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STUDIES ON INCOME INEQUALITY AND ITS EFFECTS ON ECONOMIC GROWTH

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Studies on Income Inequality and Its Effects on Economic Growth

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Abstract

This thesis consists of three papers on the effects of income inequality on economic growth and the determinants of the income inequality. First three papers which are related to each other through the direct and indirect effects of income inequality on economic growth are based on dynamic panel data models. First paper covers detailed theoretical review on income inequality, second paper cover empirical studies on direct and indirect effects of income inequality on economic growth and fourth paper handles the impact of gender inequality in financial inclusion on income inequality. Short summaries on each paper are given below:

Paper 1

In this paper, direct and indirect effects of the income inequality on economic growth is reviewed. First, the effects of income inequality and redistribution on economic growth are discussed to the extent of democracy. In the first section, its effects and in addition to the effects of redistribution and related studies are discussed to the extent of democracy. In the second section, the main inequality measures are summarized. In the third section, indirect effects of income inequality is briefly discussed. The fourth section reviews the model and dynamic panel estimators, especially system GMM and panel causality. The last section concludes.

Paper 2

Income inequality may affect economic growth also indirectly through various transmission channels. This negative impact may arise from political economy, socio-political instability, and credit market imperfection channels. In other words, inequality may have indirect effects on economic growth by affecting these transmission channels. In this paper, the focus is testing negative impact of income inequality, using either Gini index or the income share of top 10 percent of the population for the robustness, through political economy, credit market

imperfections and political instability channels on economic growth. I use taxes on income, profits, and capital gains as a proxy for redistributive pressure, secondary school enrolment rates as a proxy of credit market imperfections and rule of law index as a proxy of political stability. In order to test the possible effects through these channel, income inequality, transmission channels and related interaction terms are added into the growth model. Following the SYS-GMM estimations on a panel dataset including 3-year averaged observations for 51 countries over a period from 1996 to 2015, the results show that there is negative interaction between income inequality and mentioned channels, even the direct impact income inequality is found as positive. Marginal effects of the related transmission channels are interpreted for different levels of income inequality.

Paper 3

Abstract

We investigate the impact of gender inequality in financial inclusion on income inequality, therefore making a three-fold contribution to the recent literature. First, using a micro-dataset covering 146,000 individuals in over 140 countries, we construct novel, synthetic indices of the intensity of financial inclusion at the individual level and country level. Second, we derive the distribution of individual financial access "scores" across countries to document a "Kuznets"-curve in financial inclusion. Third, cross-country regressions confirm that our measure of inequality in financial access in general, and financial access gaps between men and women in particular, is significantly related to income inequality, above and beyond other factors previously highlighted in the literature. Finally, our findings suggest that policies related to improving access to infrastructure, higher financial development and stronger institutions could significantly reduce involuntary exclusion.

Keywords: Democracy, economic growth, financial inclusion, financial development, gender inequality, income inequality, panel data models, redistribution, sub-Saharan Africa

JEL classification: C23, E25, E62, G19, H23, J16, O11, O15, O40, O47

Contents

Introduction and Summary

In the inequality and economic growth literature, both negative and positive effects of inequality are mentioned. Inequality which can undermine progress in health, education, causes investment reducing political and economic instability and undercuting the social consensus required to adjust in the face of shocks. Inequality is also said beneficial for growth, by fostering aggregate savings (Kuznets 1955, Kaldor 1956), by promoting high return projects (Rosenzweig and Binswanger 1993), by stimulating research and development (Foellmi and Zweimüller 2006). While observing the impact of income inequality, it should be considered possible side effects. Because, inequality may be harmful for the economic growth through socio-political instability, in other words, political system and social unrest, political economy and credit market imperfection channels. In other words, inequality may have indirect effects on economic growth by affecting these transmission channels.

Related to the second paper, even though a negative direct effect was expected on economic growth, negative effects of income inequality only are justified through interactions with redistributive pressure, credit market imperfections and political instability channels, using selected variables as proxies for these channels. The results show that there is negative interaction between income inequality and mentioned channels, even the direct impact income inequality is found positive. Marginal effects of the related transmission channels are interpreted for different levels of income inequality. At the higher levels of income inequality, the impact of variables related to redistribution, political stability and human capital on economic growth vanishes and becomes sharper as inequality increases. In countries where income is distributed relatively equally, economic growth benefits from the positive impact of variables related to redistribution, political stability and human capital.

Third paper handles an independent problem arising from the unequal distribution of the financial access across population and across gender. inequality in financial access in general, and gender gaps in financial access, is significantly related to income inequality, controlling with other factors highlighted in the literature. We suggest policies which are related to improving access to infrastructure, higher financial development and stronger institutions could significantly reduce involuntary financial exclusion.

Chapter 1

A survey on direct and indirect effects of income inequality on economic growth

Göksu Aslan

Abstract

In this paper, direct and indirect effects of the income inequality on economic growth is reviewed. First, the effects of income inequality and redistribution on economic growth are discussed to the extent of democracy. In the first section, its effects and in addition to the effects of redistribution and related studies are discussed to the extent of democracy. In the second section, main inequality measures are summarized. In the third section, indirect effects of income inequality through political economy, credit market imperfections and political instability channels are discussed in the light of existing studies. The fourth section reviews the model and dynamic panel estimators, especially system GMM. The last section concludes.

Keywords: Inequality, Economic Growth, Panel data models

JEL classification: C23, E25, O47

Introduction

In this paper, the impact of income inequality on economic growth is reviewed. In the first section, its effects and in addition to the effects of redistribution and related studies are discussed to the extent of democracy. In the second section, main inequality measures are summarized. In the third section, indirect effects of income inequality through political economy, credit market imperfections and political instability channels are discussed in the light of existing studies. The fourth section reviews the model and dynamic panel estimators, especially system GMM. The last section concludes.

Literature Review

1. Income inequality, redistribution and economic growth

1.1. Income Inequality and Economic Growth

In the inequality and economic growth literature, both negative and positive effects of inequality are mentioned. Inequality which can undermine progress in health, education, causes investment reducing political and economic instability and undercuting the social consensus required to adjust in the face of shocks. Inequality is also said beneficial for growth, by fostering aggregate savings (Kuznets 1955, Kaldor 1956), by promoting high return projects (Rosenzweig and Binswanger 1993), by stimulating research and development (Foellmi and Zweimüller 2006).

Some inequality is integral to the effective functioning of a market economy and the incentives needed for investment and growth. As for the Okun's (1975) big-trade-off hypothesis, a treatment for inequality as redistributive policies may be also worse for growth than disease itself by creating disincentives and inefficiencies. For societies, it is not possible to have both perfect equality and perfect efficiency. This hypothesis is not supported with empirical examples as the existence of societies such as Denmark, Luxembourg Sweden.

Inequality is harmful for growth by promoting expensive fiscal policies (Perotti 1993; Alessina and Rodrik 1994; Persson and Tabellini 1994); by inducing an inefficient state bureaucracy (Acemoglu et al. 2011), by hampering human capital formation (Bénabou 1996); or by undermining the legal system (Glaeser et al. 2003). The paper by Barro (2000) which shows a negative significant inequality impact in developing economies, applying simultaneous equation models and brings complex relationship between inequality and the fertility rate as the negative impact of inequality on economic growth is only significant when the fertility rate is omitted. Voitchovsky (2005), applying a SYS-GMM estimator shows a negative impact of the Gini coefficient. In connection with the fact that inequality and especially redistribution may have different effects on economic growth, in the following section these effects are discussed in the light of leading studies.

1.2. Income Inequality and redistribution to the extent of the regime types

1.2.1. Democracy and Inequality

The literature on the relationship between democracy and inequality has controversial findings. Sirowy and Inkeles (1990) find that the existing evidence suggest the level of political democracy as measured at one point of time tends not to be widely associated with lower levels of income inequality. They suggest that there may be evidence in favour of the relevance of the history of democracy for inequality. Muller (1988) finds a negative correlation between inequality and the numbers of years a country has been democratic. Simpson (1990), Burkhart (1997) and Gradstein and Justman (1999b) find a nonlinear reduced form relationship between democracy and inequality where at both low and high levels of democracy, inequality is lower, and higher at intermediate levels of democracy.

However, the impact of the history of democracy identified in the models that do not include fixed effects, it will capture the impact of these omitted fixed effects. This is a special case of the difficulty of identifying duration dependence and unobserved heterogeneity. (Acemoglu et.al, 2009)

Recent studies by Li et.al (1998), Rodrik (1999), and Scheve and Stasavage (2010) use better data and exploited the time as well as cross-sectional dimensions. Li et. Al (1998) find that an index of civil liberties is negatively correlated with inequality, such that greater civil liberties

are associated with lower inequality, using a pooled OLS. Rodrik (1999) finds a positive correlation between Freedom House of Polity III measure of democracy and both average real wages in manufacturing and the share of wages in national incomes, showing both in a cross-section and in a panel of countries using country fixed effects. Also, he finds an evidence that political competition and participation at large are important parts of the mechanisms via which democracy worked. Scheve and Stasavage (2009) use a long-run panel data from 1916 to 2000 for 13 OECD countries with country specific effects. They find a significant positive correlation between the universal suffrage dummy and the share of income accruing to people between the 90^{th} and 99^{th} percentiles of the income distribution divided by the share accruing to the people above the 99^{th} percentile. Lee (2005) uses an unbalanced panel data with random effects, covering 64 countries for the period from 1970 to 1994. He finds a significant positive correlation between the size of government a measured by tax revenues as a percentage of GDP and democracy, suggesting that for large enough levels of government, democracy reduces inequality.

1.2.2. Democracy and Redistribution

Meltzer and Richard (1981) find that an expansion of democracy should lead to greater tax revenues and redistribution.

Gil et.al (2004) find no correlation between tax revenues and government spending measures and democracy, using a cross-sectional specification.

Aidt et.al (2006) and Aidt and Jensen (2009b) observe the impact of democratization measured by the proportion of adults who could vote in a cross national panel. Aidt et.al (2006) observe a cross sectional panel of 12 West European countries over the period 1830-1938. Aidt and Jensen (2009b) find positive effects of suffrage on government expenditure as percentage of GDP and also tax revenues as a percentage of GDP, using a cross national panel of 10 West European countries over the period 1860-1938.

Democracy is expected to change not only the amount of tax revenues, but also what taxes were used for. One might expect democracies to move towards more progressive taxation (Acemoglu et.al, 2015).

Aidt and Jensen (2009b) find that suffrage expansion lead to lower direct taxes and higher indirect taxes. Aidt and Jensen (2009a) find a nonlinear relationship between the introduction of an income tax and suffrage where an expansion of the franchise starting from very restrictive levels reduces the probability that an income tax will be introduced, but also that this probability increases at higher levels of the franchise. Scheve and Stasavage (2010, 2012) find no correlation between democracy and either tax progressivity or the rate of capital taxation, using a long-rung approach of the OECD countries. Lindert (1994) finds an impact of democracy on various types of social spending in a panel data over the period 1880-1930, stating that "There was so little social spending of any kind before the twentieth century mainly because political voice so restricted."

Huber and Stephens (2012) find the story of democracy which is measured by the cumulative years a country has been democratic since 1945 is positively correlated with education spending, health spending, and social security and welfare spending, observing a panel dataset for Latin America between 1970-2007.

Kaufman and Segura-Ubiergo (2001) find that democracy which is measured by dichotomous measured introduced by Przeworski et.al (2000) is positively correlated with government expenditure on health and education. Brown and Hunter (1999) also show that democracies have greater social spending than autocracies, using democracy measured by Przeworski et.al (2000).

Persson and Tabellini (2003) find some evidence that democracy measured by the Gastil index and the Polity score, has positive effects on government expenditure and government revenues, and social security spending as percentage of GDP.

An additional focus of the democracy-redistribution literature is based on whether if female enfranchisement has an additional or differential impact on government taxation or spending. Results from Lindert (1994) showing that financial enfranchisement has an independent impact on social spending are consistent with Aidt and Dallal (2008) for a later period. Lott and Kenny (1999) find that the expansion of women's voting rights in the United States between 1870 and 1940 is associated with increases in per capita government revenues and expenditures. Miller

(2008) shows that female suffrage increases health spending and let to significant falls in infant mortality.

Aidt and Jensen (2013) provides an identification strategy for the endogeneity of the democracy. They argue that revolutionary threat measured by revolutionary events in other countries is a viable instrument for democracy in a panel of West European countries, building on the theoretical ideas of Acemoglu and Robinson (2000, 2006) and Aidt and Jensen (2011). They find that democracy measured by the extent of suffrage has a robust positive effect on government spending.

Acemoglu et.al (2015) explain that the expectation in the literature has been that democracy should increase redistribution and reduce inequality, and why this expectation may not be borne out in the data because democracy may be captured or constrained, because democracy may cater to the wishes of the middle class, or because democracy may be simultaneously open up new economic opportunities to the previously excluded, contributing to economy inequality. They find that democratization increases government taxation and revenue as fractions of GDP, confirming the (basic) (prediction) (of the) standard Meltzer-Richard model. They do not find a robust evidence that democracy reduces inequality.

2. Inequality Measures

Measuring inequality is to find a scalar or distributional representation of the interpersonal differences in income within a given population. There are several ways to represent inequality in graphical form such as Pen's Parade, frequency distribution, Lorenz Curve and logarithmic transformation. In the following sections, Pen's Parade, Lorenz Curve, Gini coefficient and income shares are explained. The calculation of Gini coefficient revised and additionally covariance based calculation is mentioned in Appendix.

2.1. Graphical representation

2.1.1. Pen's Parade

Pen's Parade or The Income Parade is a concept described in a 1971 book published by Dutch economist Jan Pen describing income distribution. The parade is defined as a succession of every person in the economy, with their height proportional to their income, and ordered from

lowest to greatest. People with average income would be of average height, and so the spectator. The Pen's description of what the spectator would see is a parade of dwarves, and then some unbelievable giants at the very end. (Crook, 2006)

The parade is used by economists as a graphical representation of income inequality because it's a form of Quantile function and it is considered useful when comparing two different areas or periods. (Haughton and Khandker, 2009)

2.1.2. Lorenz Curve

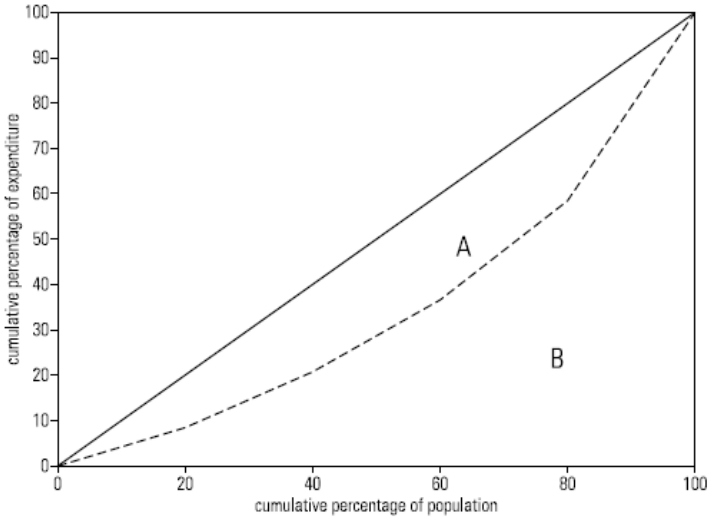
The Lorenz Curve is a tool used to represent income distributions as proposed by Lorenz (1905). It relates the cumulative proportion of income to the cumulative proportion of individuals.

The Lorenz Curve is obtained as follows:

The x-axis records the cumulative proportion of population ranked by income level. It ranges between 0 and 1.

The y-axis records the cumulative proportion of income for a given proportion of population, i.e. the income share calculated by taking the cumulated income of a given share of the population, divided by the total income Y.

Figure 1. Lorenz Curve



Source: Haughton & Khandker, 2009

2.2. Inequality measures

2.2.1. Gini coefficient

The most widely used single measure of inequality is the Gini coefficient which was developed by Italian statistician Corrado Gini (1884-1965). It is based on the Lorenz curve, a cumulative frequency curve that compares the distribution of a specific variable with the uniform distribution that represents equality. To construct the Gini coefficient, graph the cumulative percentage of households (from poor to rich) on the horizontal axis and the cumulative percentage of income on the vertical axis. The diagonal line represents perfect equality. The Gini coefficient is defined as A/(A + B), where A and B are the areas shown in the Figure 1. If A= 0, the Gini coefficient becomes 0, which means perfect equality, whereas if B = 0, the Gini coefficient becomes 1, which means complete inequality. Gini coefficient of zero represents a distribution where the Lorenz curve is just the 'Line of Equality' and incomes are perfectly equally distributed – a value of 1 means maximal inequality. (Haughton & Khandker, 2009)

Let x_i is a point on the x-axis, and y_i is a point on the y-axis. Then

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

When there are N equal intervals on the x-axis, equation simplifies to

$$Gini = 1 - \frac{1}{N}\sum_{i=1}^{N}(y_i + y_{i-1}) \quad (2)$$

2.2.2. Income shares

Percentage share of income or consumption is the share that accrues to subgroups of population indicated by deciles, quintiles or interested percentage of population. Income share held by top 1, 10, 20 percent of the population, or similarly also income share held by bottom 10, 20, 40 percent of the population are widely used measures.

3. Indirect impact of income inequality on economic growth

While observing the effects of income inequality, the indirect effects of income inequality through various transmission channels should be analysed as well as its direct effects. Because,

inequality may be harmful for the economic growth through socio-political instability, in other words, political system and social unrest, political economy and credit market imperfection channels. In other words, inequality may have indirect effects on economic growth by affecting these transmission channels. The main focus of the third chapter is to test negative impact of income inequality, through these channels. The impact of these channels and their interactions with income inequality are explained deeper in the third chapter.

4. Methodology

4.1. Dynamic Panel Estimators

Dynamic relationships are characterized by the presence of a lagged dependent variable among the regressors as below:

$$y_{it} = \delta y_{i,t-1} + x'_{it}\beta + u_{it} \quad i = 1, \dots, N; t = 1, \dots, T \tag{3}$$

where δ is a scalar, x'_{it} is 1 × K and β is K × 1, the u_{it} is assumed follow a one-way error component model

$$u_{it} = \mu_i + v_{it} \tag{4}$$

where $\mu_i \sim IID(0, \sigma_\mu^2)$ and $\mu_i \sim IID(0, \sigma_\mu^2)$ independent of each other and among themselves.

The dynamic panel data regression described in (3) and (4) is characterized by two sources of persistence over time. Autocorrelation due to the presence of a lagged dependent variable among the regressors and individual effects characterizing the heterogeneity among the individuals.

Since y_{it} is a function of μ_i, $y_{i,t-1}$ is also a function of μ_i. Therefore, $y_{i,t-1}$ is correlated with the error term. This causes the OLS estimator biased and inconsistent even if v_{it} are not serially correlated. For the fixed effects (FE) estimator, the Within transformation wipes out the μ_i, but $(y_{i,t-1} - \bar{y}_{i.-1})$ where $\bar{y}_{i.-1} = \sum_2^T y_{i,t-1}/(T-1)$ will still be correlated with $v_{it} - \bar{v}_{i.})$ even if the v_{it} are not serially correlated. This is because $y_{i,t-1}$ is correlated with $\bar{v}_{i.}$ by construction. The latter average contains $v_{i,t-1}$ which is obviously correlated with $y_{i,t-1}$. In fact, the Within estimator will be biased of $O(1/T)$ and its consistency will depend upon T being large. More

recently, Kiviet (1995) derives an approximation for the bias of the Within estimator in a dynamic panel data model with serially uncorrelated disturbances and strongly exogenous regressors. Kiviet (1995) proposed a corrected Within estimator that subtracts a consistent estimator of this bias from the original Within estimator. Therefore, for the typical labour panel where N is large and T is fixed, the Within estimator is biased and inconsistent. It is worth emphasizing that only if $T \to \infty$ will the Within estimator of δ and β be consistent for the dynamic error component model. For macro panels, studying for example long-run growth, e.g. Islam (1995) the data covers a large number of countries *N* over a moderate size *T*. In this case, T is not very small relative to N. Hence, some researchers may still favour the within estimator arguing that its bias may not be large. Judson and Owen (1999) performed some Monte Carlo experiments for N = 20 or 100 and T = 5, 10, 20 and 30 and found that the bias in the Within estimator can be sizeable, even when T = 30. This bias increases with δ and decreases with T. But even for T = 30, this bias could be as much as 20% of the true value of the coefficient of interest. The random effects GLS estimator is also biased in a dynamic panel data model. In order to apply GLS, quasi-demeaning is performed and $(y_{i,t-1} - \theta \bar{y}_{i.-1})$ will be correlated with $(u_{i,t-1} - \theta \bar{u}_{i.-1})$. An alternative transformation that wipes out the individual effects is the first difference (FD) transformation. In this case, correlation between the predetermined explanatory variables and the remainder error is easier to handle. In fact, Anderson and Hsiao (1981) suggested first differencing the model to get rid of the μ_i and then using $\Delta y_{i,t-2} = (y_{i,t-2} - y_{i,t-3})$ or $y_{i,t-2}$ as an instrument for $\Delta y_{i,t-1} = (y_{i,t-1} - y_{i,t-2})$. These instruments will not be correlated with $\Delta v_{it} = (v_{i,t} - v_{i,t-1})$, as long as the v_{it} themselves are not serially correlated. This instrumental variable (IV) estimation method leads to consistent but not necessarily efficient estimates of the parameters in the model because it does not make use of all the available moment conditions and it does not take into account the differenced structure on the residual disturbances (Δv_{it}). Arellano (1989) finds that for simple dynamic error components models, the estimator that uses differences $\Delta y_{i,t-2}$ rather than levels $y_{i,t-2}$for instruments has a singularity point and very large variances over a significant range of parameter values. In contrast, the estimator that uses instruments in levels, i.e. $y_{i,t-2}$, has no singularities and much smaller variances and is therefore recommended. Arellano and Bond (1991) proposed a generalized method of moments (GMM) procedure that is more efficient than the Anderson and Hsiao (1982) estimator, while Ahn and Schmidt (1995) derived

additional nonlinear moment restrictions not exploited by the Arellano and Bond (1991) GMM estimator. This literature is generalized and extended by Arellano and Bover (1995) and Blundell & Bond (1998) to mention a few. In addition, an alternative method of estimation of the dynamic panel data model which is proposed by Keane and Runkle (1992) is based on the forward filtering idea in time-series analysis. (Baltagi, 2005)

4.2. System GMM Estimator

Since the right-hand-side variables are typically endogenous and measured with error, and there are omitted variables, estimating growth regressions becomes problematic. In the presence of omitted variables, least squares parameter estimates are biased (Bond et.al, 2001). Applying OLS creates the problem that $Y_{i,t-1}$ is correlated with the fixed effects in the error term, which causes dynamic panel bias (Nickell, 1981).

