_{j=0}^{4} Gini^{top25}_{i,t-5+j} \times \frac{1}{5}\sum_{j=0}^{4} FM_{i,t-5+j} \times OECD\right) + \alpha_i + \eta_t + \varepsilon_{i,t},
\end{aligned}
\tag{4}
$$

where FM stands for the development of financial markets while otherwise the notation follows equation (1). Since the sGMM estimator is for numerical issues ill-suited for sub-sample analysis due to the limited data coverage of this study, additional interactions are introduced.

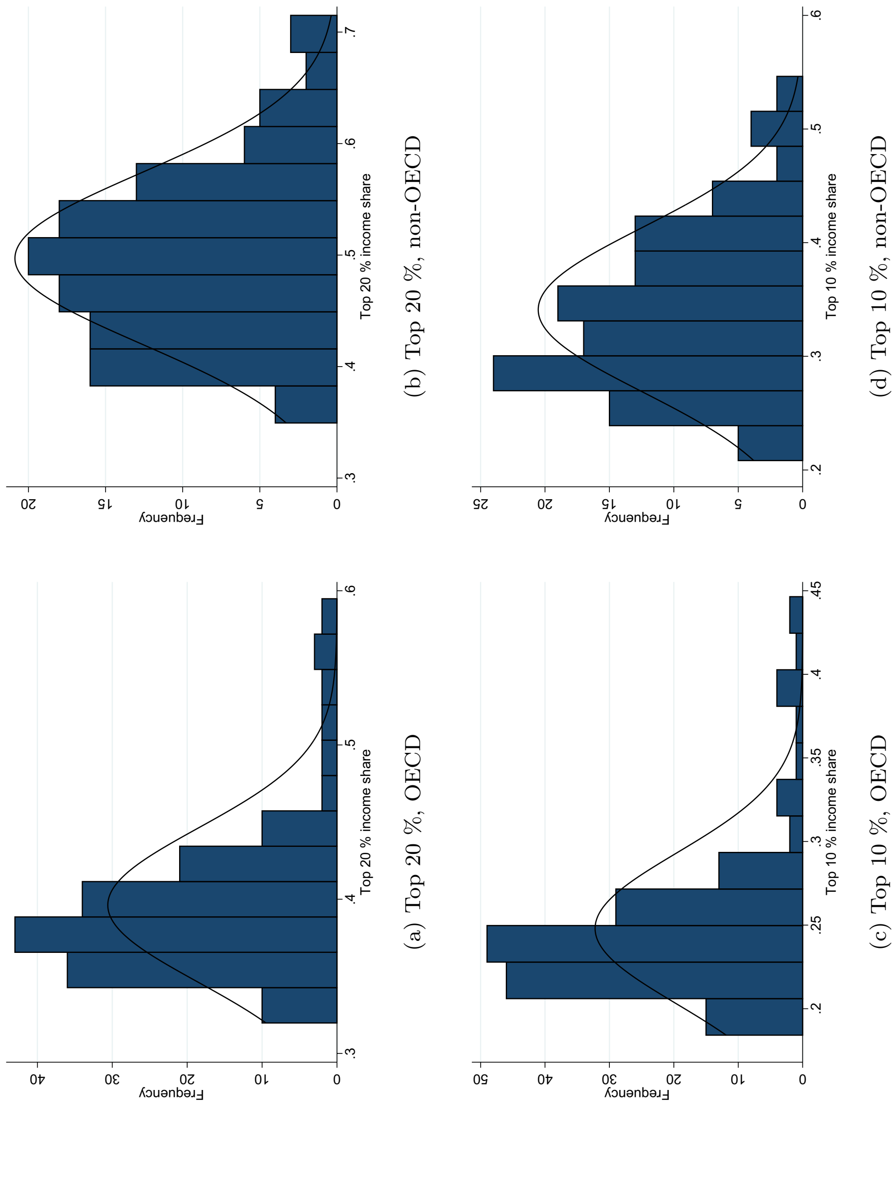
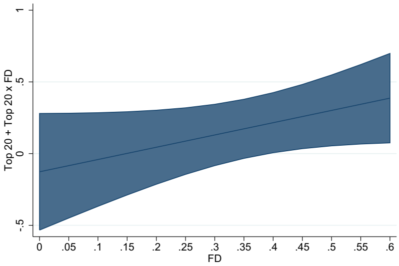
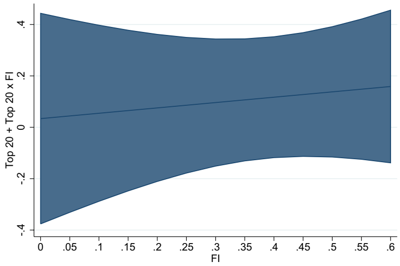