The difference and system GMM estimators are designed for dynamic panel analysis where current realizations of the dependent variable influenced by past ones in the cases where large *N*, small *T*. There may be arbitrarily distributed fixed individual effects. This argues against cross-section regressions, which must essentially assume fixed effects away, and in favour of a panel setup, where variation over time can be used to identify parameters. The DIFF-GMM and SYS-GMM estimator assume that some regressors may be endogenous; the idiosyncratic disturbances (those apart from the fixed effects) may have individual specific patterns of heteroskedasticity and serial correlation; the idiosyncratic disturbances are uncorrelated across individuals. Some regressors can be predetermined but not strictly exogenous. Finally, because the estimators are designed for general use, they do not assume that good instruments are available outside the immediate dataset. In effect, it is assumed that the only available instruments are "internal" - based on lags of the instrumented variables. However, the estimators do allow inclusion of external instruments (Roodman, 2009).

Comparing to DIFF-GMM estimator, the SYS-GMM estimator has many advantages as in variables which are random-walk or close to be random-walk (Baum, 2006). By using DIFF-GMM, differencing variables within groups will remove any variable that is constant. SYS-GMM produces more efficient and precise estimates compared to DIFF-GMM, by improving precision and reducing the finite sample bias (Baltagi, 2008). While working unbalanced panel as in our panel dataset, DIFF-GMM approach is weak in filling gaps (Roodman, 2006, p.20).

The SYS-GMM estimator is unbiased and most efficient if there are endogenous predetermined regressors.

By construction, the residuals of the differenced equation should possess serial correlation, but if the assumption of serial independence in the original errors is warranted, the differenced residuals should not exhibit significant AR(2) behaviour. If a significant AR(2) statistic is encountered, the second lags of endogenous variables will not be appropriate instruments for their current values (Baum, 2013).

4.3. Panel causality

Panel VAR models have been widely used in multiple applications across fields, with the introduction of VAR in panel data settings (Holtz-Eakin, Newey and Rosen, 1988).

Panel VAR Granger causality procedure is developed by Abrigo and Love (2015) following panel VAR procedure developed by Love and Zicchino (2006).Abrigo and Love (2015) giving an overview of panel VAR model selection, estimation and inference in a generalized method of moments (GMM) framework, provide a package of Stata programs, with additional functionality, including sub-routines to implement Granger (1969) causality tests. [1]

5. Discussion

Income inequality, in its different forms, such as Gini index or income shares of deciles of population, may harmful for economic growth. Policies reducing inequality, such as higher tax policies, may be also destructive for the economic growth. These effects could differ to the extent of democracy. In democracies, governments tend to redistribute significantly more.

Additionally, income inequality may have indirect effects through reducing non-obligatory school enrolment rates related to the fact that poor people cannot invest in education, since they do not have access to credit. Finally, income inequality may have indirect effects through creating instable political and social environment.

While observing the impact of income inequality, it should be considered possible side effects. Because, inequality may be harmful for the economic growth through socio-political

[1] Detailed panel VAR specification is given in Box 2 in Appendix.

instability, in other words, political system and social unrest, political economy and credit market imperfection channels. In other words, inequality may have indirect effects on economic growth by affecting these transmission channels.

As regard as empirical studies, analysing the impact of inequality contains the endogeneity problem of the right-hand side variables. It should be paid attention in using right and exactly identifying instrumental variables. One problem arising from the panel data with large N is to have small *T* for some of the cross sections in the dataset. The difference and system GMM estimators are designed for dynamic panel analysis where current realizations of the dependent variable influenced by past ones in the cases where large *N*, small *T*. Other problem is to have endogeneity while observing the effects of inequality on economic growth, because of the unavailability of time-variant exogenous regressors, following the difference and system GMM estimators would be appropriate approach if the instruments are correctly used.

As regard as several income inequality measures, Gini index is most widely used among them. Income shares of the deciles or quantiles of the population are also highly informative on how income distributed within population.

Another important issue is that how income inequality change before and after taxes and transfers. If inequality after taxes and transfer, in other words net inequality, is quite lower than inequality before taxes and transfer; this means that redistributive policies are implemented in the favour of the poor. Inequality effects on economic growth may be handled as before and after taxes, or with the implementation of the effects of redistributive policies. As mentioned above, these redistributive policies may differ to the extent of democracy levels of countries.

As is the case that income inequality may have direct impact on economic growth, it may affect the marginal impact of several important variables related to redistributive policies, human capital, or political stability. These effects may arise undermining progress in health, education, causes investment reducing political and economic instability and undercutting the social consensus required to adjust in the face of shocks. These negative effects should be considered in the context of unequal opportunities arising from unequal distributed income among the population.

References

Abrigo, Michael and Inessa Love (2016). "Estimation of Panel Vector Autoregression in Stata: a Package of Programs". *The Stata Journal*, 16(3): 1-27.

Acemoglu, D., & Robinson, J. (2000). Why did the west extend the franchise? *Q. J. Econ. 115*, 1167–1199.

Acemoglu, D., & Robinson, J. (2006). Economic Origins of Dictatorship and Democracy. New York, NY: Cambridge University Press.

Acemoglu, D., Johnson, S., Robinson, J., & Yared, P. (2009). Reevaluating the modernization hypothesis. *J. Monet. Econ. 56*, 1043-1058.

Acemoglu, D., Naidu, S., Restrepo, P., & Robinson, J. (2015). Democracy, redistribution and inequality. In A. B. Atkinson, *Handbook of Income Distribution, vol 2B. Chapter 21* (pp. 1885-1996). Amsterdam: Elsevier.

Acemoglu, D., Ticchi, D., & Vindigni, A. (2011). Emergence and persistence of inefficient states. *J. Eur. Econ. Assoc., 9 (2)*, 177–208.

Ahn, S., & Schmidt, P. (1995). Efficient estimation of models for dynamic panel data. *Journal of Econometrics, 68*, 5–27.

Aidt, T., & Dallal, B. (2008). Female voting power: the contribution of women's suffrage to the growth of social spending in Western Europe (1869–1960). *Public Choice 134 (3–4)*, 391–417.

Aidt, T., & Jensen, P. (2009a). The taxman tools Up: an event history study of the introduction of the personal income Tax in western Europe, 1815–1941. *J. Public Econ. 93*, 160–175.

Aidt, T., & Jensen, P. (2009b). Tax structure, size of government, and the extension of the voting franchise in western Europe, 1860–1938. *Int. Tax Public Fin. 16 (3)*, 362–394.

Aidt, T., & Jensen, P. (2011). Workers of the World Unite! Franchise Extensions and the Threat of Revolution in Europe. *Cambridge Working Papers in Economics 1102, Faculty of Economics, University of Cambridge*, pp. 1820-1938.

Aidt, T., & Jensen, P. (2013). Democratization and the size of government: evidence from the long 19th. http://ideas.repec.org/p/ces/ceswps/_4132.html.

Aidt, T., & Jensen, P. (2013). Democratization and the size of government: evidence from the long 19th century. *Public Choice 157 (3-4)*, 511-542.

Aidt, T., & Jensen, P. (n.d.). Workers of the World Unite! Franchise Extensions and the Threat of Revolution in Europe, 1820–1938. *Cambridge Working Papers in Economics 1102, Faculty of Economics.* 2011: University of Cambridge.

Aidt, T., Dutta, J., & Loukoianova, E. (2006). Democracy comes to Europe: franchise expansion and fiscal 1830–1938. *Eur. Econ. Rev. 50 (2),* 249–283.

Alesina, A., & Perotti, R. (1994). Income Distribution, Political Instability and Investment. *1994-95 Discussion Paper Series No. 751*.

Alesina, A., & Rodrik, D. (1994). Distributive Politics and Economic Growth. *Quarterly Journal of Economics, 109*, 465-490.

Alesina, A., & Tabellini, G. (1989). External Debt, Capital Flight and Political Risk. *Journal of International Economics, 27,* 199-220.

Alesina, A., Ozler, S., Roubini, N., & Swagel, P. (1996). Political Instability and Economic Growth. *Journal of Economic Growth, 1(2),* 189-211.

Anderson, T., & Hsiao, C. (1981). Estimation of dynamic models with error components. *Journal of the American Statistical Association, 76,* 598–606.

Arellano, M. (1989). A note on the Anderson–Hsiao estimator for panel data. *Economics Letters, 31*, 337–341.

Arellano, M., & Bond, S. (1991). Some tests of specification for panel data: Monte Carlo evidence and an application to employment equations. *Review of Economic Studies, 58*, 277–297.

Arellano, M., & Bover, O. (1995). Another look at the instrumental variables estimation of errorcomponent models. *Journal of Econometrics, 68*, 29–51.

Baltagi, B. (2005). *Econometric Analysis of Panel Data* (Third ed.). John Wiley & Sons, Ltd.

Barro, R. (1989). A Cross-Country Study of Growth, Saving and Government. *NBER Working Paper No. 2855*.

Barro, R. (1991). Economic Growth in a Cross Section of Countries. *The Quarterly Journal of Economics, Vol. 106, No.2*, 407-443.

Barro, R. (2000). Inequality and Growth in a Panel of Countries. *Journal of Economic Growth, 5*, 5-32.

Baum, C. (2006). *An Introduction to Modern Econometrics using Stata.* Stata Press books, StataCorp LP, number imeus September.

Baum, C. (2013). Implementing new econometric tools in Stata. *Mexican Stata Users' Group Meetings.* Stata Users Group.

Baum, C., & Schaffer, M. (2003). Instrumental variables and GMM: Estimation and testing. The Stata Journal. *3(1),* 1-31.

Baum, C., Schaffer, M., & Stillman, S. (2007). Enhanced routines for instrumental variables/generalized method of moments estimation and testing. *The Stata Journal, 7(4),* 465-506.

Bénabou, R. (1996). Inequality and Growth. *CEPR Discussion Papers 1450, C.E.P.R. Discussion Papers*.

Bénabou, R. (n.d.). Equity and Efficiency in Human Capital Investment: The Local Connection. *Review of Economic Studies, 63(2),* 237-264.

Berg, A. G., & Ostry, J. D. (2011). Inequality and Unsustainable Growth: Two Sides of the Same Coin? . *IMF (Ed.), IMF Staff Discussion Note*.

Berg, A., & Sachs, J. (1988). The Debt Crisis: Structural Explanations of Country Performance . *Journal of Development Economics, Vol. 29, No. 3*, 271–306.

Blundell, R., & Bond, S. (1998). Initial conditions and moment restrictions in dynamic panel data models. *Journal of Econometrics, 87*, 115-143.

Bond, S. (2002). Dynamic panel data models: a guide to micro data methods and practice. *Portuguese Economic Journal*, 141–162. doi:0.1007/s10258-002-0009-9

Bond, S., Anke, H., & Temple, J. (2001). GMM Estimation of Empirical Growth Models. *CEPR Discussion Papers, 3048*.

Brown, D., & Hunter, W. (1999). Democracy and social spending in Latin America, 1980–92 . *Am. Polit Sci. Rev. 93 (4),* 779–790.

Burkhart, R. (1997). Comparative democracy and income distribution: shape and direction of the causal arrow. *J. Polit. 59 (1),* pp. 148-164.

Crook, C. (2006, September). The Height of Inequality. *The Atlantic. Retrieved 28 May 2015*.

Foellmi, R., & Zweilmueller, J. (2006). Structural Change and the Kaldor Facts of Economic Growth . *2006 Meeting Papers 342, Society for Economic Dynamics.*

Galor, O., & Zeira, J. (1993). Income Distribution and Macroeconomics. *Review of Economic Studies, 60,* 35-52.

Gil, R., Mulligan, C., & Sala-i-Martin, X. (2004). Do democracies have different public policies than nondemocracies? *J. Econ. Perspect. 18*, 51–74.

Glaeser, E. (2003). Introduction to "The Governance of Not-for-Profit Organizations". *NBER Chapters*, pp. 1-44.

Gradstein, M., & Justman, M. (1999b). The democratization of political elites and the decline in inequality in modern economic growth. In E. Breizes, & P. (. Temin, *Elites, Minorities and Economic Growth.* Amsterdam: Elsevier.

Grossman, H. (1991). A General Equilibrium Model of Insurrections. *American Economic Review, 81*(4), 912-921.

Haughton, J., & Khandker, S. (2009). *Handbook on Poverty and Inequality.* World Bank Publications, The World Bank, number 11985.

Huber, E., & Stephens, J. (2012). Democracy and the Left: Social Policy and Inequality in Latin America. University of Chicago Press, Chicago, IL.

Islam, N. (1995). Growth Empirics: A Panel Data Approach. *The Quarterly Journal of Economics, 110(4)*, 1127-70.

Judson, R., & Owen, A. (1999). Estimating dynamic panel data models: A guide for macroeconomists. *Economics Letters, 65*, 9-15.

Kaldor, N. (1956). Alternative Theories of Distribution. *Review of Economic Studies, 23*, 83-100.

Kaufman, R., & Segura-Ubiergo, A. (2001). Globalization, domestic politics, and social spending in Latin America: a time-series cross-section analysis, 1973–97. *World Polit. 53 (4)*, 553–587.

Keane, M., & Runkle, D. (1992). On the estimation of panel-data models with serial correlation when instruments are not strictly exogenous. *Journal of Business and Economic Statistics, 10*, 1-9.

Kiviet, J. (1995). On bias, inconsistency and efficiency of various estimators in dynamic panel data models. *Journal of Econometrics, 68*, 53–78.

Kormendi, R., & Meguire, P. (1985). Macroeconomic Determinants of Growth: Cross-Country evidence. *Journal of Monetary Economics*, 141-163.

Kuznets, S. (1955). Economic Growth and Income Inequality. *American Economic Review 65*, 1-28.

Lee, C.-S. (2005). Income inequality, democracy, and public sector size. *Am. Sociol. Rev. 70 (1)*, 158–181.

Li, H., Squire, L., & Zou, H.-f. (1998). Explaining international and intertemporal variations in income inequality. *Econ. J. 108 (1)*, 26-43.

Lindert, P. (1994). The rise of social spending, 1880–1930. *Explor. Econ. Hist. 31 (1)*, 1-37.

Londregan, J., & Poole, K. (1990, January). Poverty, The Coup Trap and The Seizure of Executive Power. *World Politics*.

Lorenz, M. (1905). Methods of Measuring the Concentration of Wealth. *Journal of the American Statistical Association (new series), 70*, 209-217.

Lott Jr., J., & Kenny, L. (1999). How dramatically did women's suffrage change the size and scope of government? *J. Polit. Econ. 107 (6)*, 1163–1198.

Loury, G. (1981). Intergenerational Transfers and the Distribution of Earnings. *Econometrica , Vol. 49, No. 4*, 843-867.

Love, I. and L. Zicchino (2006). Financial development and dynamic investment behavior: Evidence from panel VAR. *The Quarterly Review of Economics and Finance*, 46(2), 190-210.

Meltzer, A., & Richard, S. (1981). A rational theory of the size of government. *J. Polit. Econ. 89*, 914-927.

Miller, G. (2008). Women's suffrage, political responsiveness, and child survival in American history. *Q. J. Econ. 123 (3)*, 1287–1327.

Muller, E. (1988). Democracy, economic development, and income inequality. *Am. Sociol. Rev. 53 (1)*, 50-68.

Nickell, S. (1981, November). Biases in Dynamic Models with Fixed Effects. Econometrica. *Econometrica, Vol. 49, No. 6 (, 49(6)*, 1417-1426.

Okun, A. (1975). Equality and Efficiency: the Big Trade-Off. *Brookings Institution Press*.

Ortiz-Ospina, E., & Roser, M. (2016). *Income Inequality.* Retrieved from OurWorldInData.org: ourworldindata.org/income-inequality

Perotti, R. (1993, September). Political Equilibrium, Income Distribution, and Growth. *Review of Economic Studies, 60(4)*, 755-776.

Persson, T., & Tabellini, G. (2003). The Economic Effects of Constitutions. MIT Press, Cambridge.

Przeworski, A., Alvarez, M., Cheibub, J., & Limongi, F. (2000). Democracy and Development: Political Institutions and Material Well-being in the World, 1950–1990. New York, NY: Cambridge University Press.

Rodrik, D. (1999). Democracies pay higher wages. . *Q. J. Econ. 114*, 707–738.

Roodman, D. (2006). How to Do xtabond2: An Introduction to "Difference" and "System" GMM in Stata. *Working Papers 103, Center for Global Development*.

Roodman, D. (2009). How to do xtabond2: An introduction to difference and system GMM. *The Stata Journal,, 9(1)*, 86-136.

Rosenzweig, M., & Binswanger, H. (1993). Wealth, Weather Risk and the Composition and Profitability of Agricultural Investments. *Economic Journal 103(416)*, 56-78.

Scheve, K., & Stasavage, D. (2009). Institutions, Partisanship, and Inequality in the Long Run. *World Polit. 61*, 215–253.

Scheve, K., & Stasavage, D. (2010). The conscription of wealth: mass warfare and the demand for progressive taxation. *Inter. Organ. 64*, 529–561.

Scheve, K., & Stasavage, D. (2012). Democracy, war, and wealth: lessons from two centuries of inheritance taxation. *Am. Polit. Sci. Rev. 106 (1)*, 82–102.

Simpson, M. (1990). Political rights and income inequality: a cross-national test. *Am. Sociol. Rev. 55 (5)*, 682-693.

Sirowy, L., & Inkeles, A. (1990). The effects of democracy on economic growth and inequality: a review. *Stud. Comput. Inter. Develop. 25*, pp. 126-57.

Stiglitz, J. (2012). *The Price of Inequality: How Today's Divided Society Endangers Our Future.* W. W. Norton & Company.

Voitchovsky, S. (2005). Does the Profile of Income Inequality Matter for Economic Growth? *Journal of Economic Growth, 10(3)*, 273-296.

Appendix

Box 1. Covariance based calculation of Gini coefficient

Covariance-based Gini coefficient as mentioned by Yitzhaki (1998):

$$GINI(X) = -2Cov\left(\frac{X}{\mu(X)}, (1 - F(X))\right)$$

Where X is a random variable of interest with mean $\mu(X)$ and $F(X)$ is its cumulative distribution function. The Concentration coefficient measures the association between two random variables and can be expressed as

$$CONC(X,Y) = -2Cov\left(\frac{X}{\mu(X)}, (1 - G(Y))\right)$$

Where $G(Y)$ is the cumulative distribution function of Y. $CONC(X,Y)$ reflects how much X concentrated on observations with high ranks in Y.

A single-parameter generalization of the Gini coefficient has been proposed by Donaldson & Weymark (1980, 1983) and Yitzhaki (1983). The generalized Gini coefficient (S-Gini, or extended Gini coefficient) can also be expressed as a covariance:

$$GINI(X;v) = -vCov\left(\frac{X}{\mu(X)}, (1 - F(X))^{v-1}\right)$$

Where v is a parameter tuning the degree of 'aversion to inequality'. The standard Gini correspongs to v=2

The fractional ranks are calculated as following

Consider a sample of N observations on a variable Y with associated sample weights: $\{(y_i, w_i)\}_{i=1}^{N}$. Lek K be the number of distinct values observerd on Y, denoted $y_1^* < y_2^* < \cdots < y_k^*$, and denote by π_k^* the corresponding weighted sample proportions:

$$\pi_k^* = \frac{\sum_{i=1}^{N} w_i 1(y_i = y_k^*)}{\sum_{i=1}^{N} w_i}$$

(1(condition) is equal to 1 if condition is true and 0 otherwise). The fractional rank attached to each y_k^* is given by

$$F_k^* = \sum_{j=0}^{k-1} \pi_j^* + 0.5\pi_k^*$$

where $\pi_0^* = 0$ (Lerman & Yitzhaki, 1989, Chotikapanich & Griffiths, 2001). Each observation in the sample is then associated with the fractional rank

$$F_k^* = \sum_{k=1}^{K} F_k^* 1(y_i = y_k^*)$$

This procedure ensures that tied observations are associated with identical fractional ranks and that the sample mean of the fractional ranks is equal to 0.5. $\{(F_i, y_i, w_i)\}_{i=1}^{N}$ can then be plugged in a standard sample covariance formula. This makes the resulting Gini coefficient estimate independent on the sample/population size.

Box2. Panel VAR specification

Abrigo and Love (2015) consider a k-variate homogeneous panel VAR of order p with panel-specific fixed effects represented by the following system of linear equations:

$$\boldsymbol{Y_{it}} = \boldsymbol{Y_{it-1}A_1} + \boldsymbol{Y_{it-2}A_2} + \cdots + \boldsymbol{Y_{it-p+1}A_{p-1}} + \boldsymbol{Y_{it-p}A_p} + \boldsymbol{X_{it}B} + \boldsymbol{u_i} + \boldsymbol{e_{it}}$$
$$i \in \{1,2,\dots,N\}, t \in \{1,2,\dots,T_i\} \quad (1)$$

where $\boldsymbol{Y_{it}}$ is a $(1xk)$ vector of dependent variables; $\boldsymbol{X_{it}}$ is a $(1xl)$ vector of exogenous covariates; $\boldsymbol{u_i}$ and $\boldsymbol{e_{it}}$ are $(1xk)$ vectors of dependent variable-specific panel fixed-effects and idiosyncratic errors, respectively. The (kxk) matrices $\boldsymbol{A_1}, \boldsymbol{A_2}, \dots, \boldsymbol{A_{p-1}}, \boldsymbol{A_p}$ and the (lxk) matrix $\boldsymbol{B}$ are parameters to be estimated. We assume that the innovations have the following characteristics: $\boldsymbol{E}[\boldsymbol{e_{it}}] = \boldsymbol{0}, \boldsymbol{E}[\boldsymbol{e_{it}'e_{it}}] = \boldsymbol{\Sigma}$ and $\boldsymbol{E}[\boldsymbol{e_{it}'e_{is}}] = \boldsymbol{0}$ for all $t > s$.

The parameters above may be estimated jointly with the fixed effects or, alternatively, independently of the fixed effects after some transformation, using equation-by-equation ordinary least squares (OLS). With the presence of lagged dependent variables in the right-hand side of the system of equations, however, estimates would be biased even with large N (Nickell, 1981). Although the bias approaches zero as T gets larger, simulations by Judson and Owen (1999) find significant bias even when $T = 30$.

GMM Framework

Various estimators based on GMM have been proposed to calculate consistent estimates of the above equation, especially in fixed T and large N settings. With our assumption that errors are serially uncorrelated, the first-difference transformation may be consistently estimated equation-by-equation by instrumenting lagged differences with differences and levels of $\boldsymbol{Y_{it}}$ from earlier periods as proposed by Anderson and Hsiao (1982). This estimator, however, poses some problems. The first-difference transformation magnifies the gap in unbalanced panels. For instance, if some $\boldsymbol{Y_{it-1}}$ are not available, then the first-differences at time t and $t-1$ are likewise missing. Also, the necessary time periods each panel is observed gets larger with the lag order of the panel VAR. As an example, for a second-order panel VAR, instruments in levels require that $T_i \geq 5$ realizations are observed for each subject.

Box2. Panel VAR specification contd'

Arellano and Bover (1995) proposed forward orthogonal deviation as an alternative transformation, which does not share the weaknesses of the first-difference transformation. Instead of using deviations from past realizations, it subtracts the average of all available future observations, thereby minimizing data loss. Since past realizations are not included in this transformation, they remain valid instruments. Potentially, only the most recent observation is not used in estimation. In a second-order panel VAR, for instance, only $T_i \geq 4$ realizations are necessary to have instruments in levels. Improving efficiency by including a longer set of lags as instruments will reduce observations especially with unbalanced panels or with missing observations, in general. As a remedy, Holtz-Eakin, Newey and Rosen (1988) proposed creating instruments using observed realizations, with missing observations substituted with zero, based on the standard assumption that the instrument list is uncorrelated with the errors.

While equation-by-equation GMM estimation yields consistent estimates of panel VAR, estimating the model as a system of equations may result in efficiency gains (Holtz-Eakin, Newey and Rosen, 1988). Suppose the common set of $L \geq kp + l$ instruments is given by the row vector $\boldsymbol{Z_{it}}$, where $\boldsymbol{X_{it}} \in \boldsymbol{Z_{it}}$, and equations are indexed by a number in superscript. Consider the following transformed panel VAR model based on equation (1) but represented in a more compact form:

$$\begin{gathered}
\boldsymbol{Y_{it}^{*}} = \overline{\boldsymbol{Y_{it}^{*}}}\boldsymbol{A} + \boldsymbol{e_{it}^{*}} \\
\boldsymbol{Y_{it}^{*}} = [\boldsymbol{y_{it}^{1*}} \quad \boldsymbol{y_{it}^{2*}} \quad \ldots \quad \boldsymbol{y_{it}^{k-1*}} \quad \boldsymbol{y_{it}^{k*}}] \\
\overline{\boldsymbol{Y_{it}^{*}}} = [\boldsymbol{Y_{it-1}^{*}} \quad \boldsymbol{Y_{it-2}^{*}} \quad \ldots \quad \boldsymbol{Y_{it-p+1}^{*}} \quad \boldsymbol{Y_{it-p}^{*}} \quad \boldsymbol{X_{it}^{*}}] \\
\boldsymbol{e_{it}^{*}} = [\boldsymbol{e_{it}^{1*}} \quad \boldsymbol{e_{it}^{2*}} \quad \ldots \quad \boldsymbol{e_{it}^{k-1*}} \quad \boldsymbol{e_{it}^{k*}}] \\
\boldsymbol{A'} = \left[\boldsymbol{A_1}' \quad \boldsymbol{A_2}' \quad \ldots \quad \boldsymbol{A_{p-1}'} \quad \boldsymbol{A_p}' \quad \boldsymbol{B'}\right]
\end{gathered} \tag{2}$$

where the asterisk denotes some transformation of the original variable. If the original variable is denoted as m_{it}, then the first difference transformation imply that $m_{it}^{*} = m_{it} - m_{it-1}$, while for the forward orthogonal deviation $m_{it}^{*} = (m_{it} - \overline{m_{it}})\sqrt{T_{it}/(T_{it}+1)}$, where T_{it} is the number of available future observations for panel i at time t, and $\overline{m_{it}}$ is its average.

The GMM estimator is given by

$$\boldsymbol{A} = \left(\overline{\boldsymbol{Y^{*}}}'\boldsymbol{Z}\,\widehat{\boldsymbol{W}}\,\boldsymbol{Z}'\overline{\boldsymbol{Y^{*}}}\right)^{-1}(\overline{\boldsymbol{Y^{*}}}'\boldsymbol{Z}\,\widehat{\boldsymbol{W}}\,\boldsymbol{Z}'\boldsymbol{Y^{*}}) \tag{3}$$

where $\widehat{\boldsymbol{W}}$ is a $(L\ x\ L)$ weighting matrix assumed to be non-singular, symmetric and positive semi-definite. Assuming that $\boldsymbol{E}[\boldsymbol{Z'e}] = \boldsymbol{0}$ and rank $\boldsymbol{E}\left[\overline{\boldsymbol{Y^{*}}}'\boldsymbol{Z}\right] = kp + l$, the GMM estimator is consistent. The weighting matrix $\widehat{\boldsymbol{W}}$ may be selected to maximize efficiency (Hansen, 1982).

Joint estimation of the system of equations makes cross-equation hypothesis testing straightforward. Wald tests about the parameters may be implemented based on the GMM estimate of $\boldsymbol{A}$ and its covariance matrix. Granger causality tests, with the hypothesis that all coefficients on the lag of variable m are jointly zero in the equation for variable n, may likewise be carried out using this test.

Chapter 2

Negative Impact of Inequality on Economic Growth: Testing Transmission Channels

Göksu Aslan

Abstract

Income inequality may affect economic growth indirectly through various transmission channels, in addition to its direct effects. Negative effects may arise from political economy, socio-political instability, and credit market imperfection channels. In other words, inequality may have indirect effects on economic growth by affecting these transmission channels. In this paper, the focus is testing negative impact of income inequality, using both Gini index or the income share of top 10 percent of the population for robustness, through political economy, credit market imperfections and political instability channels on economic growth. I use taxes on income, profits, and capital gains as a proxy for redistributive pressure, secondary school enrolment rates as a proxy of credit market imperfections and rule of law index as a proxy of political stability. In order to test the possible effects through these channel, income inequality, transmission channels and related interaction terms are added into the growth model. Following the system GMM estimations on a panel dataset including 3-year averaged observations for 51 countries over a period from 1996 to 2015, the results show that there is negative interaction between income inequality and mentioned channels, even the direct impact income inequality is found as positive. Marginal effects of the related transmission channels are interpreted for different levels of income inequality.

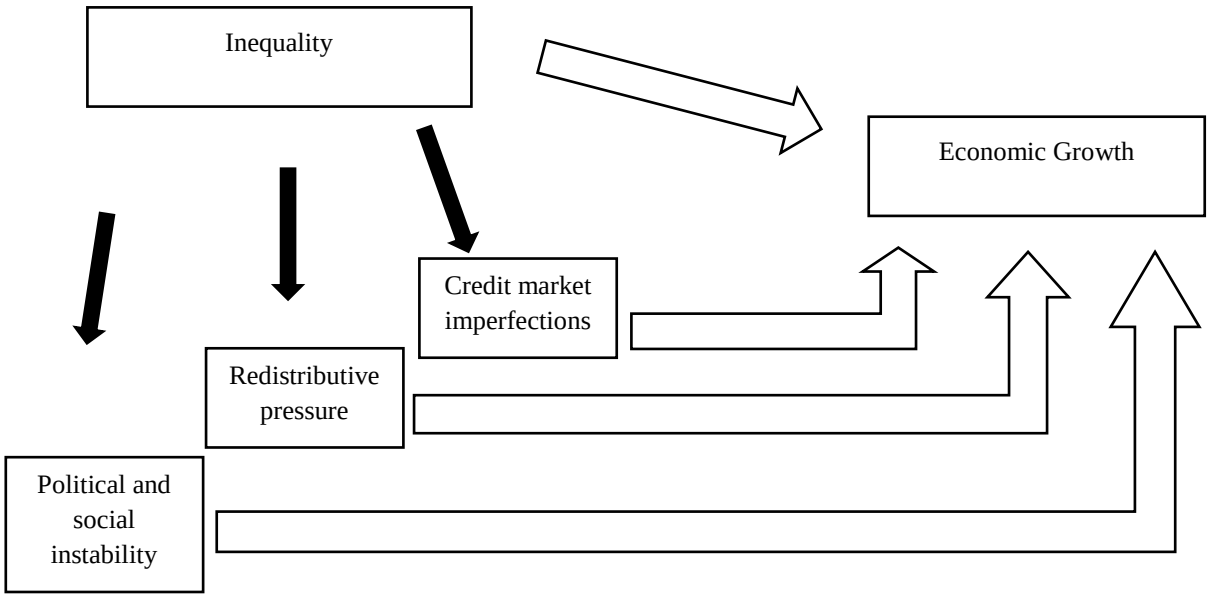
Keywords: Economic growth, inequality, panel data

JEL classification: H23, O15, O47

Introduction

The indirect effects of income inequality on economic growth may occur through various transmission channels. Inequality which can undermine progress in health, education, causes investment reducing political and economic instability and undercutting the social consensus required to adjust in the face of shocks. Negative impact may arise from socio-political instability, in other words political system and social unrest, political economy and credit market imperfection channels. Therefore, inequality may have indirect effects on economic growth by affecting these transmission channels. In this paper, main focus is testing the existence of the negative interaction between income inequality and mentioned channels, after controlling for its direct impact. Following the estimation results, marginal effects of related channels are shown and interpreted. Diagram 1 shows the summary of the complex relationship explaining the aim of the this paper.

Diagram 1. Inequality and its indirect impact through transmission channels



Testing for significant interaction terms is the focus of the analyses. Main questions to be answered here are “What are the effects of these channels on economic growth?” and “What is the effect of income inequality on economic growth?”. Answers rely on “They depend on how income is distributed” and “It mainly depends on policies implied by government”

respectively. Consequently, policy introducing income taxes, improving education opportunities and socio-political environment will depend how income is distributed among the population.

First section covers literature review on income inequality effects especially through mentioned transmission channels. This section is subsectioned into the extent of three transmission channels. Second section explains the model and the data used in the analyses. Third section gives the results for each channel through subsections. Last section concludes.

1. Literature Review

The existing literature considers two forms of inequality. These are inequality of opportunities and inequality of outcomes as mentioned in The World Bank Development Report 2006. These may also be called structural inequality and market inequality according to Easterly (2007). The idea of this denomination is that structural inequality relates to socio-institutional factors and that market inequality relates to market forces. Structural inequality refers to bad institutions, low human capital investment and underdevelopment. Market inequality refers to uneven success in free markets. While the former is expected to have a negative effect on subsequent economic growth, market inequality is expected to have a positive effect. Both classical and modern views suggest growth enhancing effect through the incentives for capital accumulation and for innovation such as incentives to work hard and take risks and to agglomeration economies.

Kaldor (1955) emphasizes the impact of income distribution on capital accumulation and therefore on economic growth, concentrating on the opposite direction which is the impact of economic growth or stage of development on income distribution. Inequality can generate socio-political instability which undermines incentives to save and invest.

Alesina and Perotti (1996) analyse inequality measured as the share of the income in the third and fourth quintiles on economic growth through the fiscal policy approach. Their results related to the transmission channels argue that economic growth increases as distortionary taxation decreases (the economic mechanism), redistributive government expenditure and therefore distortionary taxation decrease as equality increases (the political mechanism) and growth increases as equality increases.

Castells-Quintana and Royuela (2014) review the theory and the evidence on the different transmission channels through which inequality affects growth. They argue that inequality may have both a positive and negative impact in which negative impact accounts for roughly 80 per cent of the total impact. Their results suggest that each transmission channel may depend on the circumstances of each country, such that the negative impact of inequality is significant in developing countries. They brief the mechanisms through which inequality may affect negatively long-term economic growth, such as socio-political instability, political economy approach, credit-market imperfections, market size approach and endogenous fertility approach. Castells-Quintana and Royuela (2014) mentions also the transmission channels related to the positive impact. They set a neoclassical growth model approach based Sala-i-Martin`s analysis where economic growth is the dependent variable, cumulative average GDP growth rate, and the income inequality are independent variables and the other control variables including the initial income level. They use system of recursive equation using cross sectional data.

The existing applied research mostly uses introducing a single measure of income inequality in an economic growth model.

Davis and Hopkins (2011) argue that the quality of economic institutions is the key omitted variable which explains the negative impact of inequality on long-term growth.

Ferreira (1999) briefs three channels; political economy channels, capital market imperfections and social conflict channels.

There are few studies which separately measure each transmission channel. These studies mostly investigate this controversial relationship using variables which are already known as relevant to economic growth, such as investment. Existing studies do not consider the different channels in a single model.

Mo (2000) summarizes the transmission channels into three parts such that inequality can generate socio-political instability undermining incentives to save and invest; the socio-political instability caused by income inequality would generate pressure to government to increase income redistribution which reduces economic incentives, thereby slowing down capital accumulation and economic growth and the accumulation of human capital. The latest

channel states in the case that borrowing is difficult and costly, the poor are denied to investment in human capital; therefore income inequality results in a poverty cycle reducing the average skill level of the labour force by making it harder for the poor to invest in human capital for themselves as well as for their children. Mo (2000) examines the impact of inequality on the growth of productivity, capital and GDP, by considering also the roles of political instability, income redistribution and human capital channels in the inequality-growth linkage.

Barro (2000) argue that the negative effect of inequality on growth shows up for poor countries while the relationship for rich countries is positive, but finds weak the overall effects of inequality on growth and investment, using a dataset over three decades. In the growth literature, it is most likely to use 5-year or 10-year average data since applying the theories to annual or other high-frequency observations would compound the measurement error in the data by emphasizing errors related to the timing of relationships.

Easterly (2007) shows that inequality predicts a lower level of development, worse institutions, and a lower level of schooling. This impact is higher in instrumental variables than in OLS which underestimates the negative impact because of the causal effect of inequality on development outcomes. Reduced form estimations are most likely to include different effects at the same time (Bourguignon, 1996). A common approach is to use some variables as proxies for the transmission channels. Under the endogeneity on the impact of inequality on economic growth and the existence of two-way impact, another approach is to isolate one of the components using specific instruments for inequality. These approaches use instrumental variables to capture a particular component of inequality or any other transmission channel. Castells-Quintana and Royuela (2014) assess the relevance of each transmission channel by using different variables proposed in the literature and differentiate between two forms of inequality in its relationship with long-term economic growth. They apply the Control Function Approach (CFA) as to deal with the endogeneity problem. CFA uses instruments to break the correlation between endogenous explanatory variables and unobservable variables. In linear models with one endogenous regressor, CFA yields identical results to those obtained with 2SLS. CFA yields consistent estimates if instruments are valid. (Imbens and Wouldridge 2009, Wouldridge 2010) CFA use instruments for inequality that are exogenous in model. They use

the initial level of GDP per capita, the life expectancy at birth, the primary school enrolment rate, the number of years in which the economy had been open between 1950 and 1994, the fraction of primary exports in total exports, and the fraction of mining in GDP as the data which come from Sala-i-Martin et al. (2004), the Penn World Table (PWT) , the World Bank Development Indicators database, and Gruen and Klasen (2008); covering a sample of 51 countries over the period of 1970-2007.

As mentioned World Bank Development Report (2006), in the case of high inequality in economic and political institutions, those with more influence may systematically more benefit from the economic institutions and social arrangements. Therefore, society becomes more efficient and omits the opportunities for innovation and investment. Globally speaking, developing countries have little influence on global governance. Economic and political inequalities are associated with impaired institutional development. The second channel through which inequality affects long-run processes of development is the shaping of economic and political institutions. Institutions determine the incentives and constraints people face and provide the context in which markets function. Different sets of institutions are the outcome of complex historical processes that reflect the interests and structure of political influence of different individuals and groups in a society. From this perspective, market imperfections may arise not by accident but because they distribute income or power in particular ways. In this view, there will be social conflict over the institutions of society and incentives for people who control power to shape institutions in ways that benefit them. In the case of market imperfection, the distributions of wealth and power affect the allocation of investment opportunities.

The impact of unequal opportunities and political power is more damaging because economic, political, and social inequalities tend to reproduce themselves over time and across generations.

Castells-Quintana and Royuela (2014) use proxies of variables as share of average government spending and share of average expenditure on education in GDP for redistributive policies; the sound money and patents as proxies for innovation for credit market imperfections, aggregate GDP and the share of the 3rd quantile in the income distribution for domestic market size; population growth rates, infant mortality rates, and the proportion of family farms for fertility decisions. They add control variables, stating the time-invariant variables are expected to

capture structural component of inequality. Their results suggest that the higher inequality has a negative impact on the long-term economic growth, by social unrest and political instability, and by lowering aggregate demand.

Inequalities of opportunities, in the other words structural inequality, are related to socio-institutional factors, such as bad institutions, low human capital investment, underdevelopment.

Following the literature, transmission channels are observed into three groups such as political instability, political economy and credit market imperfections.

1.1. Political economy

The demand for fiscal redistribution financed by distortionary taxation is higher, causing a lower rate of growth. Unequal income distribution is associated with lower economic growth. Alesina and Rodrik (1994) mention that this relationship arises from the redistributive policies. Less equal societies tend to redistribute more and in turn, redistributive policies reduce growth by introducing economic distortion. They focus on capital taxation because of the simplicity of formalizing redistributive policy.

In economically unequal countries, political power may be distributed in a more egalitarian fashion than economic power. Efforts to use this political power to effect redistribution, through the tax system, may create disincentives to investment and result in lower or less durable growth (Alesina and Rodrik, 1994). Meanwhile, efforts by economic elites to resist this redistribution, for example, through vote buying and other corrupt behaviour, itself could be distortionary and wasteful and thus also detrimental to growth (Barro, 2000).

1.2. Credit market imperfections

Poor people may not have the means to finance their education. A more equal distribution of income could thus increase investment in human capital and hence growth. Berg and Ostry (2011) find a negative correlation between some indicators of human capital (notably, secondary education achievement) and income distribution, even controlling for per capita income, related to the arguments in Wilkinson and Pickett (2009) that more unequal countries suffer from relatively poor social indicators. Galor and Zeira (1993) mention that the household

needs to be wealthy enough to be able to finance the profitable investment, such as setting up a company or having higher education.

Galor and Zeira (1993) show that in the presence of credit market imperfections and indivisibilities in human capital, the initial distribution of wealth affects aggregate output and investment both for short and long run, as there are multiple steady states. Their paper explains a theoretical linkage between income distribution and macroeconomics, through investment in human capital. They develop an equilibrium model of open economies with overlapping generations and inter-generational altruism that include a single good produced by either skill-intensive or an unskilled intensive process. Individuals live two periods. In the first period, they may choose between invest in human capital and have education or work as unskilled. In the second period, they work as skilled or unskilled according to their education level, consume and leave bequests. The inheritance of individuals determines whether they invest in human capital or not. As soon as the different levels of investment in human capital in turn determine the distribution of income which change the distribution of wealth through time, its effects do not occur only in short run but also in the long run. Their two major assumptions are that credit markets are imperfect, as the interest rate for individual borrowers is higher than that for lenders; and that investment in human capital is invisible, as namely there is a technological non-convexity. The short-run impact of credit market imperfection arises from the fact that when borrowing is difficult and costly, those who inherit a large initial wealth and do not need to borrow have better access to investment in human capital. Loury (1981) shows that under credit market imperfections the effect of wealth distribution which converges to a unique ergodic distribution in his model disappears in the long run. Galor and Zeira (1993) add the assumption into the model where technology is non-convex, the inherited distribution of wealth affects the economy not only in the short run but also in the long run. This assumption results the existence of multiple long-run equilibria and non-ergodic dynamics. They examine the differences in economies through investment in human capital due to credit market imperfections. In the case of variable wage, if the economy is developed, an egalitarian long-run equilibrium, where net life-time income of skilled workers and of unskilled workers are equal. In other words, a less developed economy converges to an unequal distribution of income, a rich economy converges to an equal distribution of lifetime income. They also mention that the way an economy adjusts to macroeconomic shocks and technological

improvement depends on the initial distribution of income. The economies with more equal distribution of income adjust better to macroeconomic shocks; and they face increases in investment in human capital and the economic benefits from the innovation compare to the economies with highly unequal distribution of income.

Wasmer and Weil (2004) introduce endogenous frictions in credit and labour market following Diamond (1990)'s approach. Credit frictions amplify macroeconomic volatility through a financial accelerator which is proportional to the credit gap defined as the variation of actual output from its perfect credit market level.

The borrower's net worth plays crucial roles in allocating the credit across entrepreneurs, firms, industries and nations. A change in the aggregate level of the wealth and a change of distribution of wealth affect the equilibrium allocation of the credit and patterns of investments resulting a change in the level of distribution of wealth that would cause in turn a change in the equilibrium patterns of investments. (Matsuyma, 2007)

1.3. Political instability

Political instability is the durability and integrity of a current government regime. This is determined based on the amount of violence and terrorism expressed in the nation and by citizens associated with the state. A stable society is one that is satisfied with the ruling party and system of operations and is not interested in revolutionary or despotic ideas.

Income inequality may increase the risk of political instability, and the resulting uncertainty could reduce incentives to invest and hence impair growth. Rodrik (1999) argues that inequality and political instability may hamper countries' effectiveness in responding to external shocks. Similarly, Berg and Sachs (1988) find that unequal societies tended to experience relatively severe debt crises in the 1980s. IILS (2010) highlights links between unemployment and social unrest.

Barro (1991) finds that political instability measures, such as number of assassinations and the occurrence of violent revolutions and military coups significantly affect the average growth level in cross section regressions on a large sample of countries.

Kormendi and McGuire (1985) and Barro (1989) find that a measure of the extent of political rights is positively correlated with growth.

Londregan and Poole (1990, 1991a) have addressed the problem of joint endogeneity between the economy and polity by estimating a system of equations in which the dependent variables are GNP growth and coups d'etat. They do not find evidence of reduced growth as a consequence of increased political instability.

Alesina and Tabellini (1989) examine the effect of political uncertainty on investment and capital flight, explaining the simultaneous occurrence of large external debts, private capital outflows and low domestic capital formation, considering a general equilibrium model in which two government types with conflicting distributional goals randomly alternate in office. They argue that uncertainty over the fiscal policies of future governments generates capital flight and small domestic investment, and induces the overaccumulation of external debt by the government. The model also predicts that left-wing governments are more inclined to restrict capital outflows than right-wing governments. They examine how political uncertainty affects the risk premium and how debt repudiation may occur after a regime change.

Grossman (1991) examines the probability of revolutions, and argue that in countries where rulers are relatively weak, the probability of revolutions is higher and the citizens have higher incentives to engage in revolutionary activities rather than productive market activities.

Alesina and Perotti (1994), using a cross sectional dataset of 71 countries for the period of 1960-85, find that income inequality increases social discontent and this causes social unrest, in turn by creating unstable political environment creates a negative effect on investment, thus on growth. They test whether income distribution influences investment directly, in addition to the channel via politically instability.

Defining and measuring political and social stability/instability are not easy in a way which can be used in econometric research. Alesina and Perotti (1994) describe two channels that can be into measuring political instability as executive instability and indicators of social unrest and political violence. While executive instability is related to the propensity to observe government changes which can be constitutional or unconstitutional, the latter is related to the constructed indices which summarize various variable capturing phenomena of social unrest.

Hibbs (1973) uses the method of principal components to construct such index. Recently, Venieris and Gupta (1986), (1989), Gupta (1990), Barro (1991), Ozler and Tabellini (1991), Benhabib and Spiegel (1992) and Mauro (1993) use several indices of socio-political instability as an explanatory variable in growth regressions.

Alesina et.al (1996) defines political instability as the propensity of government collapse, either by "constitutional" or "unconstitutional" means. Their results argue that in countries and time periods with high propensity of government collapse, growth is significantly lower than otherwise. An unstable political environment may reduce may reduce investments and therefore the speed of economic growth. Additionally, poor economic performance may lead to government collapse and political unrest. They mention two types of government changes, such as that all government turnovers including those that do not involve a significant change in ideological direction or an "irregular" transfer of power or alternatively those government turnovers that involve only these two types of changes. Their growth equation controlled for several economic determinants of growth, as identified by the recent empirical literature on economic growth, as well as some indicators of political unrest in the government change equation. Their analysis also includes constitutional transfers of power as well as coups d'etat.

Sbaouelgi (2013) follows a simultaneous equation model to decompose the direct and indirect effects of income inequality on economic growth as to quantify the transmission channels of income inequality, analysing direct and indirect effects of income inequality on growth through five channels such as human capital, financial liberalization, political stability, corruption and trade liberalization, by using cross sectional data.