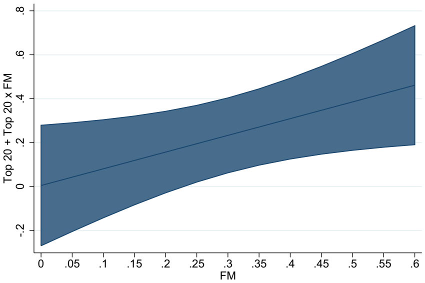
Fig. 7 The distributions of top disposable income shares in OECD and non-OECD countries



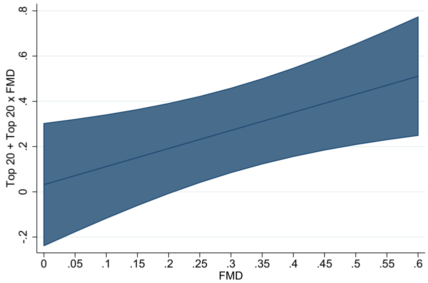
(a) Financial development (FD)



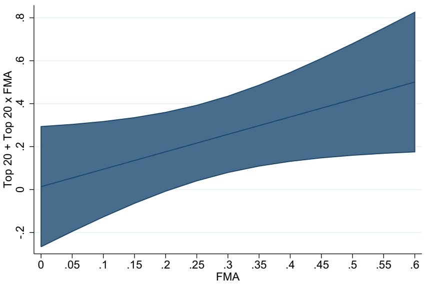
(b) Development of financial institutions (FI)



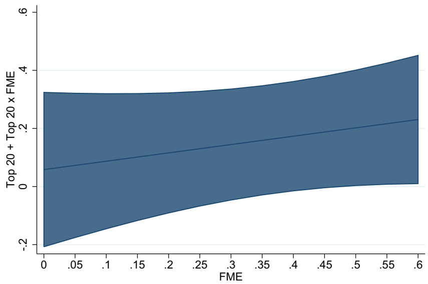
(c) Development of financial markets (FM)



(d) Depth of financial markets (FMD)

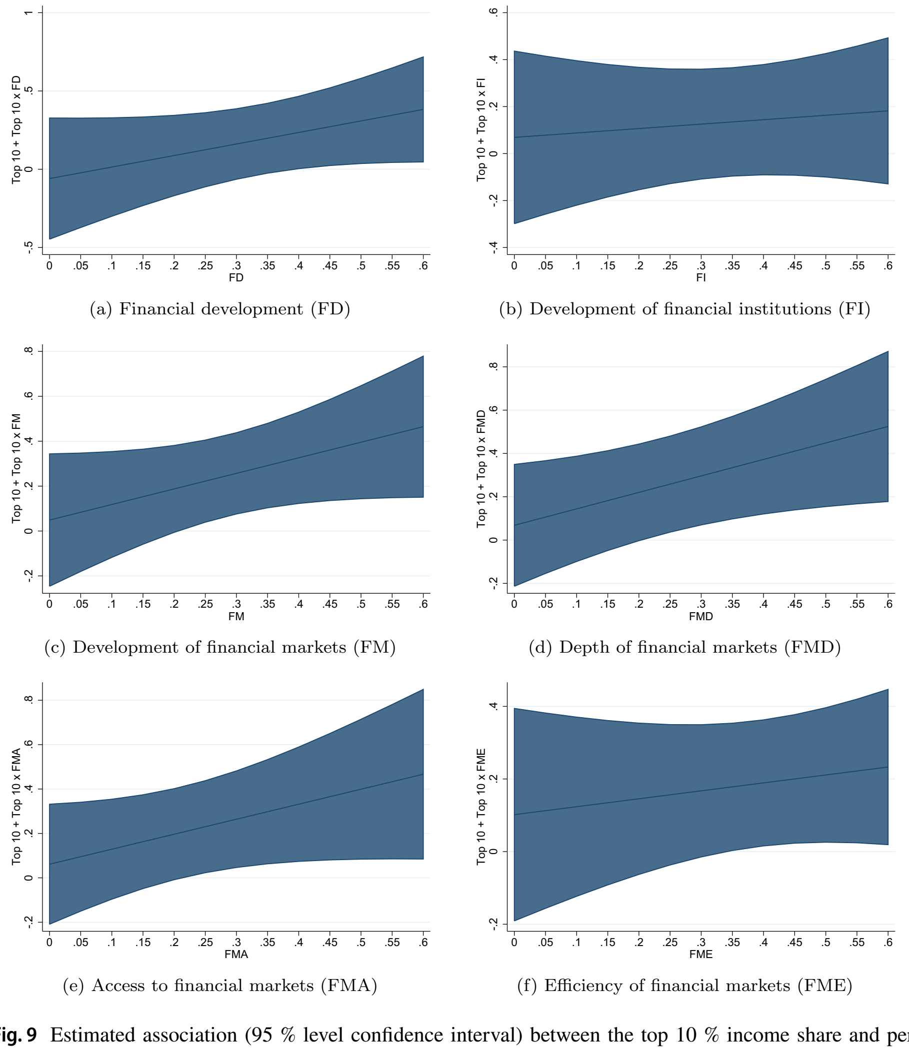


(e) Access to financial markets (FMA)