Political instability may cause uncertainty on productive economic decisions, such as investment, production and labour supply. Existing research has the common idea that political instability lead to economic inefficiencies.

2. Methodology

2.1. The model

The starting point is the dynamic panel notation of the so-called Solow-Swan model which is developed by Islam (1995). This approach allows including unobservable individual country

and period specific effects. The inclusion of the regressors is not based upon a theoretical model, indeed the focus is testing the existence and direction of the interaction effects between income inequality and mentioned channels, after controlling also control variables. To do so, following dynamic specification of the panel data method, Equation 1 as below:

$$y_{it} - y_{it-1} = \beta_0 + \beta_1 y_{i,t-1} + \beta_2 I_{it} + \beta_3 \chi_{it} + \gamma' Z_{it} + \eta_i + \nu_{it} + \xi_t \quad (1)$$

for *i*=1, …, N and *t*=1, …, T.

Where

y_{it}: log of real GDP per capita of country *i* for time *t*

$y_{i,t-1}$: log of real GDP per capita of country *i* for time *t-1*.

$y_{it} - y_{it-1} \cong$ Average growth rate of country *i* for time *t*.

I_{it}: Initial level of net inequality of country *i* for time *t*.

X_{it}: Initial level of other dependent variables of country *i* for time *t*.

Z_{it}: Initial level of control variables of country *i* for time *t*.

η_i: unobserved country-specific effects

ξ_t: time effect of period *t*

ν_{it}: idiosyncratic error term

$I_{i,t-s}$, $X_{i,t-s}$: lagged terms of independent variables are used as instrumental variables

Z_{it}: Additional control variables, including investment share, population growth, total education and trade openness.

Equation 1 in more general form:

$$g_{it} = \beta_0 + \beta_1 y_{i,t-1} + \beta_2 I_{it} + \beta_3 X_{it} + \gamma' Z_{it} + \eta_i + \nu_{it} + \xi_t \quad (2)$$

$g_{\mathrm{it}} = y_{\mathrm{it}} - y_{\mathrm{it}-1} \cong$ 3-year average growth rate of country *i* for time *t*.[2]

The model in this paper introduces nonlinearities in the form of interaction effect of two regressors into the growth regression in Equation 2. This comes by adding up interaction term between income inequality and aforementioned variables as proxies for transmission channels.

As for testing the possible effects through various transmission channels, the interaction terms are added in the model such as:

$$\mathrm{INT\_TERM}_{it} = \mathrm{I}_{\mathrm{it}} * \mathrm{X}_{it} \quad (3)$$

By adding the interaction terms which will be separately added into each estimation, equation 2 becomes:

$$g_{\mathrm{it}} = \beta_0 + \beta_1 y_{\mathrm{i,t}-1} + \beta_2 \mathrm{I}_{\mathrm{it}} + \beta_3 \mathrm{X}_{it} + \beta_3 \mathrm{I}_{\mathrm{it}} * \mathrm{X}_{it} + \gamma' Z_{it} + \eta_{\mathrm{i}} + \nu_{\mathrm{it}} + \xi_t + \mathrm{u}_{1,t} \mathrm{I}_{\mathrm{it}} + \mathrm{u}_{2,t} \mathrm{Z}_{it} \quad (4)$$

A significant coefficient of the interaction term, β_3, shows that there exists an interaction between two variables, in the same direction of its sign.

The effect of a one-unit change in I_{it} on g_{it} when condition transmission channel is present and will be equal to $\beta_1 + \beta_3 x(\mathrm{X}_{it})$. This is the impact of inequality on economic growth, for a given level of the transmission channel.

The effect of a one-unit change in X_{it} on g_{it} when condition I_{it} is present and will be equal to $\beta_2 + \beta_3 x(\mathrm{I}_{\mathrm{it}})$. This is the impact of the transmission channel on economic growth, for a given level of income inequality.

Equation 4 may be extended for all transmission channels in order to observe the direct effect of inequality and the possible indirect effect when condition the transmission channel is present.

Although *T* is short and unavailability of the lags of the variables, panel granger causality tests results are documented in Appendix separately for each estimation, using Arellano and Bover (1995) proposed forward orthogonal deviation as an alternative transformation which does not

[2] In the models where credit market imperfections and political instability channels are tested, growth rate is used as $\ln(y_{\mathrm{it}}) - \ln(y_{\mathrm{it}-1})$. However, in the models where political economy channel is tested, growth rate is used as the annualized average of growth rate of GDP per capita of 3 years.

share the weaknesses of the first-difference transformation. Instead of using deviations from past realizations, it subtracts the average of all available future observations, thereby minimizing data loss.[3]

Inclusion of control variables

A higher saving rate can sustain a higher level of output per capita as capital accumulation per individual also increases. In turn, the higher rate of saving is associated the richer country, in contrast with the higher rate of population growth. Augmented Solow Growth model associates higher saving rate to higher growth rate of real GDP per capita, higher $n+g+\delta$ to lower growth rate of real GDP per capita, with $g+\delta$ constant and equal to 0.05 across countries.[4]. Their model includes a constant and country specific shocks, assuming saving rate and population growth rates are independent. This assumption is relevant in models which have endogenous saving and population growth rate, since permanent differences in the level of technology do not affect savings rates or population growth rates. Without inclusion of human and physical capital, the rate of saving and population growth are too large. Human capital, particularly as attained through education, to economic progress (Lucas, 1988 and Mankiw, Romer and Weil, 1992). An abundance of well-educated people goes along with a high level of labour productivity. It also implies larger numbers of more skilled workers and greater ability to absorb advanced technology from developed countries. The level and distribution of educational attainment also have impact on social outcomes, such as child mortality, fertility, education of children, and income distribution (see for example Barro and Lee, 1994; de Gregorio and Lee, 2002; Breierova and Duflo, 2004; Cutler et al., 2006). Trade liberalization is expected to have a positive impact on economic growth, related to the fact that increased market size, promotion of competition, and transmission of know-how may link trade openness and growth and make growth more durable. Trade openness calculated as the rate of total import and exports to GDP, savings to GDP ratio and average annual hours worked by persons engaged are added as control variables, and expected to have positive sign.

[3] Potentially, only the most recent observation is not used in estimation. Since past realizations are not included in this transformation, they remain as valid instruments. For example, in a second-order panel VAR only $t \geq 4$ realizations are necessary to have instruments in levels.

[4] Where n, growth rate of working age population rate, g, technological growth rate, and δ, depreciation rate of capital.

Observed variables, inequality, income and profit taxes, secondary school enrolment, government indicators which are defined within countries, rely on government preferences; governments have the policy power on growth enhancing policies such as improving education, introducing taxes and changing the law.

2.2. Data

The dataset includes 3-year averaged observations for 51 countries over a period from 1996 to 2015. The Countries and periods are restricted to the availability of data. Since longer time periods are not available in the data, averaging annual data into 5-year would be problematic to keep *T* acceptable, therefore the data are averaged into 3-year to keep *T* acceptable and analyses comparable for the panel data methods. Going further than this range could limit *T* smaller than 4 for some of cross sections. Countries and variables are listed in Table 1a and Table 1b in Appendix. The data comes from PWT (Penn World Table) version 8.1, World Bank poverty and equity database, and World Governance Indicators.

The Penn World Table (PWT) is a database with information on relative levels of income, output, inputs and productivity, with country and period coverage depending on the release. PWT version 8.1 which is an updated version of PWT 8.0 covering the same (167) countries and period is released on April 13, 2015.

World Bank database is a free and open access to data about development in countries around the globe.

The Global Economy website is an open educational resource on the world economy. The website offers interactive data tools for over 200 countries with data from The World Bank, the United Nations, the International Monetary Fund, the U.S. Energy Information Administration, UNESCO, and the World Economic Forum.

The World Governance Indicators (WGI) project covers aggregate and individual governance indicators for over 200 countries and territories over the period 1996-2015 for six dimensions of the government and political system. The data for government and political system include rule of law, government effectiveness, control of corruption, regulatory quality, voice and accountability, political stability, corruption perceptions, political rights, civil liberties and women in parliament indices. Rule of law, government effectiveness, control of corruption,

regulatory quality, voice and accountability, political stability indices range between -2.5 and 2.5 where lowest values indicate weakness. Corruption perceptions index les between 0 and 100 where it equals to 100 in the case of no corruption. Political rights and civil liberties indices range between 1 and 7 where highest values indicate weakness, so that these two variables are renamed as lack in political rights and lack in civil liberties. Voice and accountability captures perceptions of the extent to which a country's citizens are able to participate in selecting their government, as well as freedom of expression, freedom of association, and a free media. Political stability and absence of Violence/terrorism captures perceptions of the likelihood that the government will be destabilized or overthrown by unconstitutional or violent means, including politically-motivated violence and terrorism. Government effectiveness captures perceptions of the quality of public services, the quality of the civil service and the degree of its independence from political pressures, the quality of policy formulation and implementation, and the credibility of the government's commitment to such policies. Regulatory quality captures perceptions of the ability of the government to formulate and implement sound policies and regulations that permit and promote private sector development. Rule of law captures perceptions of the extent to which agents have confidence in and abide by the rules of society, and in particular the quality of contract enforcement, property rights, the police, and the courts, as well as the likelihood of crime and violence. Control of corruption captures perceptions of the extent to which public power is exercised for private gain, including both petty and grand forms of corruption, as well as capture of the state by elites and private interests.

I used taxes on income, profit and capital gains as a proxy of political economy channel. Taxes on income, profits, and capital gains are levied on the actual or presumptive net income of individuals, on the profits of corporations and enterprises, and on capital gains, whether realized or not, on land, securities, and other assets. Intragovernmental payments are eliminated in consolidation.

I used net secondary school enrolment rate, lower secondary school completion rate and percentage of adolescent who are out of school for unequal opportunities in education, as a proxy for credit market imperfections. Net secondary school enrolment rate is calculated as the total number of students in the theoretical age group for secondary education enrolled in that

level, expressed as a percentage of the total population in that age group. Divide the number of students enrolled who are of the official age group for secondary education by the population for the same age group and multiply the result by 100. Net enrolment rate at each level of education is based on enrolment of the relevant age group in all types of schools and education institutions, including public, private and all other institutions that provide organized educational programs. Lower secondary education completion rate is measured as the gross intake ratio to the last grade of lower secondary education (general and pre-vocational). It is calculated as the number of new entrants in the last grade of lower secondary education, regardless of age, divided by the population at the entrance age for the last grade of lower secondary education. Adolescents out of school are the percentage of lower secondary school age adolescents who are not enrolled in school.

I used World Governance Indicators as proxies of political and governance system, rescaling into 0 and 1. However, even there exists positive direct impact of rule of law, government effectiveness, control of corruption, regulatory quality, voice and accountability, political stability on economic growth, I found negative and significant interaction only between rule of law and inequality.

2.3. Estimations

The system GMM estimator which is designed for dynamic panel analysis where current realizations of the dependent variable influenced by past ones in the cases where large N, small T. There may be arbitrarily distributed fixed individual effects is used, ince the right-hand-side variables are typically endogenous and measured with error, and there are omitted variables, estimating growth regressions becomes problematic.

The DIFF-GMM and SYS-GMM estimators assume that some regressors may be endogenous; the idiosyncratic disturbances (those apart from the fixed effects) may have individual specific patterns of heteroskedasticity and serial correlation; the idiosyncratic disturbances are uncorrelated across individuals and some regressors can be predetermined but not strictly exogenous.

The SYS-GMM estimator has many advantages as in variables which are random-walk or close to be random-walk (Baum, 2006). By using DIFF-GMM, differencing variables within groups

will remove any variable that is constant. SYS-GMM produces more efficient and precise estimates compared to DIFF-GMM, by improving precision and reducing the finite sample bias (Baltagi, 2008). While working unbalanced panel as in our panel dataset, DIFF-GMM approach is weak in filling gaps (Roodman, 2006, p.20). The SYS-GMM estimator is unbiased and most efficient if there are endogenous predetermined regressors.

Unit root tests are conducted for related variables as pre-test for GMM based dynamic panel techniques which requires stationary. Results of the Fisher-type unit root tests based on augmented Dickey-Fuller which are documented in Table 1c in Appendix show 3-year average values of the variables are stationary when time trend is included. Model 5 is estimated with time (period) dummies, with orthogonal deviations transformation and with the Windmeijer (2005) finite-sample correction to the standard errors in two-step estimation.

Panel VAR Granger causality procedure following the approach developed by Abrigo and Love (2015) after panel VAR procedure developed by Love and Zicchino (2006) is applied in order to show the directions of causality in a GMM framework. The results of the Panel VAR Granger causality tests are documented in from Table 1d to 1i in Appendix. Gini index and income share held by 10 percent Granger cause equation variable, 3-year averaged annualized growth rate, while the reverse does not occur. Income and profit taxes do not Granger-cause directly 3-year averaged annualized growth rate, but Gini index.

Gini index and income share held by highest 10 percent Granger-cause equation variable, 3-year average growth rate, while the reverse does not occur. Top income share Granger-causes net enrolment rate, so does secondary net enrolment rate

Gini index and rule of law index Granger-cause equation variable, 3-year averaged growth of log of real per capita GDP, while vice versa does not occur. Additionally, Gini index does Granger-cause rule of law index, so does rule of law index. Gini index and rule of law index do Granger-cause equation variable, 3-year averaged growth of log of real per capita GDP, while vice versa does not occur. Additionally, Gini index and rule of law index have reverse causality. Top income share (10%) does not directly Granger-cause equation variable, 3-year averaged growth of log of real per capita GDP, but it Granger-causes rule of law index which Granger causes Additionally, 3-year averaged growth of log of real per capita GDP.

I used first and second lags of dependent and independent variables as GMM-style instruments for the political economy channel and political instability channel estimations, and first, second and third lags of dependent and independent variables as GMM-style instruments for the credit market imperfections channels. Related Hansen overidentification and Hansen in difference p values for the GMM instruments are shown in the regression tables. Since the estimators do allow inclusion of external instruments, in addition to internal instruments, I used some democracy dummy for the political economy channel and political instability channel, and education in 1960 for the credit market imperfections channel as time invariant and IV-style instruments). Related Hansen in difference p values for the IV instruments are shown in the regression tables.

Following section is subsectioned into the estimation results for three transmission channels.

3. Results

The focus is testing negative impact of income inequality, using either Gini index or the income share of top 10 percent of the population for robustness, through political economy, credit market imperfections and political instability channels on economic growth. In order to test the possible effects through these channel, income inequality, related channel and their interaction are added into the growth model. Estimations are conducted following the SYS-GMM estimations on a panel dataset including 3-year averaged observations for 51 countries over a period from 1996 to 2015. In order to check for robustness, all results are replicated instrumenting with one less and more lags of the regressors, as documented documented in Table from 4.1a to 4.1h in Appendix. Additionally, OLS and WG estimates are documented in Table 3.1b 3,2b and 3,3b in Appendix, to check for the DPD estimates' validity is that the estimated coefficient of the lagged dependent variable lies between the values obtained from OLS and WG estimators. Related tables are documented in Table from 4.1a to 4.1h in Appendix.

3.1. Political economy channel

Descriptive statistics of the variables in the regressions and the scatter plot matrix are shown in Table 3.1a and Figure 3.1a respectively in Appendix.

Table 1. Impact of inequality and income taxes on economic growth

	Model 1	Model 1 + Ctrls	Model 2	Model 2 + Ctrls
L.3-year averaged GDP per capita growth (annualized %)	0.241***	0.252***	0.232**	0.231***
	(0.0870)	(0.0656)	(0.0907)	(0.0697)
Income and profits taxes	1.168***	1.243***	1.113***	1.182***
	(0.380)	(0.415)	(0.342)	(0.439)
Income share held by highest 10%	0.222***	0.314***		
	(0.0801)	(0.109)		
Income and profits taxes # Income share held by highest 10%	-0.0339***	-0.0358***		
	(0.0121)	(0.0121)		
Gini index			0.186***	0.254***
			(0.0573)	(0.0892)
Income and profits taxes # Gini index			-0.0257***	-0.0270***
			(0.00883)	(0.0104)
Savings (% of GDP)		0.0706		0.0742
		(0.0643)		(0.0592)
Trade (% of GDP)		0.0292		0.0330*
		(0.0199)		(0.0182)
AR(1) p value	0.0505	0.0480	0.0473	0.0435
AR(2) p value	0.440	0.297	0.378	0.246
Hansen overidentification p value	0.431	0.260	0.334	0.170
Hansen in difference p value	0.778	0.646	0.673	0.481
Number of instruments	43	43	43	43
Number of countries	46	46	47	47
Number of observations	182	182	183	184

Notes: The table reports SYS-GMM estimations. All regressions include time dummies; second lags in GMM instruments; robust standard errors in parentheses; AR(1) is the *p*-value on the test for the first order serial correlation in the differenced error terms; AR(2) is the *p*-value on the test for the second order serial correlation in the differenced error terms; Hansen denotes the *p*-value on the test for the validity of the full instrument set; Difference-in-Hansen denotes the *p*-value for the validity of the set of level-equation.
***, **, * denote significance at the 1, 5, and 10 % levels, respectively

Estimations results shown in Table 1 that there is a significant negative interaction between inequality and mentioned taxes. Even inequality measures seem to have positive effect on per capita economic growth, this effect is almost ¼ of the positive effect of the taxes. Moreover, the significant negative interaction term means that higher income inequality measures are associated to a negative effect of taxes on economic growth. A negative value of the interaction term implies that higher inequality, more negative the effects of taxes on economic growth is. Accordingly, the higher taxes, more negative the effect of inequality on economic growth.

As income inequality increases, taxes become to have sharper impact on per capita economic growth.

The negative interaction term between Gini index (or the income share of top 10 percent of the population) may arise from the fact that governments aim to reduce income inequality through taxes on income and profits and higher taxes lower income inequality. Interpreting for different levels of income inequality, decomposing its effect, negative marginal impact of income and profit taxes can be seen especially for the higher levels of income inequality as shown in Figure 1 and 2. Related marginal effects are shown Table 3.1c and 3.1d in Appendix.

Figure 1. Predictive margins

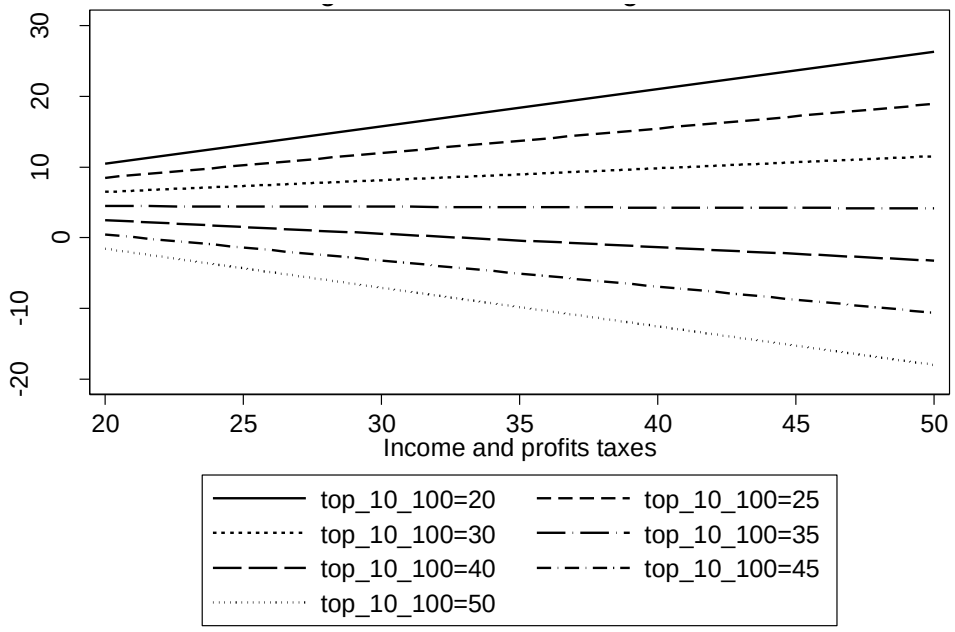


Figure 1 shows the impact of income and profit taxes for different levels of income inequality. When top 10 percent of the population owe less than 35 percent of the total income, income and profit taxes which has a positive impact on per capita economic growth vanishes as top 10 percent of the population owe higher percent of total income. Even this impact becomes negative if they owe more than 35 percent of the total income. As reported in Table 3.1d in Appendix, the marginal effect of income and profit taxes on economic growth ranges from 0.53 to -0.54 percentage point while top 10 percent of the population owe 20 to 50 percent of income.

Figure 2. Predictive margins

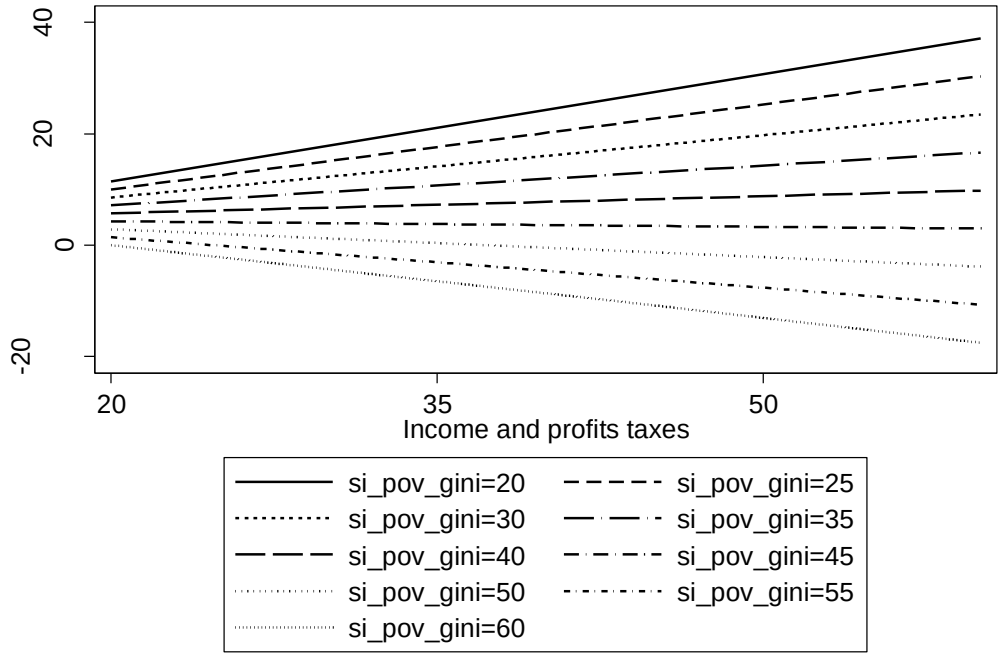


Figure 2 shows the impact of income and profit taxes for different levels of income inequality, using Gini index instead of income share of top 10 percent. When Gini index is less than 40, income and profit taxes which has a positive impact on per capita economic growth vanishes as Gini index increases. This impact becomes negative when Gini index is higher than 45. As reported in Table 3.1c in Appendix, the marginal effect of income and profit taxes on economic growth range from 0.64 to -0.44 while Gini changes from 20 to 60. It ranges from 0.64 to 0.23 percentage point while Gini index ranges between 20 and 35. Where Gini index is 55 and 60 respectively -0.30 and -0.44 respectively.

Higher taxes on income, profits, and capital gains could decrease per capita income if there is high income inequality. In high income inequality case, here higher than 45, governments could aim to reduce income inequality through increasing taxes on income, profits, and capital gains in a very long-term gradually. Because if they choose introducing higher taxes on income, profits, and capital gains, this may create a pressure on per capita income. On the other hand, in case that Gini is less than 40, introducing taxes on income, profits, and capital gains would be promoting for per capita economic growth.

3.2. Credit market imperfections channel

There is negative interaction term between Gini index (or the income share of top 10 percent of the population) and secondary school variables that may arise from the fact that in the case of high inequality, much less people may invest in human capital. Interpreting for different levels of income inequality, decomposing its effect, negative marginal impact of secondary school net enrolment rate can be seen especially for the higher levels of income inequality.

Descriptive statistics of the variables in the regressions and the scatter plot matrix are shown in Table 3.2a and Figure 3.2a respectively in Appendix.

Table 2. Impact of inequality and secondary school enrolment on economic growth

	Model 1	Model 1 + Ctrls	Model 2	Model 2 + Ctrls
L.diffyy_3yr_ln_rgdpopc	0.122*	0.122	0.122	0.123
	(0.0664)	(0.0836)	(0.0866)	(0.0983)
Secondary net enrolment rate	0.265**	0.211*	0.236***	0.191*
	(0.114)	(0.126)	(0.0910)	(0.101)
Gini coefficient	0.463**	0.403*		
	(0.227)	(0.242)		
Secondary net enrolment rate # Gini coefficient	-0.733**	-0.588*		
	(0.315)	(0.349)		
Income share held by highest 10%			0.488**	0.425*
			(0.206)	(0.232)
Secondary net enrolment rate # Income share held by highest 10%			-0.812***	-0.651*
			(0.296)	(0.346)
Log of savings to GDP		0.0281		0.0162
		(0.0287)		(0.0260)
Log of trade to GDP		0.0104		0.00753
		(0.0139)		(0.0147)
AR(1) p value	0.0370	0.0399	0.0404	0.0462
AR(2) p value	0.546	0.522	0.594	0.564
AR(3) p value	0.190	0.254	0.222	0.263
Hansen overidentification p value	0.189	0.412	0.293	0.390
Hansen in difference p value - GMM instruments	0.678	0.926	0.833	0.995
Hansen in difference p value - IV instruments	0.342	0.722	0.511	0.828
Number of instruments	51	51	51	51
Number of countries	50	50	50	50
Number of observations	172	171	172	171

Notes: The table reports SYS-GMM estimations. All regressions include time dummies; second and third lags in GMM instruments; robust standard errors in parentheses; AR(1) is the *p*-value on the test for the first order serial correlation in the differenced error terms; AR(2) is the *p*-value on the test for the second order serial correlation; AR(3) is the *p*-value on the test for the third order serial correlation in the differenced error terms; Hansen denotes the *p*-value on the test for the validity of the full instrument set; Difference-in-Hansen denotes the *p*-value for the validity of the set of level-equation.

***, **, * denote significance at the 1, 5, and 10 % levels, respectively

Estimations results shown in Table 2 that there is a negative interaction between inequality, either as Gini coefficient or income share held by top 10 percent and net secondary school enrolment rate. These interaction terms are robust after controlling with savings and trade to GDP ratios. Analyses are replicated also using several secondary school variables, such as lower secondary school completion rate and adolescents out of school, instead of secondary school net enrolment, however their impact and interactions have not been found consistent. Related results are documented in Appendix. The significant negative interaction term means between inequality and net secondary school enrolment rate explains that higher income inequality measures are associated to a negative effect of net secondary school enrolment, and vice versa. As Gini coefficient increases, the positive marginal impact of net secondary school enrolment rate on per capita economic growth vanishes. Interpreting for different levels of Gini coefficient, decomposing its effect, the marginal effects of net school enrolment rate can be seen in Figure 3.

Estimations results shown in Table 3 are consistent with Table 2. There is a negative interaction between inequality and net secondary school enrolment rate. This interaction term is robust after controlling with savings and trade to GDP ratios. The significant negative interaction term means between inequality and net secondary school enrolment rate shows that as higher income share held by top 10 percent is associated to a negative effect of net secondary school enrolment, and vice versa. As income share held by top 10 percent increases, the positive marginal impact of net secondary school enrolment rate on per capita economic growth vanishes. Interpreting for different levels of income share held by top 10 percent, the marginal effects of net school enrolment rate can be seen in Figure 4.

The interaction between secondary school enrolment and inequality, both Gini coefficient and income share held by top 10, has a negative impact on economic growth also after having controlled with savings and trade to GDP ratios. Following the Model 1 and 2 from Table 2, marginal impact of the net enrolment rate to the secondary school conditional on inequality. These effects may be seen on Figure 3 and 4 for Gini coefficient and income share of top 10 percent respectively. Related marginal effects are shown in Appendix Table 3.2c and 3.2d.

Figure 3. Predictive margins

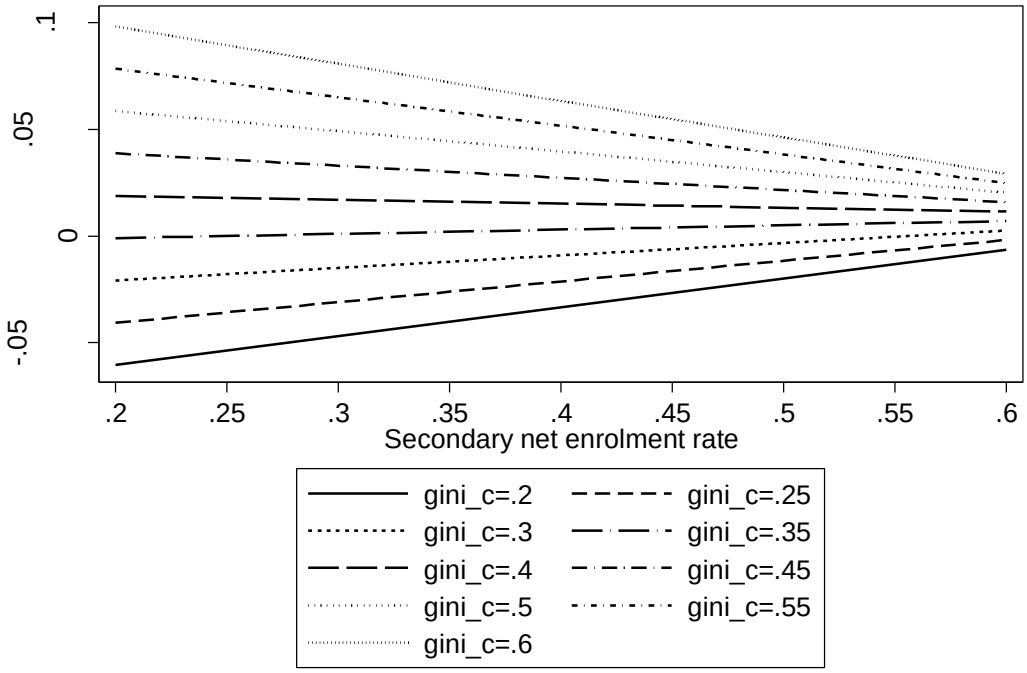


Figure 3 shows the impact of secondary school net enrolment rate for different levels of income inequality. When Gini coefficient is less than 0.40, secondary school net enrolment rate has a positive impact on per capita economic growth. This impact becomes smaller as income inequality increases. In the high levels of inequality, the impact of secondary school net enrolment rate is negative and even more harmful as income inequality increases. As reported in Table 3.2c in Appendix, the marginal effects of net secondary school enrolment rate on economic growth range from 0.12 to -0.14 percentage point while Gini coefficient changes from 0.20 to 0.55. It ranges from 0.12 to 0.05 percentage point while Gini coefficient ranges between 0.20 and 0.30, from -0.07 to -0.13 percentage point while Gini coefficient ranges between 0.45 and 0.55.

Figure 4. Predictive margins

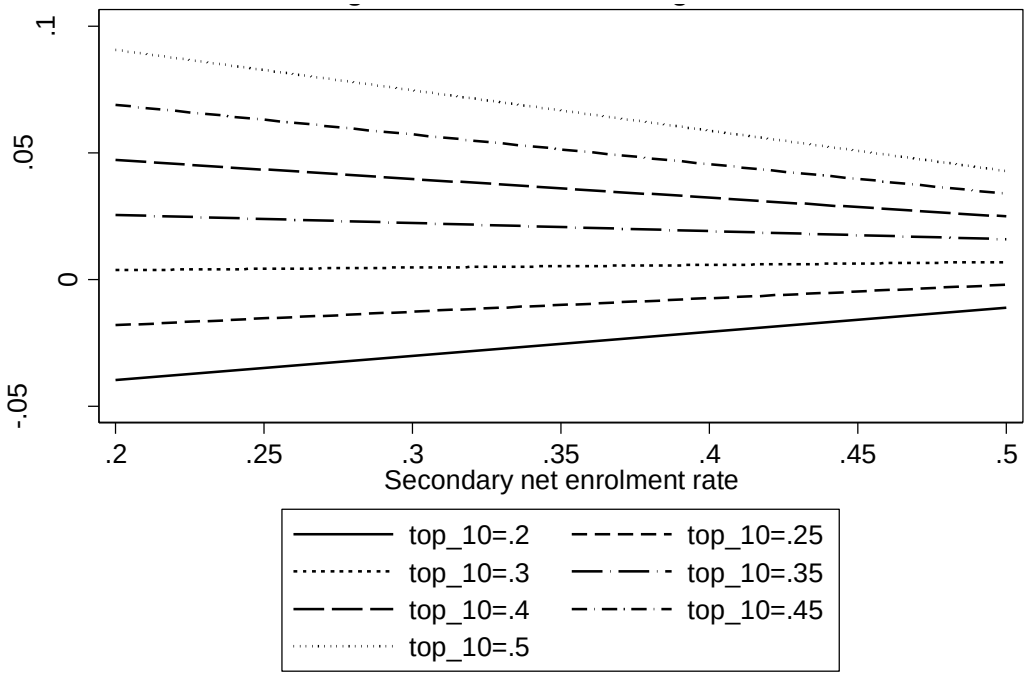


Figure 4 shows the impact of secondary school net enrolment rate for different levels of income inequality, income share of top 10 percent of population. When top 10 percent of the population owe less than 35 percent of the total income, secondary school net enrolment rate has a positive impact on per capita economic growth. This impact becomes smaller as top 10 percent of the population owe much more share of the total income. The impact of secondary school net enrolment rate becomes negative and even more harmful as the share of top 10 percent of the population increases. As reported in Table 3.2c in Appendix, the marginal effect of net secondary school enrolment on economic growth ranges from 0.12 to -0.18 percentage point while top 10 percent of the population owe 20 to 60 percent of income.

3.3. Political and governance system channel

There is a significant negative interaction term between Gini index (or the income share of top 10 percent of the population) which is related to the fact that high inequality is associated with weaker political and governance system. Interpreting for different levels of income inequality, decomposing its effect, negative marginal impact of rule of law can be seen especially for the higher levels of income inequality. Descriptive statistics of the variables in the regressions, the

scatter plot matrix and panel VAR Granger test results are documented in Table 3.3a, Figure 3.3a and Table 1e respectively in Appendix.

Table 3. Impact of inequality and rule of law on economic growth

	Model 1	Model 1 + Ctrls	Model 2	Model 2 + Ctrls
L.diffyy_3yr_ln_rgdpopc	0.155*	0.188**	0.149*	0.174**
	(0.0836)	(0.0786)	(0.0845)	(0.0684)
Gini coefficient	0.317**	0.378**		
	(0.140)	(0.182)		
Rule of law	0.250**	0.306**	0.225**	0.173**
	(0.107)	(0.133)	(0.0899)	(0.0836)
Gini coefficient # Rule of law	-0.610**	-0.741**		
	(0.301)	(0.372)		
Income share held by highest 10%			0.358**	0.249*
			(0.144)	(0.130)
Income share held by highest 10% # Rule of law			-0.689**	-0.483*
			(0.331)	(0.267)
Log of savings to GDP		0.00222		0.00378
		(0.0216)		(0.0109)
Log of average annual hours worked by persons engaged		0.0573		0.0300
		(0.0557)		(0.0398)
AR(1) p value	0.00994	0.0127	0.0113	0.00921
AR(2) p value	0.173	0.652	0.165	0.655
Hansen overidentification p value	0.157	0.145	0.225	0.429
Hansen in difference p value - GMM instruments	0.638	0.673	0.799	0.993
Hansen in difference p value - IV instruments	0.788	0.795	0.810	0.806
Number of instruments	48	43	49	49
Number of countries	57	44	57	44
Number of observations	238	180	237	179

Notes: The table reports SYS-GMM estimations. All regressions include time dummies; second and third lags in GMM instruments; robust standard errors in parentheses; AR(1) is the *p*-value on the test for the first order serial correlation in the differenced error terms; AR(2) is the *p*-value on the test for the second order serial correlation; Hansen denotes the *p*-value on the test for the validity of the full instrument set; Difference-in-Hansen denotes the *p*-value for the validity of the set of level-equation.
***, **, * denote significance at the 1, 5, and 10 % levels, respectively

The interaction between rule of law and inequality, both Gini coefficient and income share held by top 10, has a negative impact on economic growth also after having controlled with log of savings to GDP ratio and average worked hours. Following the Model 1 and 2 from Table 3, marginal effects of the rule of law conditional on inequality are shown in Figure 5 and 6 for Gini coefficient and income share of top 10 percent respectively. Related marginal effects are shown in Appendix Table 3.3c and 3.3d.

Figure 5. Predictive margins

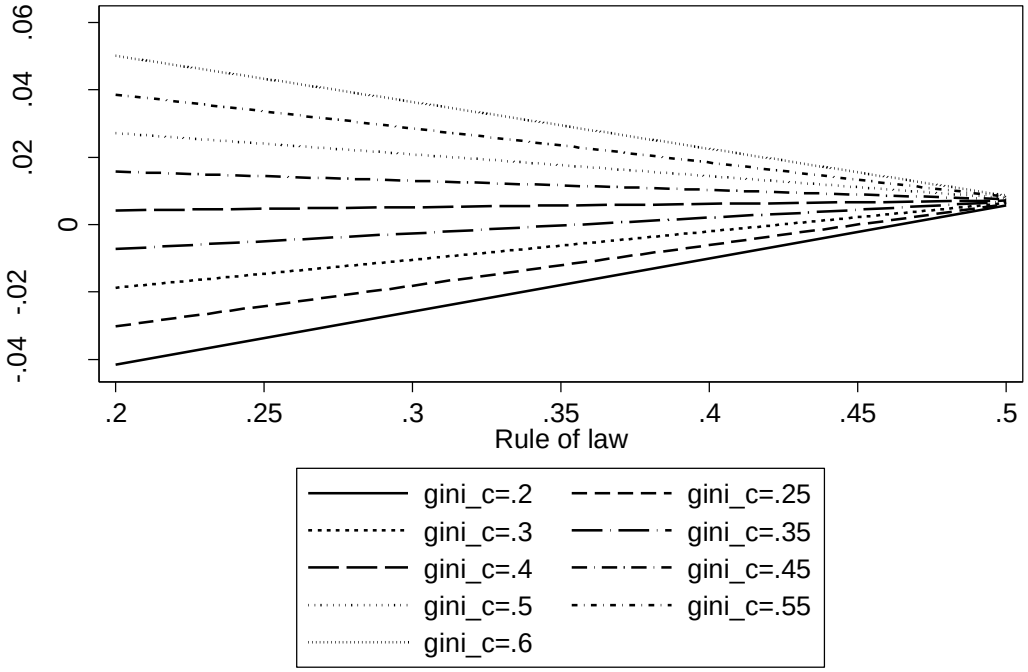


Figure 5 shows the impact of rule of law for different levels of income inequality. When Gini coefficient is less than 0.40, rule of law has a positive impact on per capita economic growth. This impact becomes smaller as income inequality increases. In the high levels of inequality, the marginal impact of rule of law becomes negative. As reported in Table 3.3c in Appendix, the marginal effect of rule of law index on economic growth range from 0.16 to -0.14 percentage point while Gini coefficient changes from 0.20 to 0.60. It ranges from 0.16 to 0.05 percentage point while Gini coefficient ranges between 0.20 and 0.35. However, the marginal effect of rule of law index on economic growth which ranges between 0.01 to -0.13, while Gini coefficient is greater than 0.4, is not significant. This relates where income inequality in its high level, rule of law index loses its positive effect.

Figure 6. Predictive margins

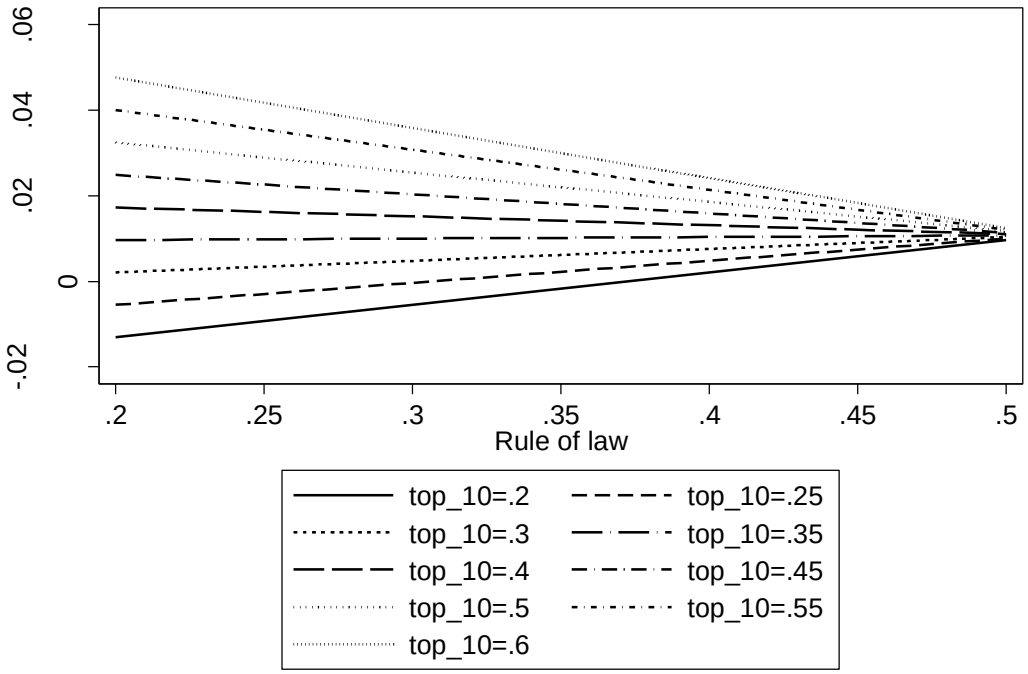


Figure 6 shows the impact of rule of law for different levels of income inequality, income share of top 10 percent of population. When top 10 percent of the population owe less than 35 percent of the total income, rule of law has a positive impact on per capita economic growth. This impact becomes smaller as top 10 percent of the population owe much more share of the total income. The impact of rule of law becomes smaller as income inequality increases. In the high levels of inequality, the marginal impact of rule of law becomes negative. As reported in Table 3.3d in Appendix, the marginal effect of rule of law index on economic growth ranges from 0.08 to -0.12 percentage point while top 10 percent of the population owe 20 to 60 percent of income.

4. Conclusion

The direct and indirect effects of income inequality are tested. Even though, also a negative direct effect of income inequality was expected on economic growth, negative effects only are justified through interactions with redistributive pressure, credit market imperfections and political instability channels, using selected variables as proxies for these channels. The estimations are replicated instrumenting with less and more lags of the regressors. The effects

of the transmission channels and their interaction terms with inequality are consistent with the results included in the third section.

For political economy channel, using taxes income, profits and capital gains variable, the negative interaction term between Gini index (or the income share of top 10 percent of the population) is found. This effect may arise from the fact that governments aim to reduce income inequality through taxes on income and profits and higher taxes lower income inequality. Therefore, this interaction may have also decreasing effect on 3-year average growth rate of income per capita, through income and profit taxes. Higher taxes on income, profits, and capital gains could decrease per capita income if there is high income inequality. In high income inequality case, here higher than 45, governments could aim to reduce income inequality through increasing taxes on income, profits, and capital gains in long-term, gradually. Because if they choose introducing higher taxes on income, profits, and capital gains, this may create a pressure on per capita income. On the other hand, in case that Gini is less than 40, introducing taxes on income, profits, and capital gains would be promoting for per capita economic growth. Another take-away from this analysis, optimum taxation level also depends on the level of inequality. In other words, optimum taxation levels sould be defined how income is distributed among people.

For credit market imperfections channel, secondary school variables are used since that in the existence of credit market imperfections, poor people are less likely to invest in human capital. I believe this relation is needed to have deeper attention in the sense that school enrolment or in a broad sense investing in human capital may be the consequnces of the imperfect credit markets. Additionally, perfect credit markets depend on how income is distributed among the population. It is found a negative interaction between inequality and net secondary school enrolment rate. This interaction term is robust after controlling with savings and trade to GDP ratios. There is a negative interaction between lower secondary school completion rate and income inequality, however this interaction is not significant after having added control variables. The significant negative interaction term means between inequality and net secondary school enrolment rate means that higher income inequality measures are associated to a negative effect of net secondary school enrolment, and vice versa. As Gini coefficient

increases, the positive marginal impact of net secondary school enrolment rate on per capita economic growth vanishes.

For political stability channel, rule of law variable is used since high income inequaity may lower political stability. Rule of law captures perceptions of the extent to which agents have confidence in and abide by the rules of society, and in particular the quality of contract enforcement, property rights, the police, and the courts, as well as the likelihood of crime and violence. The interaction between rule of law and inequality, both Gini coefficient and income share held by top 10, has a negative impact on economic growth also after having controlled with log of savings to GDP ratio and average worked hours.

The results show that there is negative interaction between income inequality and mentioned channels, even the direct impact income inequality is found positive. Marginal effects of the related transmission channels are interpreted for different levels of income inequality. At the higher levels of income inequality, the impact of variables related to redistribution, political stability and human capital on economic growth vanishes and becomes sharper as inequality increases. In countries where income is distributed relatively equally, economic growth benefits from the positive impact of variables related to redistribution, political stability and human capital.

Overall, redistributive policies aiming to reduce income inequality should be defined carefully, since that at the high levels of income inequality, higher taxation also could be destructive for the economic growth. If reducing income inequality is aimed by increasing taxes on income, profits and capital gains, it should be done gradually. In order to achieve equal opportunities for investing in human capital, longer obligatory years of schooling should be introduced with the aim of public schooling. Governments should be more sanctioning on obligatory years of education by introducing by law. Political stability in a country is a determinant of the economic growth, but at the higher levels of income inequality, a country may not benefit from the political environment as it should be. Income inequality, itself, could create instability in social and political environment from which only rich people may benefit. In turn, this may create again higher inequality as opportunities will be distributed more unequal. Consequently, inequality arising from the instability in social and political environment would have the most threatening interaction effect, since the instable and political environment create inequalities

internally. Policies to create stable socio-political environment would not have immediate effect even it is aimed so. However, inequality reducing policies through optimal taxation and improving equal opportunities in schooling by governments would be effective on equal distribution of income much more immediately and in turn they would helpful for more stable socio-political environment.