(f) Efficiency of financial markets (FME)

Fig. 8 Estimated association (95 % level confidence interval) between the top 20 % income share and per capita growth conditional on different measures of financial development, non-OECD countries



(a) Financial development (FD)

(b) Development of financial institutions (FI)

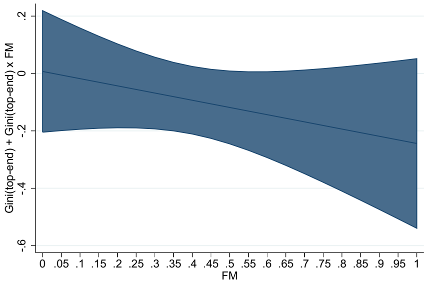
(c) Development of financial markets (FM)

(d) Depth of financial markets (FMD)

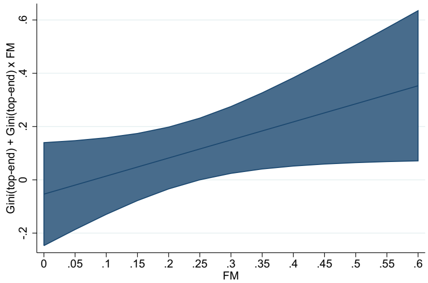
(e) Access to financial markets (FMA)

(f) Efficiency of financial markets (FME)

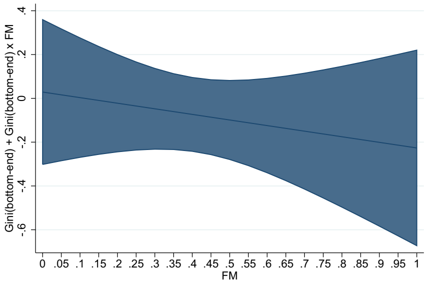
Fig. 9 Estimated association (95 % level confidence interval) between the top 10 % income share and per capita growth conditional on different measures of financial development, non-OECD countries



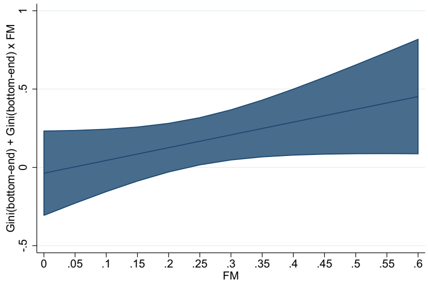
(a) Gini at the top 25 %, OECD



(b) Gini at the top 25 %, non-OECD



(c) Gini at the bottom 75 %, OECD



(d) Gini at the bottom 75 %, non-OECD

Fig. 10 System GMM estimates (95 % level confidence interval) for the Gini coefficient at the top 25 % and at the bottom 75 % percent on per capita growth conditional on development of financial markets (FM)

Table 14 System GMM estimates for the association between the Gini coefficient and economic growth conditional on financial market development and the level of inequality. System GMM panel estimation, dependent variable: growth of per capita GDP inside non-overlapping five-year growth windows. The model is given in equation (4)

Initial per capita GDP	− 0.0457***
	(0.0110)
Gini at the top 25 %	− 0.0536
	(0.0986)
Gini at the bottom 75 %	− 0.0372
	(0.1374)
Development of financial markets (FM)	− 0.3814**
	(0.1873)
Gini at the top 25 % × OECD	0.0665
	(0.0958)
Gini at the bottom 75 % × OECD	0.0490
	(0.0499)
FM × OECD	0.5087***
	(0.1488)
Gini at the top 25 % × FM	0.6778*
	(0.3513)
Gini at the bottom 75 % × FM	0.8157*
	(0.4730)
Gini at the top 25 % × FM × OECD	− 1.0491***
	(0.3234)
Gini at the bottom 75 % × FM × OECD	− 1.0393***
	(0.3696)
Constant	0.0000
	(0.0000)
Observations	318
Number of countries	69
Number of instruments	126
AR1 test (*p* values)	< 0.000
AR2 test (*p* values)	0.193
Hansen test of joint instrument validity (*p* values)	1.000
Difference-in-Hansen tests of instrument subsets (*p* values)	
For levels	1.000
For initial per cap GDP	0.970
For IV-type (time dummies)	0.693

Robust standard errors in parantheses. *, ** and *** indicate statistical significance at 10 %, 5 % and 1 % levels, respectively

Acknowledgements I wish to thank Mika Nieminen, the participants of the 42nd Annual Meeting of the Finnish Economic Association, and two anonymous referees for valuable comments.

Declarations

Conflicts of interest The author declares no conflict of interest. The work was supported by the Finnish Cultural Foundation under Grant 12181963 and the OP Group Research Foundation under Grant 20190078.

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