References

Abrigo, Michael and Inessa Love (2016). "Estimation of Panel Vector Autoregression in Stata: a Package of Programs". *The Stata Journal*, 16(3): 1-27.

Acemoglu, D., & Robinson, J. (2000). Why did the west extend the franchise? *Q. J. Econ. 115*, 1167–1199.

Acemoglu, D., & Robinson, J. (2006). Economic Origins of Dictatorship and Democracy. New York, NY: Cambridge University Press.

Acemoglu, D., Johnson, S., Robinson, J., & Yared, P. (2009). Reevaluating the modernization hypothesis. *J. Monet. Econ. 56*, 1043-1058.

Acemoglu, D., Naidu, S., Restrepo, P., & Robinson, J. (2015). Democracy, redistribution and inequality. In A. B. Atkinson, *Handbook of Income Distribution, vol 2B. Chapter 21* (pp. 1885-1996). Amsterdam: Elsevier.

Aidt, T., & Dallal, B. (2008). Female voting power: the contribution of women's suffrage to the growth of social spending in Western Europe (1869–1960). *Public Choice 134 (3–4)*, 391–417.

Aidt, T., & Jensen, P. (2009a). The taxman tools Up: an event history study of the introduction of the personal income Tax in western Europe, 1815–1941. *J. Public Econ. 93*, 160–175.

Aidt, T., & Jensen, P. (2009b). Tax structure, size of government, and the extension of the voting franchise in western Europe, 1860–1938. *Int. Tax Public Fin. 16 (3)*, 362–394.

Aidt, T., & Jensen, P. (2011). Workers of the World Unite! Franchise Extensions and the Threat of Revolution in Europe. *Cambridge Working Papers in Economics 1102, Faculty of Economics, University of Cambridge*, pp. 1820-1938.

Aidt, T., & Jensen, P. (2013). Democratization and the size of government: evidence from the long 19th. http://ideas.repec.org/p/ces/ceswps/_4132.html.

Aidt, T., & Jensen, P. (2013). Democratization and the size of government: evidence from the long 19th century. *Public Choice 157 (3-4)*, 511-542.

Aidt, T., & Jensen, P. (n.d.). Workers of the World Unite! Franchise Extensions and the Threat of Revolution in Europe, 1820–1938. *Cambridge Working Papers in Economics 1102, Faculty of Economics.* 2011: University of Cambridge.

Aidt, T., Dutta, J., & Loukoianova, E. (2006). Democracy comes to Europe: franchise expansion and fiscal 1830–1938. *Eur. Econ. Rev. 50 (2)*, 249–283.

Alesina, A., & Perotti, R. (1994). Income Distribution, Political Instability and Investment. *1994-95 Discussion Paper Series No. 751*.

Alesina, A., & Perotti, R. (1996). Income Distribution, Political Instability, and Investment. European Economic Review. *40(6),* 1203-1228.

Alesina, A., & Rodrik, D. (1994). Distributive Politics and Economic Growth. *Quarterly Journal of Economics, 109*, 465-490.

Alesina, A., & Tabellini, G. (1989). External Debt, Capital Flight and Political Risk. *Journal of International Economics, 27,* 199-220.

Alesina, A., Ozler, S., Roubini, N., & Swagel, P. (1996). Political Instability and Economic Growth. *Journal of Economic Growth, 1(2)*, 189-211.

Baltagi, B. (2008). Forecasting with panel data. *Journal of Forecasting, 27(2)*, 153-173.

Barro, R. (1989). A Cross-Country Study of Growth, Saving and Government. *NBER Working Paper No. 2855*.

Barro, R. (1991). Economic Growth in a Cross Section of Countries. *The Quarterly Journal of Economics, Vol. 106, No.2*, 407-443.

Barro, R. (2000). Inequality and Growth in a Panel of Countries. *Journal of Economic Growth, 5*, 5-32.

Baum, C. (2006). *An Introduction to Modern Econometrics using Stata.* Stata Press books, StataCorp LP, number imeus September.

Baum, C. (2013). Implementing new econometric tools in Stata. *Mexican Stata Users' Group Meetings.* Stata Users Group.

Baum, C., & Schaffer, M. (2003). Instrumental variables and GMM: Estimation and testing. The Stata Journal. *3(1),* 1-31.

Baum, C., Schaffer, M., & Stillman, S. (2007). Enhanced routines for instrumental variables/generalized method of moments estimation and testing. *The Stata Journal, 7(4)*, 465-506.

Berg, A. G., & Ostry, J. D. (2011). Inequality and Unsustainable Growth: Two Sides of the Same Coin? . *IMF (Ed.), IMF Staff Discussion Note*.

Berg, A., & Sachs, J. (1988). The Debt Crisis: Structural Explanations of Country Performance . *Journal of Development Economics, Vol. 29, No. 3*, 271–306.

Berg, A., Ostry, J., & Tsangarides, C. (2014, February). Redistribution, inequality, and growth. *IMF Staff Discussion Note*.

Bond, S. (2002). Dynamic panel data models: a guide to micro data methods and practice. *Portuguese Economic Journal*, 141–162. doi:0.1007/s10258-002-0009-9

Bond, S., Anke, H., & Temple, J. (2001). GMM Estimation of Empirical Growth Models. *CEPR Discussion Papers, 3048*.

Brown, D., & Hunter, W. (1999). Democracy and social spending in Latin America, 1980–92 . *Am. Polit Sci. Rev. 93 (4)*, 779–790.

Burkhart, R. (1997). Comparative democracy and income distribution: shape and direction of the causal arrow. *J. Polit. 59 (1)*, pp. 148-164.

Castells-Quintana, D., & Royuela, V. (2014). Tracking positive and negative effects of inequality on long-run growth. *R. I. o. A. Economics & R. Q. A. R. Group (Eds.) , 01*.

Davis, L., & Hopkins, M. (2011). The Institutional Foundations of Inequality and Growth. *Journal of Development Studies, 47(7)*, 977-997. doi:http://dx.doi.org/10.2139/ssrn.1223762

Easterly, W. (2007). Inequality does cause underdevelopment: insights from a new instrument. *Journal of Developmen Economics, 84*, 755-776.

(2006). *Equity and Development.* New York: The World Bank.

Feenstra, R., Inklaar, R., & Timmer, M. (2015). The next generation of the Penn World Table, . *Forthcoming American Economic Review*. Retrieved from www.ggdc.net/pwt

Ferreira, F. (1999). Inequality and Economic Performance: A Brief Overview to Theories of Growth and Distribution. *T. W. Bank (Ed.).*

Foellmi, R., & Zweilmueller, J. (2006). Structural Change and the Kaldor Facts of Economic Growth . *2006 Meeting Papers 342, Society for Economic Dynamics.*

Forbes, K. (2000). A reassessment of the relationship between inequality and growth. *American Economic Reviews, American Economic Association, 90(4)*, 869-887.

Galor, O., & Zeira, J. (1993). Income Distribution and Macroeconomics. *Review of Economic Studies, 60*, 35-52.

Gil, R., Mulligan, C., & Sala-i-Martin, X. (2004). Do democracies have different public policies than nondemocracies? *J. Econ. Perspect. 18*, 51–74.

Gradstein, M., & Justman, M. (1999b). The democratization of political elites and the decline in inequality in modern economic growth. In E. Breizes, & P. (. Temin, *Elites, Minorities and Economic Growth.* Amsterdam: Elsevier.

Grossman, H. (1991). A General Equilibrium Model of Insurrections. *American Economic Review, 81*(4), 912-921.

Gründler, K., & Scheuermeyer, P. (2014). Income inequality, economic growth, and the effect of redistribution. Würzburg Economic Papers. *95*, 1-45.

Halter, D., Oechslin, M., & Zweimüller, J. (2014). Inequality and growth: the neglected time dimension. *Journal of Economic Growth, 19(1)*, 81-104.

Huber, E., & Stephens, J. (2012). Democracy and the Left: Social Policy and Inequality in Latin America. University of Chicago Press, Chicago, IL.

Islam, N. (1995). Growth Empirics: A Panel Data Approach. *The Quarterly Journal of Economics, 110(4)*, 1127-70.

Kaldor, N. (1956). Alternative Theories of Distribution. *Review of Economic Studies, 23*, 83-100.

Kaufman, R., & Segura-Ubiergo, A. (2001). Globalization, domestic politics, and social spending in Latin America: a time-series cross-section analysis, 1973–97. *World Polit. 53 (4)*, 553–587.

Kormendi, R., & Meguire, P. (1985). Macroeconomic Determinants of Growth: Cross-Country evidence. *Journal of Monetary Economics*, 141-163.

Kuznets, S. (1955). Economic Growth and Income Inequality. *American Economic Review 65*, 1-28.

Lee, C.-S. (2005). Income inequality, democracy, and public sector size. *Am. Sociol. Rev. 70 (1)*, 158–181.

Li, H., Squire, L., & Zou, H.-f. (1998). Explaining international and intertemporal variations in income inequality. *Econ. J. 108 (1)*, 26-43.

Lindert, P. (1994). The rise of social spending, 1880–1930. *Explor. Econ. Hist. 31 (1)*, 1-37.

Londregan, J., & Poole, K. (1990, January). Poverty, The Coup Trap and The Seizure of Executive Power. *World Politics*.

Lott Jr., J., & Kenny, L. (1999). How dramatically did women's suffrage change the size and scope of government? *J. Polit. Econ. 107 (6)*, 1163–1198.

Loury, G. (1981). Intergenerational Transfers and the Distribution of Earnings. *Econometrica , Vol. 49, No. 4*, 843-867.

Love, I. and L. Zicchino (2006). Financial development and dynamic investment behavior: Evidence from panel VAR. *The Quarterly Review of Economics and Finance*, 46(2), 190-210.

Matsuyma, K. (2007, June). Aggregate implicatios of credit market imperfections. *NBER Working Paper Series*.

Meltzer, A., & Richard, S. (1981). A rational theory of the size of government. *J. Polit. Econ. 89*, 914-927.

Miller, G. (2008). Women's suffrage, political responsiveness, and child survival in American history. *Q. J. Econ. 123 (3)*, 1287–1327.

Mo, P. (2000). Income Inequality and Economic Growth. *KYKLOS, 53(3)*, 293–316.

Muller, E. (1988). Democracy, economic development, and income inequality. *Am. Sociol. Rev. 53 (1)*, 50-68.

Okun, A. (1975). Equality and Efficiency: the Big Trade-Off. *Brookings Institution Press*.

Penn World Table, version 8.0. (2013). Retrieved from rug.nl/research/ggdc/data/pwt

Persson, T., & Tabellini, G. (2003). The Economic Effects of Constitutions. MIT Press, Cambridge.

PolityIV Project. (2014). Retrieved from systemicpeace.org/polityproject.html

Przeworski, A., Alvarez, M., Cheibub, J., & Limongi, F. (2000). Democracy and Development: Political Institutions and Material Well-being in the World, 1950–1990. New York, NY: Cambridge University Press.

Rodrik, D. (1999). Democracies pay higher wages. . *Q. J. Econ. 114*, 707–738.

Roodman, D. (2006). How to Do xtabond2: An Introduction to "Difference" and "System" GMM in Stata. *Working Papers 103, Center for Global Development*.

Roodman, D. (2009). How to do xtabond2: An introduction to difference and system GMM. *The Stata Journal,, 9(1)*, 86-136.

Rosenzweig, M., & Binswanger, H. (1993). Wealth, Weather Risk and the Composition and Profitability of Agricultural Investments. *Economic Journal 103(416)*, 56-78.

Sbaouelgi, J. (2013). Income Inequality And Economic Growth: Empirical Investigations On The Transmission Channels. *Romanian Economic and Business Review, 8(2)* , 75-92.

Scheve, K., & Stasavage, D. (2010). The conscription of wealth: mass warfare and the demand for progressive taxation. *Inter. Organ. 64*, 529–561.

Scheve, K., & Stasavage, D. (2012). Democracy, war, and wealth: lessons from two centuries of inheritance taxation. *Am. Polit. Sci. Rev. 106 (1)*, 82–102.

Simpson, M. (1990). Political rights and income inequality: a cross-national test. *Am. Sociol. Rev. 55 (5)*, 682-693.

Sirowy, L., & Inkeles, A. (1990). The effects of democracy on economic growth and inequality: a review. *Stud. Comput. Inter. Develop. 25*, pp. 126-57.

Solt, F. (2014). *SWIID Version 5.0*. Retrieved from The standardized world income inequality database.

Stiglitz, J. (2009). The global crisis, social protection and jobs. *International Labour Review, 148(1-2)*, 1-13.

Thewissen, S. (2013). Is it the income distribution or redistribution that affects growth? *Socio-Economic Review*.

Wasmer, E., & Weil, P. (2004, September). The Macroeconomics of Labor and Credit Market Imperfections. *American Economic Review, 94(4)*, 944-963.

Wilkinson, R., & Pickett, K. (2009). *The Spirit Level: Why More Equal Societis Almost Always Do Better.* London: Allen Lane.

(2010). *World of Work Report.* Geneva: International Labour Oranization (IILS).

Appendix

Table 1a. Country list

Albania Argentina Armenia Austria Belarus Belgium Bolivia Brazil Bulgaria Cambodia Canada Chile China Colombia Costa Rica Cyprus Czech Republic Dominican Republic Ecuador El Salvador Estonia Finland France Georgia Greece Honduras Hungary Iceland Indonesia Ireland Italy Kyrgyz Republic Latvia Lithuania Luxembourg Macedonia, FYR Mexico Moldova Mongolia Netherlands Norway Pakistan Panama Paraguay Peru Poland Portugal Romania Russian Federation Slovak Republic Slovenia Spain Sri Lanka Sweden Tajikistan Thailand Turkey Uganda Ukraine United Kingdom United States Uruguay Venezuela, Vietnam

Of which are OECD: Belgium Estonia Finland Greece Hungary Iceland Ireland Italy Luxembourg Mexico Netherlands Norway Poland Slovenia Spain Turkey United Kingdom United States

Table 1b. Variable list

Variables	Source
3-year averaged GDP per capita growth (annualized %)	World Bank
Gini index	World Bank
Income share held by highest 10%	Word Bank
Income and profits taxes	World Bank
Secondary net enrolment rate	World Bank
Lower secondary completion rate	Word Bank
Adolescents out of school	World Bank
Rule of law index	World Governance Indicators, World Bank
Control variables	Source
Savings (% of GDP)	World Bank
Trade (% of GDP)	World Bank
Average annual hours worked by persons engaged	Penn World Table 8.1
Instrument variables	Source
Democracy dummy	Polity IV
Education in 1960	Barro & Lee

Table 1c. Fisher-type unit-root tests based on augmented Dickey-Fuller tests

gdp_pc_gr_avg_of_annual_gr		Statistic	p-value
Inverse chi-squared(128)	P	262.5469	0.000
Inverse normal	Z	-4.1393	0.000
Inverse logit t(319)	L*	-5.6183	0.000
Modified inv. chi-squared	Pm	8.4092	0.000
diffyy_3yr_ln_rgdpopc			
Inverse chi-squared(114)	P	651.6611	0.000
Inverse normal	Z	-10.9364	0.000
Inverse logit t(289)	L*	-20.8145	0.000
Modified inv. chi-squared	Pm	35.6075	0.000
Gini coefficient			
Inverse chi-squared(128)	P	272.0307	0.000
Inverse normal	Z	-4.7631	0.000
Inverse logit t(179)	L*	-9.256	0.000
Modified inv. chi-squared	Pm	9.0019	0.000
Income share held by highest 10%			
Inverse chi-squared(128)	P	199.3232	0.0001
Inverse normal	Z	-2.6443	0.0041
Inverse logit t(179)	L*	-5.2779	0.000
Modified inv. chi-squared	Pm	4.4577	0.000
Taxes on income, profits and capital gains			
Inverse chi-squared(88)	P	167.9385	0.000
Inverse normal	Z	-2.3834	0.0086
Inverse logit t(169)	L*	-3.8766	0.0001
Modified inv. chi-squared	Pm	6.0256	0.000
Secondary school net enrolment rate			
Inverse chi-squared(86)	P	476.4213	0.000
Inverse normal	Z	-9.3682	0.000
Inverse logit t(199)	L*	-18.3569	0.000
Modified inv. chi-squared	Pm	29.7693	0.000
Rule of law index			
Inverse chi-squared(128)	P	207.7244	0.000
Inverse normal	Z	2.0557	0.9801
Inverse logit t(324)	L*	-0.3947	0.3466
Modified inv. chi-squared	Pm	4.9828	0.000

Notes: All four of the tests strongly reject the null hypothesis that all the panels contain unit roots for growth, inequality, taxes and schooling variables. For rule of law index variable, chi-squared and modified chi-squared tests strongly reject the null hypothesis that all the panels contain unit roots. AR parameter: Panel-specific. Panel means and time trend included.

Table 1.d. Panel VAR-Granger causality Wald test

Equation \ Excluded	chi2	df	Prob > chi2
L.3-year averaged GDP per capita growth (annualized %)			
Income and profits taxes	0.536	1	0.464
Gini index	4.695	1	0.030
ALL	11.907	2	0.003
Income and profits taxes			
L.3-year averaged GDP per capita growth (annualized %)	0.612	1	0.434
Gini index	4.53	1	0.033
ALL	4.532	2	0.104
Gini index			
L.3-year averaged GDP per capita growth (annualized %)	2.564	1	0.109
Income and profits taxes	8.638	1	0.003
ALL	9.856	2	0.007

Ho: Excluded variable does not Granger-cause Equation variable

Table 1.e. Panel VAR-Granger causality Wald test

Equation \ Excluded	chi2	df	Prob > chi2
L.3-year averaged GDP per capita growth (annualized %)			
Income and profits taxes	0.394	1	0.530
Income share held by highest 10%	6.692	1	0.010
ALL	10.886	2	0.004
Income and profits taxes			
L.3-year averaged GDP per capita growth (annualized %)	1.283	1	0.257
Income share held by highest 10%	6.957	1	0.008
ALL	7.058	2	0.029
Income share held by highest 10%			
L.3-year averaged GDP per capita growth (annualized %)	2.573	1	0.109
Income and profits taxes	11.706	1	0.001
ALL	12.724	2	0.002

Ho: Excluded variable does not Granger-cause Equation variable

Table 1.f. Panel VAR-Granger causality Wald test

Equation \ Excluded	chi2	df	Prob > chi2
Diffyy_3yr_ln_rgdpopc			
Gini index	5.58	1	0.018
Secondary net enrolment rate	0.007	1	0.932
ALL	5.674	2	0.059
Gini index			
Diffyy_3yr_ln_rgdpopc	0.588	1	0.443
Secondary net enrolment rate	0	1	0.998
ALL	0.769	2	0.681
Secondary net enrolment rate			
Diffyy_3yr_ln_rgdpopc	1.261	1	0.261
Gini index	5.546	1	0.019
ALL	7.383	2	0.025

Ho: Excluded variable does not Granger-cause Equation variable

Table 1.g. Panel VAR-Granger causality Wald test

Equation \ Excluded	chi2	df	Prob > chi2
Diffyy_3yr_ln_rgdpopc			
Income share held by highest 10%	5.195	1	0.023
Secondary net enrolment rate	8.452	1	0.004
ALL	8.563	2	0.014
Income share held by highest 10%			
Diffyy_3yr_ln_rgdpopc	0.005	1	0.946
Secondary net enrolment rate	13.157	1	0.000
ALL	13.851	2	0.001
Secondary net enrolment rate			
Diffyy_3yr_ln_rgdpopc	1.407	1	0.236
Income share held by highest 10%	12.303	1	0.000
ALL	16.871	2	0.000

Ho: Excluded variable does not Granger-cause Equation variable

Table 1.h. Panel VAR-Granger causality Wald test

Diffyy_3yr_ln_rgdpopc			
Rule of law index	4.779	1	0.029
Gini index	10.911	1	0.001
ALL	13.134	2	0.001
Rule of law index			
Diffyy_3yr_ln_rgdpopc	0.027	1	0.870
Gini index	7.471	1	0.006
ALL	17.075	2	0.000
Gini index			
Diffyy_3yr_ln_rgdpopc	1.281	1	0.258
Rule of law index	10.93	1	0.001
ALL	11.554	2	0.003

Ho: Excluded variable does not Granger-cause Equation variable

Table 1.i. Panel VAR-Granger causality Wald test

Equation \ Excluded	chi2	df	Prob > chi2
Diffyy_3yr_ln_rgdpopc			
Rule of law index	2.991	1	0.084
Income share held by highest 10%	0.204	1	0.652
ALL	8.414	2	0.015
Rule of law index			
Diffyy_3yr_ln_rgdpopc	0.338	1	0.561
Income share held by highest 10%	0.812	1	0.367
ALL	10.296	2	0.006
Income share held by highest 10%			
Diffyy_3yr_ln_rgdpopc	0.943	1	0.332
Rule of law index	6.023	1	0.014
ALL	6.49	2	0.039

Ho: Excluded variable does not Granger-cause Equation variable

Table 3.1a. Descriptive Statistics

Variable	Obs	Mean	Std. Dev.	Min	Max
3-year averaged GDP per capita growth (annualized %)	448	2.863885	3.121977	-6.09653	14.08213
Income and profits taxes	256	4.705794	5.941125	-5.405	39.47
Income share held by highest 10%	330	30.27868	7.181872	20.45	47.44333
Gini index	331	38.65744	9.507793	24.49333	59.99333
Savings (% of GDP)	446	20.43192	11.31086	-28.94	52.8362
Trade (% of GDP)	446	87.93389	46.92724	16.2168	382.8226

Figure 3.1a. Scatter plot matrix: Growth, inequality and taxes

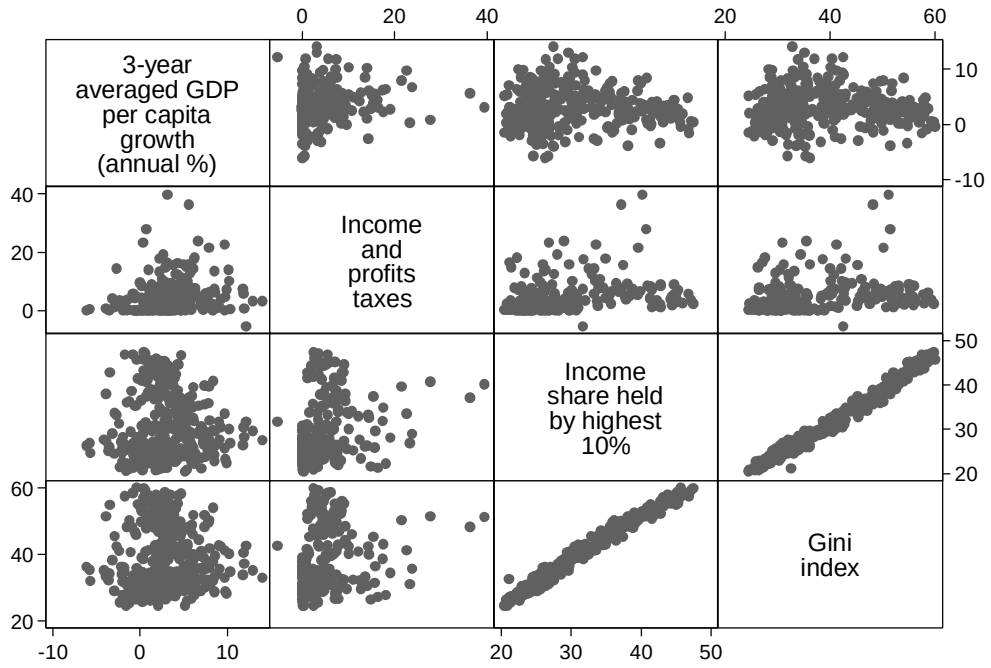


Table 3.1b. Estimated coefficient of the lagged dependent variable with OLS and WG

Inequality variable	Estimations	OLS/WG	L.3-year averaged GDP per capita growth
Gini coefficient	Model 1	OLS	0.161*
		WG	-0.0742
	Model 1 + Ctrls	OLS	0.159*
		WG	-0.0835
Top 10 income share	Model 1	OLS	0.160*
		WG	-0.0752
	Model 1 + Ctrls	OLS	0.159*
		WG	-0.0843

Table 3.1c. Marginal effects of taxes on economic growth for different levels of income inequality

Gini index	dy/dx	Std. Err	z	P>z	95% Confidence Interval	
20	0.642225	0.235592	2.73	0.006	0.180474	1.103976
25	0.507215	0.186426	2.72	0.007	0.141827	0.872602
30	0.372205	0.139297	2.67	0.008	0.099187	0.645222
35	0.237194	0.097217	2.44	0.015	0.046653	0.427736
40	0.102184	0.069976	1.46	0.144	-0.03497	0.239335
45	-0.03283	0.075765	-0.43	0.665	-0.18132	0.115671
50	-0.16784	0.109464	-1.53	0.125	-0.38238	0.046708
55	-0.30285	0.153696	-1.97	0.049	-0.60408	-0.00161
60	-0.43786	0.201645	-2.17	0.03	-0.83307	-0.04264

Table 3.1d. Marginal effects of taxes on economic growth for different levels of income inequality

Income share held by top 10%	dy/dx	Std. Err	z	P>z	95% Confidence Interval	
20	0.526491	0.179885	2.93	0.003	0.173923	0.879059
25	0.347401	0.125745	2.76	0.006	0.100945	0.593857
30	0.168311	0.081398	2.07	0.039	0.008774	0.327848
35	-0.01078	0.069282	-0.16	0.876	-0.14657	0.125011
40	-0.18987	0.101661	-1.87	0.062	-0.38912	0.009382
45	-0.36896	0.152415	-2.42	0.015	-0.66769	-0.07023
50	-0.54805	0.208534	-2.63	0.009	-0.95677	-0.13933

Table 3.2a. Descriptive Statistics

Variable	Obs	Mean	Std. Dev.	Min	Max
diffyy_3yr_ln_rgdpopc	377	0.013458	0.0423711	-0.3045961	0.1007875
Gini coefficient	331	0.3865744	0.0950779	0.2449333	0.5999333
Income share held by highest 10%	330	0.3027868	0.0718187	0.2045	0.4744333
Secondary net enrolment rate	268	0.7839087	0.181195	0.1387894	0.9957336
Lower secondary completion rate	289	0.8256145	0.1961855	0.1500342	1.354159
Adolescents out of school	271	0.0821967	0.1202468	0.0001208	0.8599262
Log of savings to GDP	429	3.004924	0.3449206	0.9569555	3.944968
Log of trade to GDP	446	4.350787	0.505871	2.786048	5.947572
Education in 1960	441	0.6036508	0.4455176	0	1

Figure 3.2a. Scatter plot matrix: Growth, inequality and secondary school enrolment

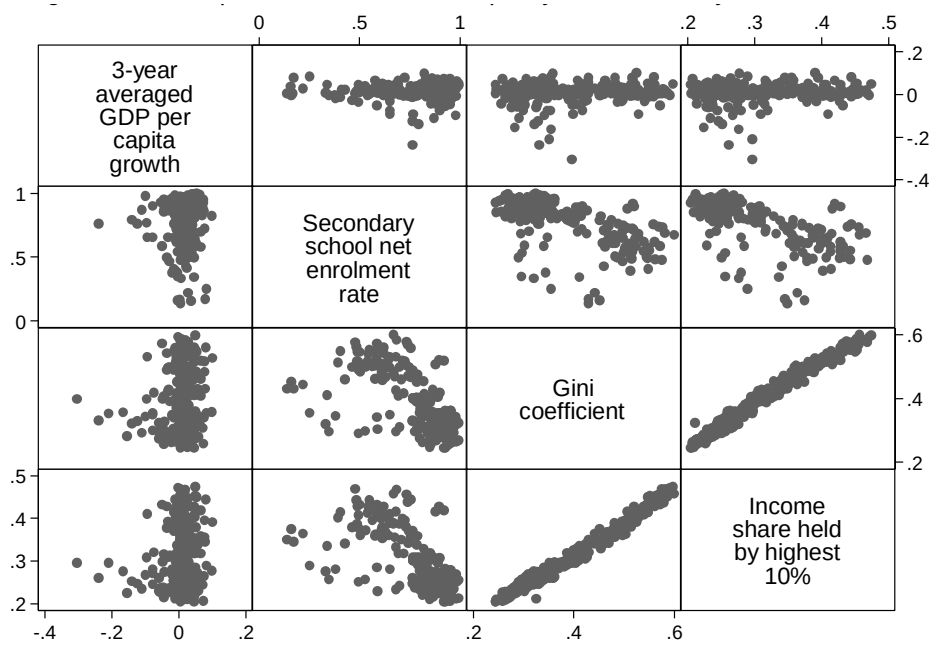


Table 3.2b. Estimated coefficient of the lagged dependent variable with OLS and WG

Estimations	OLS/WG	L.3-year averaged GDP per capita growth (annualized %)
Model 1	OLS	0.394***
	WG	0.0129
Model 1 + Ctrls	OLS	0.396***
	WG	0.0174
Model 2	OLS	0.397***
	WG	0.0133
Model 2 + Ctrls	OLS	0.395***
	WG	0.0173

Table 3.2c. Marginal effects of net secondary school enrolment on economic growth for different levels of income inequality

Gini coefficient	dy/dx	Std. Err	z	P>z	95% Confidence Interval	
0.2	0.118435	0.053312	2.22	0.026	0.013945	0.222926
0.25	0.081807	0.039222	2.09	0.037	0.004933	0.15868
0.3	0.045178	0.027056	1.67	0.095	-0.00785	0.098206
0.35	0.008549	0.020571	0.42	0.678	-0.03177	0.048868
0.4	-0.02808	0.024735	-1.14	0.256	-0.07656	0.0204
0.45	-0.06471	0.036027	-1.8	0.072	-0.13532	0.005903
0.5	-0.10134	0.049815	-2.03	0.042	-0.19897	-0.0037
0.55	-0.13797	0.064519	-2.14	0.032	-0.26442	-0.01151
0.6	-0.17459	0.079632	-2.19	0.028	-0.33067	-0.01852

Table 3.2d. Marginal effects of net secondary school enrolment on economic growth for different levels of income inequality

Income share held by top 10%	dy/dx	Std. Err	z	P>z	95% Confidence Interval	
0.2	0.073639	0.03617	2.04	0.042	0.002747	0.14453
0.25	0.033025	0.025701	1.28	0.199	-0.01735	0.083398
0.3	-0.00759	0.021214	-0.36	0.721	-0.04917	0.033989
0.35	-0.0482	0.026014	-1.85	0.064	-0.09919	0.002784
0.4	-0.08882	0.036615	-2.43	0.015	-0.16058	-0.01705
0.45	-0.12943	0.049415	-2.62	0.009	-0.22628	-0.03258
0.5	-0.17005	0.063089	-2.7	0.007	-0.2937	-0.04639

Table 3.3a. Descriptive Statistics

Variable	Obs	Mean	Std. Dev.	Min	Max
diffyy_3yr_ln_rgdpopc	377	0.013458	0.042371	-0.3046	0.100788
Gini coefficient	331	0.386574	0.095078	0.244933	0.599933
Income share held by highest 10%	330	0.302787	0.071819	0.2045	0.474433
Rule of law	448	0.528662	0.251342	0	1
Log of savings to GDP	429	3.004924	0.344921	0.956956	3.944968
Log of average annual hours worked by persons engaged	304	7.525165	0.126711	7.256382	7.842491
Democracy	448	0.828125	0.377694	0	1

Figure 3.3a. Scatter plot matrix: Growth, inequality and rule of law

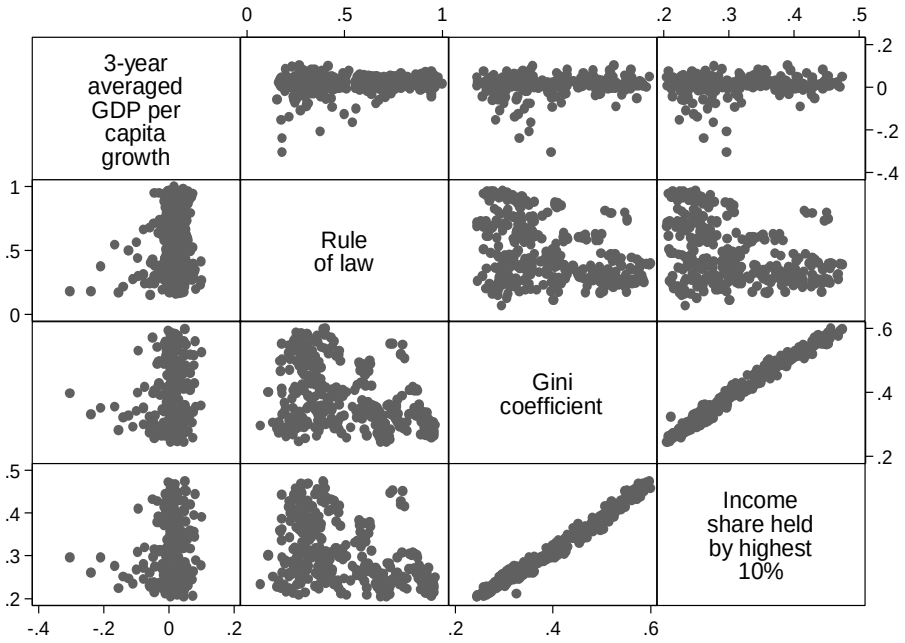


Table 3.3b. Estimated coefficient of the lagged dependent variable with OLS and WG

Estimated coefficient of the lagged dependent variable	OLS/WG	L.3-year averaged GDP per capita growth
Model 1	OLS	0.117*
	WG	-0.0541
Model 1 + Ctrls	OLS	0.116*
	WG	-0.0548
Model 2	OLS	0.115*
	WG	-0.0532
Model 2 + Ctrls	OLS	0.114*
	WG	-0.0539

Table 3.3c. Marginal effects of rule of law on economic growth for different levels of income inequality

Gini coefficient	dy/dx	Std. Err	z	P>z	95% Confidence Interval	
0.2	0.157824	0.061177	2.58	0.01	0.0379185	0.2777286
0.25	0.120791	0.044241	2.73	0.006	0.03408	0.2075015
0.3	0.083758	0.02936	2.85	0.004	0.0262136	0.1413022
0.35	0.046725	0.021374	2.19	0.029	0.0048326	0.0886176
0.4	0.009692	0.027236	0.36	0.722	-0.0436899	0.0630745
0.45	-0.02734	0.041436	-0.66	0.509	-0.1085525	0.0538715
0.5	-0.06437	0.058156	-1.11	0.268	-0.1783565	0.0496098
0.55	-0.10141	0.075746	-1.34	0.181	-0.2498649	0.0470525
0.6	-0.13844	0.093717	-1.48	0.14	-0.3221204	0.0452424

Table 3.3d. Marginal effects of rule of law on economic growth for different levels of income inequality

Income share held by top 10%	dy/dx	Std. Err	z	P>z	95% Confidence Interval	
0.2	0.075921	0.034248	2.22	0.027	0.0087966	0.1430462
0.25	0.051759	0.024617	2.1	0.036	0.0035099	0.1000072
0.3	0.027596	0.019859	1.39	0.165	-0.0113279	0.0665193
0.35	0.003433	0.023197	0.15	0.882	-0.0420322	0.048898
0.4	-0.02073	0.032204	-0.64	0.52	-0.0838491	0.0423892
0.45	-0.04489	0.043491	-1.03	0.302	-0.130133	0.0403474
0.5	-0.06906	0.055687	-1.24	0.215	-0.1782008	0.0400896
0.55	-0.09322	0.068308	-1.36	0.172	-0.2271004	0.0406635
0.6	-0.11738	0.081156	-1.45	0.148	-0.2764442	0.0416816

Table 4.1a. Impact of inequality and income taxes on economic growth – Replication of Table 1 using less instruments

	Model 1	Model 1 + Ctrls	Model 2	Model 2 + Ctrls
L.3-year averaged GDP per capita growth (annualized %)	0.186*	0.262**	0.177	0.248**
	(0.107)	(0.116)	(0.116)	(0.105)
Income and profits taxes	1.129***	1.143***	1.024***	1.097***
	(0.377)	(0.392)	(0.350)	(0.363)
Income share held by highest 10%	0.155	0.189*		
	(0.0945)	(0.107)		
Income and profits taxes # Income share held by highest 10%	-0.0322***	-0.0315***		
	(0.0118)	(0.0110)		
Gini index			0.127*	0.179**
			(0.0664)	(0.0781)
Income and profits taxes # Gini index			-0.0232***	-0.0241***
			(0.00875)	(0.00801)
Savings (% of GDP)		0.0693		0.0552
		(0.0813)		(0.0806)
Trade (% of GDP)		0.0178		0.0282
		(0.0262)		(0.0221)
AR(1) p value	0.0484	0.0508	0.0511	0.0495
AR(2) p value	0.524	0.223	0.432	0.189
Hansen overidentification p value	0.148	0.108	0.134	0.164
Hansen in difference p value - GMM instruments	0.587	0.747	0.561	0.886
Hansen in difference p value - IV instruments	0.459	0.721	0.434	0.763
Number of instruments	32	32	32	32
Number of countries	46	46	47	47
Number of observations	182	182	183	183

Table 4.1b. Impact of inequality and income taxes on economic growth – Replication of Table 1 using more instruments

	Model 1	Model 1 + Ctrls	Model 2	Model 2 + Ctrls
L.3-year averaged GDP per capita growth (annualized %)	0.235***	0.248***	0.215**	0.241***
	(0.0901)	(0.0830)	(0.0915)	(0.0766)
Income and profits taxes	1.255***	1.342***	1.129***	1.262***
	(0.365)	(0.441)	(0.330)	(0.363)
Income share held by highest 10%	0.264***	0.311***		
	(0.0898)	(0.112)		
Income and profits taxes # Income share held by highest 10%	-0.0360***	-0.0378***		
	(0.0115)	(0.0127)		
Gini index			0.193***	0.272***
			(0.0685)	(0.0838)
Income and profits taxes # Gini index			-0.0257***	-0.0287***
			(0.00864)	(0.00868)
Savings (% of GDP)		0.0803		0.0849
		(0.0725)		(0.0622)
Trade (% of GDP)		0.0253*		0.0341**
		(0.0135)		(0.0152)
AR(1) p value	0.0537	0.0474	0.0526	0.0427
AR(2) p value	0.442	0.279	0.366	0.245
AR(3) p value	0.636	0.978	0.579	0.917
Hansen overidentification p value	0.606	0.668	0.468	0.585
Hansen in difference p value - GMM instruments	0.900	0.969	0.737	0.900
Hansen in difference p value - IV instruments	1.000	1.000	1.000	1.000
Number of instruments	51	51	51	51
Number of countries	46	46	47	47
Number of observations	182	182	183	183

Table 4.1c. Impact of inequality and school enrolment on economic growth – Replication of Table 2 using less instruments with inclusion of other secondary school variables

	Model 1	Model 1 + Ctrls	Model 2	Model 2 + Ctrls	Model 3	Model 3 + Ctrls
L.diffyy_3yr_ln_rgdpopc	0.160	0.168	0.200	0.146	0.290***	0.279***
	(0.111)	(0.116)	(0.159)	(0.141)	(0.0906)	(0.104)
Secondary net enrolment rate	0.236***	0.179*				
	(0.0827)	(0.0968)				
Gini coefficient	0.381**	0.307	0.615	0.696	-0.114**	-0.0788
	(0.176)	(0.200)	(0.382)	(0.449)	(0.0540)	(0.0843)
Secondary net enrolment rate # Gini coefficient	-0.630**	-0.468*				
	(0.252)	(0.277)				
Lower secondary completion rate			0.292*	0.349		
			(0.177)	(0.254)		
Lower secondary completion rate # Gini coefficient			-0.729	-0.856		
			(0.464)	(0.599)		
Adolescents out of school					-0.307	-0.254
					(0.205)	(0.200)
Adolescents out of school # Gini coefficient					0.826	0.645
					(0.503)	(0.495)
Log of savings to GDP		0.00891		-0.00202		-0.0117
		(0.0239)		(0.0136)		(0.0208)
Log of trade to GDP		0.0117		-0.0183		0.0105
		(0.0223)		(0.0475)		(0.0210)
AR(1) p value	0.0481	0.0517	0.0551	0.0592	0.0282	0.0313
AR(2) p value	0.564	0.573	0.478	0.531	0.427	0.433
Hansen overidentification p value	0.154	0.280	0.160	0.107	0.214	0.117
Hansen in difference p value - GMM instruments	0.631	0.879	0.366	0.383	0.188	0.131
Hansen in difference p value - IV instruments	0.645	0.816	0.162	0.681	0.918	0.619
Number of instruments	43	43	43	43	43	43
Number of countries	50	50	50	50	51	51
Number of observations	172	171	166	162	169	168

Table 4.1d. Impact of inequality and school enrolment on economic growth – Replication of Table 2 using more instruments with inclusion of other secondary school variables

	Model 1	Model 1 + Ctrls	Model 2	Model 2 + Ctrls	Model 3	Model 3 + Ctrls
L.diffyy_3yr_ln_rgdpopc	0.0922	0.0935	0.115	0.0993	0.252**	0.248***
	(0.0930)	(0.0806)	(0.162)	(0.151)	(0.107)	(0.0906)
Secondary net enrolment rate	0.281***	0.186				
	(0.0966)	(0.139)				
Gini coefficient	0.501***	0.383	0.571*	0.717	-0.0874	-0.0228
	(0.192)	(0.255)	(0.324)	(0.581)	(0.0595)	(0.0790)
Secondary net enrolment rate # Gini coefficient	-0.779***	-0.525				
	(0.259)	(0.392)				
Lower secondary completion rate			0.247	0.325		
			(0.154)	(0.262)		
Lower secondary completion rate # Gini coefficient			-0.637	-0.837		
			(0.391)	(0.666)		
Adolescents out of school					-0.304	-0.244
					(0.242)	(0.224)
Adolescents out of school # Gini coefficient					0.834	0.655
					(0.642)	(0.621)
Log of savings to GDP		0.0313		0.0108		0.0181
		(0.0278)		(0.0234)		(0.0336)
Log of trade to GDP		0.0157		-0.0103		0.0100
		(0.0169)		(0.0314)		(0.0163)
ar1p	0.0489	0.0439	0.0779	0.0802	0.0338	0.0286
ar2p	0.550	0.514	0.526	0.546	0.426	0.422
ar3p	0.176	0.267	0.394	0.361	0.161	0.203
Hansen overidentification p value	0.485	0.641	0.494	0.586	0.653	0.607
Hansen in difference p value - GMM instruments	0.920	1.000	0.632	0.896	0.847	0.796
Hansen in difference p value - IV instruments	0.878	1.000	0.476	0.981	1.000	1.000
Number of instruments	56	56	56	56	56	56
Number of countries	50	50	50	50	51	51
Number of observations	172	171	166	162	169	168

Table 4.1e. Impact of inequality and school enrolment on economic growth – Replication of Table 2 using less instruments with inclusion of other secondary school variables

	Model 1	Model 1 + Ctrls	Model 2	Model 2 + Ctrls	Model 3	Model 3 + Ctrls
L.diffyy_3yr_ln_rgdpopc	0.167	0.178	0.231**	0.164	0.315***	0.295***
	(0.105)	(0.120)	(0.116)	(0.154)	(0.0905)	(0.107)
Secondary net enrolment rate	0.245***	0.189**				
	(0.0800)	(0.0954)				
Income share held by highest 10%	0.497**	0.391*	0.667	0.822	-0.155**	-0.133
	(0.195)	(0.211)	(0.522)	(0.580)	(0.0762)	(0.120)
Secondary net enrolment rate # top_10	-0.828***	-0.623*				
	(0.275)	(0.323)				
Lower secondary completion rate			0.265	0.348		
			(0.193)	(0.261)		
Lower secondary completion rate # top_10			-0.784	-1.045		
			(0.605)	(0.748)		
Adolescents out of school					-0.311	-0.291
					(0.201)	(0.209)
Adolescents out of school # top_10					1.069*	0.955
					(0.625)	(0.660)
Log of savings to GDP		0.00395		-0.0161		-0.0144
		(0.0206)		(0.0242)		(0.0188)
Log of trade to GDP		0.00688		-0.0209		0.00616
		(0.0196)		(0.0404)		(0.0203)
AR(1) p value	0.0429	0.0488	0.0323	0.0554	0.0249	0.0265
AR(2) p value	0.574	0.575	0.418	0.498	0.439	0.433
Hansen overidentification p value	0.196	0.223	0.268	0.0531	0.219	0.112
Hansen in difference p value - GMM instruments	0.722	0.843	0.538	0.273	0.142	0.103
Hansen in difference p value - IV instruments	0.736	0.603	0.264	0.425	0.806	0.431
Number of instruments	43	43	43	43	43	43
Number of countries	50	50	50	50	51	51
Number of observations	172	171	166	162	169	168

Table 4.1f. Impact of inequality and school enrolment on economic growth – Replication of Table 2 using more instruments with inclusion of other secondary school variables

	Model 1	Model 1 + Ctrls	Model 2	Model 2 + Ctrls	Model 3	Model 3 + Ctrls
L.diffyy_3yr_ln_rgdpopc	0.0960	0.0944	0.130	0.0992	0.279***	0.256***
	(0.0872)	(0.0641)	(0.147)	(0.123)	(0.0962)	(0.0937)
Secondary net enrolment rate	0.287***	0.169*				
	(0.0922)	(0.1000)				
Income share held by highest 10%	0.623***	0.400*	0.558	0.717	-0.137	-0.0773
	(0.236)	(0.234)	(0.435)	(0.548)	(0.0858)	(0.0891)
Secondary net enrolment rate # top_10	-0.991***	-0.573*				
	(0.323)	(0.335)				
Lower secondary completion rate			0.194	0.273		
			(0.157)	(0.236)		
Lower secondary completion rate # top_10			-0.612	-0.825		
			(0.503)	(0.691)		
Adolescents out of school					-0.333	-0.251
					(0.258)	(0.208)
Adolescents out of school # top_10					1.130	0.829
					(0.834)	(0.689)
Log of savings to GDP		0.0205		-0.00586		0.00138
		(0.0184)		(0.0195)		(0.0307)
Log of trade to GDP		0.0104		-0.00806		0.00664
		(0.0166)		(0.0311)		(0.0149)
ar1p	0.0440	0.0361	0.0611	0.0600	0.0268	0.0285
ar2p	0.581	0.547	0.453	0.505	0.453	0.463
ar3p	0.205	0.255	0.380	0.312	0.186	0.204
Hansen overidentification p value	0.545	0.688	0.519	0.518	0.730	0.652
Hansen in difference p value - GMM instruments	0.971	1.000	0.741	0.904	0.980	0.851
Hansen in difference p value - IV instruments	0.980	1.000	0.617	1.000	1.000	0.912
Number of instruments	56	56	56	56	56	56
Number of countries	50	50	50	50	51	51
Number of observations	172	171	166	162	169	168

Table 4.1g. Impact of inequality and rule of law on economic growth – Replication of Table 3 using less instruments

	Model 1	Model 1 + Ctrls	Model 2	Model 2 + Ctrls
L.diffyy_3yr_ln_rgdpopc	0.160**	0.165	0.141*	0.166*
	(0.0808)	(0.109)	(0.0794)	(0.0912)
Gini coefficient	0.247**	0.171		
	(0.118)	(0.133)		
Rule of law	0.194**	0.138	0.178**	0.141
	(0.0893)	(0.0938)	(0.0859)	(0.0947)
Gini coefficient # Rule of law	-0.463*	-0.290		
	(0.266)	(0.287)		
Income share held by highest 10%			0.277*	0.217
			(0.141)	(0.154)
Income share held by highest 10% # Rule of law			-0.516	-0.367
			(0.325)	(0.365)
Log of savings to GDP		-0.00749		-0.0150
		(0.0247)		(0.0183)
Log of average annual hours worked by persons engaged		-0.00548		-0.00765
		(0.0124)		(0.0126)
AR(1) p value	0.00789	0.0129	0.00869	0.0100
AR(2) p value	0.165	0.182	0.171	0.175
Hansen overidentification p value	0.0877	0.0411	0.132	0.0749
Hansen in difference p value - GMM instruments	0.361	0.112	0.481	0.183
Hansen in difference p value - IV instruments	0.992	0.898	0.936	0.85
Number of instruments	43	43	43	43
Number of countries	57	57	57	57
Number of observations	238	234	237	233

Table 4.1h. Impact of inequality and rule of law on economic growth – Replication of Table 3 with more instruments

	Model 1	Model 1 + Ctrls	Model 2	Model 2 + Ctrls
L.diffyy_3yr_ln_rgdpopc	0.154**	0.137	0.144*	0.146*
	(0.0766)	(0.0907)	(0.0767)	(0.0793)
Gini coefficient	0.273**	0.159		
	(0.127)	(0.101)		
Rule of law	0.205**	0.115*	0.219**	0.145
	(0.0945)	(0.0692)	(0.0964)	(0.0976)
Gini coefficient # Rule of law	-0.507*	-0.235		
	(0.274)	(0.203)		
Income share held by highest 10%			0.363**	0.238
			(0.158)	(0.169)
Income share held by highest 10% # Rule of law			-0.681*	-0.399
			(0.356)	(0.367)
Log of savings to GDP		0.00161		-0.00551
		(0.0176)		(0.0144)
Log of trade to GDP		-0.00513		-0.00662
		(0.00971)		(0.0105)
ar1p	0.00829	0.0117	0.0101	0.0111
ar2p	0.172	0.191	0.167	0.171
ar3p	0.0582	0.0542	0.0524	0.0476
Hansen overidentification p value	0.210	0.181	0.238	0.187
Hansen in difference p value - GMM instruments	0.585	0.399	0.613	0.394
Hansen in difference p value - IV instruments	0.916	0.944	0.755	0.78
Number of instruments	53	53	53	53
Number of countries	57	57	57	57
Number of observations	238	234	237	233

Chapter 3

INEQUALITY IN FINANCIAL INCLUSION,

GENDER GAPS,

AND

INCOME INEQUALITY

IMF Working Paper

African Department

Inequality in Financial Inclusion, Gender Gaps, and Income Inequality

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Abstract

We investigate the impact of gender inequality in financial inclusion on income inequality, therefore making a three-fold contribution to the recent literature. First, using a micro-dataset covering 146,000 individuals in over 140 countries, we construct novel, synthetic indices of the intensity of financial inclusion at the individual level and country level. Second, we derive the distribution of individual financial access "scores" across countries to document a "Kuznets"-curve in financial inclusion. Third, cross-country regressions confirm that our measure of inequality in financial access in general, and financial access gaps between men and women in particular, is significantly related to income inequality, above and beyond other factors previously highlighted in the literature. Finally, our findings suggest that policies related to improving access to infrastructure, higher financial development and stronger institutions could significantly reduce involuntary exclusion.

Keywords: Financial inclusion, financial development, gender inequality, income inequality, sub-Saharan Africa

JEL Classification: G19, J16, O11

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FIGURES

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I. Introduction

There are many reasons to examine potential drivers of income inequality. First, a more equal income distribution may be a policy goal in itself, and has indeed gained renewed attention worldwide after the global financial crisis. In addition, there are various channels through which income inequality can affect other macroeconomic variables, in particular growth. While some income inequality can provide incentives to economic activity or the minimum capital to some individuals (Lazear and Rosen 1981; Barro 2000), inequality of wealth and income can (i) lead to underinvestment in human capital (Galor and Zeira 1993) therefore resulting an an inefficient allocation of talent, (ii) decrease aggregate demand (Carvalho and Rezai 2014), (iii) impede intergenerational mobility (Corak 2013), and (iv) pose social stability risks. Indeed, a large body of literature has shown that less equal income distributions are associated with lower average growth and shorter growth spells (Dabla-Norris and others 2015; Ostry, Berg and Tsangarides).**By examining the impact of (gender-)inequality in financial access on income inequality, this paper contributes to the following strands of the literature**.

- *Finance and inequality.* Financial depth is typically measured by private sector credit or broad money to GDP (reviewed in Beck, Demirguc-Kunt and Levine, 2007, and Claessens and Perrotti, 2007), and to more recent studies that look into the macroeconomic impact of breadth of financial access —or financial inclusion as a multidimensional concept, rather than just depth (Dabla Norris and others 2015, Han and Melecky 2013; Merothra and Yetman 2015; Sahay and others 2015). The existing empirical evidence points to a significant impact of financial development on poverty and inequality reduction, but to our knowledge there are no cross-country empirical studies of broader concepts of financial *inclusion* and income inequality.
- *The macroeconomic effects of gender.* This body of the literature finds that inequality of economic opportunities for women, in particular inequality in access to education and health is associated with lower growth and higher income inequality overall, and especially in low-income countries (Klasen 1999; Klasen and Lamanna 2009; Gonzales and others 2015b, Hakura and others 2016, Dabla-Norris and others 2015b, IMF 2015, World Bank, 2011). While a systematic bias against women's financial inclusion is well-documented (Allen et al, 2012 and Demirguc-Kunt, Klapper and Singer, 2013), no empirical study

zooms in on the impact of gender biases in financial inclusion, their distribution within the population, and income inequality.[5]

- *Financial access and income inequality in sub-Saharan Africa.* Our analysis is particularly relevant for sub-Saharan Africa, where both gender and income inequality are significantly higher than in other regions, and financial access to formal financial services is comparatively low, in particular for women (Allen and others 2012; Aterido, Beck and Iacovone 2013; Demirguc-Kunt, Klapper and Singer 2013; Demirguc-Kunt and Klapper 2013; IMF 2015).

We construct novel indices of financial inclusion based on micro-level data to capture both the level and the distribution of financial access at the country level. We exploit the microeconomic data collected to build the FINDEX data base, consisting in world-wide GALLUP surveys on financial inclusion, with representative samples of about 1,000 individuals per country (a total of about 146,000 observations on over 140 countries, 34 of which are from sub-Saharan Africa). By relying on individual data to construct a synthetic measure of financial inclusion, it is possible to aggregate information on the types and intensity of use of different types of financial services by individuals. For example, it is possible to find out whether, at the individual level, certain financial services are substitutes or complements, whereas the aggregated country data will only give information on the share of the population using either formal or informal services.

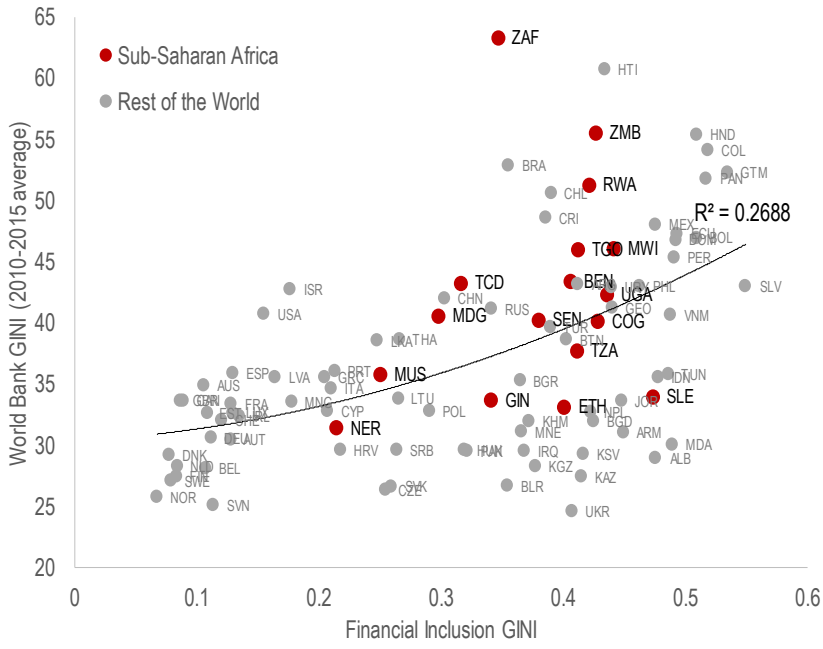
The micro-level data also allows to assess the equality of the distribution of financial services within each country—which follows a Kuznets-type relationship. Similarly to the construction of a Gini coefficient from individual household data, we derive Gini coefficients of inequality of financial access from the micro-level data. The pattern in the inequality in financial access is strongly reminiscent of the Kuznets curve: At lower average intensities of financial access per country, increases in financial inclusion are driven by an increase in the intensity of the use of financial services by a smaller share of the population, therefore

[5]Amin et al. (2015) study gender inequality and growth, using a broad gender inequality index. They find a strong negative relationship between growth and gender inequality, but which mostly holds for low income countries and tends to vanish at higher income levels. Konte (2015) investigates the impact of gender-based financial discrimination on economic growth in developing countries. Dabla-Norris and others (2015) calibrate their model to developing countries and show that removing barriers to access (participation cost) can benefit the poor and reduce inequality, if participation cost is the most binding access constraint. Policies that improve the depth of access by those already included could however increase inequality.

exacerbating inequality in financial inclusion. After a turning point, however, increases in financial access are mainly driven by more people gaining access to financial services, which in turn lowers inequality in financial inclusion.

We find a strong association between this inequality in financial access—as well as inequality in financial access between men and women—and income inequality (Figure 1). Controlling for a wide set of structural and policy determinants of income inequality, as well as financial development and other types of gender gaps, results show that unequal financial access both overall and between men and women is significantly and robustly related to greater income inequality at the country level. In turn, the level of financial inclusion, as per our measure, does not seem to have a significant impact on income inequality, implying that policies should target more equal access to a broad range of financial services across the population.

Figure 1. Inequality in Financial Access and Income Inequality



Finally, we highlight a range of policy options to increase financial inclusion based on the most binding constraints highlighted by individuals. We distinguish between individuals that are involuntarily excluded from formal financial services (because of cost, physical barriers such as distance to banks, documentation requirements, lack of money, lack of trust)

and those that self-exclude (no need for financial services, cultural or religious reasons, have indirect access). We find that, overall, addressing the main drivers of involuntary financial exclusion through better provision of infrastructure, including electricity, improving financial and general institutions, and higher levels of human capital at the country level, would significantly help enhance financial inclusion.

The remainder of the paper is structured as follows. Section II briefly reviews the relevant empirical literature. The data, the methodology used to construct the financial inclusion indices and some stylized facts are presented in Section III. In Section IV, we discuss the estimation strategy and empirical results. Section V concludes.

II. Literature Review

Finance and Inequality

A well-established strand of theoretical and empirical studies focus on the relationship between finance and income inequality. Early theoretical models imply that financial development enhances growth and reduces inequality in the presence of financial frictions: information and transaction costs may be especially binding on the poor who lack collateral and credit histories, so that relaxation of these constraints will disproportionately benefit the poor, improving the efficiency of capital allocation (growth) and reducing income inequality by facilitating funding to poor talented individuals (Galor and Zeira 1993; Aghion and Bolton 1997; Galor and Moav 2004).

Other models predict a non-linear relationship between financial development and inequality. For example, Greenwood and Jovanovic (1990), argue for a Kuznets-type of relationship, with the distributional effects of financial development depending on the level of economic development: at early stages of development, only the rich can afford to access financial markets, while the benefits of financial development are more widely distributed at higher levels of economic development. Townsend and Ueda (2006) also highlight the prevalence of non-linearities as economic growth with financial deepening and changing inequality are transitional phenomena, and caution against regression analysis in this context.

Independently of the form of the relationship, these models posit that financial development will affect income inequality, but the causality goes the other way in other models. In contrast, Claessens and Perotti (2007) present a political economy argument for inequality affecting financial development, or at a minimum for inequality and financial

underdevelopment to be jointly determined by institutional factors which cause unequal access to political and contractual rights. They review recent evidence suggesting that unequal access to political influence produces unequal access to finance and ultimately unequal opportunities, which can reinforce economic inequality. Perotti and Volpin (2007) find that access to finance is better in more equal countries and in countries with greater political accountability, also after controlling for legal origin and economic development.

Whereas the theory refers explicitly to a link between financial access or inclusion and income inequality, the empirical literature has initially analyzed this link using financial depth measures to proxy financial development. In doing so, and although the theory is inconclusive on the direction of causality between financial development and income inequality, empirical results point to robust and significant effects of financial development on income inequality. Beck, Demirguc Kunt and Levine (2007) find that financial development disproportionately boosts incomes of the poorest quintile and reduces income inequality. Their findings suggest that financial reforms that reduce market frictions can boost growth without the potential incentive problem associated with redistributive policies. For a panel of 22 sub-Saharan African countries between 1990 and 2004, Batuo et al. (2010) find that income inequality declines as economies develop their financial sector.

Other studies suggest that the impact of financial development on inequality may only be indirect, working through higher labor force participation of the poor. Beck, Levine and Levkov (2007) found that commercial bank branch deregulation in the U.S. (an exogenous reform) did lead to lower income inequality, but by affecting labor market conditions, not by providing the poor with greater access to finance. Similarly, Giné and Townsend (2004) study the growth and distributional effects of financial liberalization in Thailand and also find that the main impact of finance on income inequality is indirect, working through the inclusion of a larger share of the population in the formal economy and higher wages rather than through the provision of direct access to credit to the poor.

More recent analyzes focus on financial access or financial inclusion as a broader concept, and its relationship with macroeconomic outcomes including income inequality, taking advantage of previously-unavailable data (Beck and Demirguc-Kunt, 2008). The early studies that have attempted to measure financial outreach and exclusion look mostly at supply-side data such as number of bank branches, ATMs and number of bank

deposit and loan accounts and find very sharp differences in financial inclusion across countries with the poorest countries having the least access (Beck et al., 2007, Honohan, 2007, Moockerjee and Kalipioni, 2011). In a sample of about 60 developed and developing countries, Mockerjee and Kalipioni (2011) find that availability of financial services measured by the number of bank branches per 100,000 people, cost of opening an account and number of locations where loan applications can be submitted are significantly related to income inequality in cross-country regressions.

Financial inclusion thus broadly-defined is an important dimension of overall financial development, which encompasses access, depth and efficiency (Dabla Norris and others 2015a; Sahay and others 2015).

- Dabla Norris and others (2015a) develop a general equilibrium model where the macroeconomic impact of financial inclusion policies will vary with the particular source of friction or combination thereof in a given country. In the model, greater financial inclusion can help reduce income inequality if it focuses on increasing access (or reducing participation costs) of the poor. However, policies that focus on relaxing the borrowing constraint can disproportionately benefit wealthy agents and increase income inequality but as new agents access credit inequality can decline.
- Using both data on the availability of financial infrastructure, as well as information on the users' side, including account ownership, use of bank credit, etc., Sahay and others (2015) document a wide variation among countries in account holding and usage, systematic gender gaps in financial inclusion, and difficulties by small firms in accessing finance. They find that greater financial inclusion increases growth but with declining marginal benefits as both inclusion and depth increase. In particular, financial stability risks increase when access to credit is expanded without proper supervision, but other types of access to finance have a monotonic relationship to growth. They also show a positive relationship between the gender gap in account holding and income inequality.

Gender gaps and inequality

The literature on gender inequality and macroeconomic outcomes has been growing rapidly. The 2012 World Development Report (WDR) reviews the evidence on gender and development. The WDR notes that gender equality can enhance productivity, improve development outcomes for the next generation, and make institutions more representative.

Various studies have confirmed the negative effect of gender inequality in education on growth (Dollar and Gatti 1999; Klasen 1999; Klasen and Lamanna 2009; Seguino 2010). Amin and others (2015) confirm a strong impact of gender gaps beyond those in education on economic growth but only in poor countries. Kazandjian and others (2016) find, in addition, that gender gaps may impede economic diversification, and therefore growth in low-income and developing countries. As noted in World Banks (2011), solutions are complex and cannot exclusively be addressed through policies: for example, gender gaps in productivity and earnings are driven by the interaction of deep-seated gender differences in social norms about house and care work, in rights of ownership and control over land and assets, and in the workings of markets and formal institutions, which disadvantage women.

A new strand of the literature has focused on the relationship between gender inequality and income inequality. Gonzales and others (2015b) find that greater gender equity and in particular higher female labor participation and lower gender gaps in financial access is associated with better development outcomes but also higher growth, and lower income inequality. Different types of gender gaps contribute to income inequality: gender wage gaps and gaps in labor force participation rates result in inequality in male and female earnings, and thus contribute to overall income inequality, particularly so in advanced economies (also see Gonzalez and others 2015b). Inequality of economic opportunities, in particular access to education, health and financial services have also been found to be related to income inequality overall and in particular in low-income countries (see Hakura and others 2016).

Gender gaps in financial inclusion

There is an extensive micro and cross-country literature on women and financial inclusion (see review in Aterido, Beck and Iacovone 2013; Demirguc-Kunt, Klapper and Singer 2013; Swamy 2013). For example, using Indian household survey data, Swamy (2013) find a strong impact of financial inclusion programs in terms of the change in income of the poor, and particularly women. Income growth net of inflation was 8.4 percent against 4 percent for men. She finds positive welfare effects of targeting financial inclusion program on women, as they tend to use the resources in such ways that improve the family well-being and contribute to significantly increase in savings levels of the households.

Most recent studies use the Findex database, an extensive cross-country database on financial inclusion, presented in more detail in the next section. Demirguc-Kunt and Klapper

(2012) present the database and key characteristics of financial inclusion worldwide and document a systematic gender gap in financial access, with only 37 percent of women having a formal bank account compared with 46 percent of men. The difference is persistent across all income groups in developing countries. Allen et al. (2012) use the Findex data to analyze the drivers of financial inclusion and find that, controlling for other individual characteristics, women are negatively associated with having accounts and saving, but not significantly. However, women are significantly and negatively related with frequent use of bank accounts. Using somewhat older World Bank enterprise surveys for 37 sub-Saharan African countries, Aterido and others (2013) do find an unconditional gender gap in access to finance in sub-Saharan Africa, but when key observable characteristics of the enterprises or individuals are taken into account the gender gap disappears. In their view, the causes of these gender gaps lie mainly outside the financial sector, in other dimensions related to female participation in the modern market economy, including labor force participation and education.

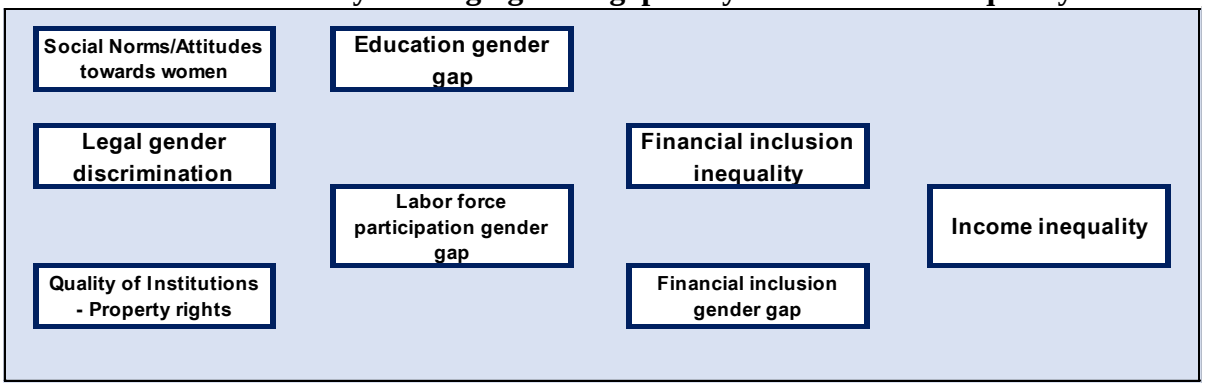
Demirguc-Kunt, Klapper and Singer (2013) focus on the drivers of the gender gap in financial inclusion using the Findex database and find a different result for developing countries. After controlling for a host of individual characteristics such as income, education, employment status, rural residency and age, they find that gender remains significantly related to usage of financial services. They also find that legal discrimination against women and gender norms may explain some of the cross-country variation in access to finance for women. Where women face legal restrictions in their ability to work, head a household, choose where to live, and receive inheritance, women are less likely to own an account, relative to men, as well as to save and borrow. Their results also confirm that gender norms, such as the level of violence against women and the incidence of early marriage for women, contribute to explaining the variation in the use of financial services between men and women, after controlling for other individual and country characteristics.

Putting the Pieces Together

The literature suggests that interactions between inequality in financial access and income inequality may take place through various channels. It shows that, in addition to measures of the structure of the economy, institutions, policies as well as gender-based inequality of opportunities, inequality in financial access, and in particular gender gaps in financial inclusion, may affect income inequality both directly and indirectly. They could

affect income inequality directly through enabling economic participation, providing access to productive tools, and helping to improve economies of scale. It is also possible that gender gaps in financial inclusion are the result of other types of gender gaps (in education, health), which affect income inequality both directly or indirectly through their impact on female labor force participation (Chart 1).

Chart 1. The ways through gender gaps may affect income inequality



III. Data

The Findex database

The Findex dataset provides the most comprehensive information on financial inclusion. The World Bank's Findex dataset provides the largest set of comparable, cross-country information on a broad range of financial services and the intensity of their use based on a worldwide survey of representative samples of 1,000 individuals in over 140 countries. So far two waves of the FINDEX have been conducted, in 2011 and 2014, with broadly comparable information and a plan to conduct new surveys every three years. Given that income inequality data are only available with a lag and up to 2013, in this paper we use the 2011 data.

The Findex database closes an important gap in the information on financial inclusion by focusing on individuals, rather than financial institutions or aggregate measures of financial depth. It thus complements existing data such as the IMF's Financial Access Survey data and World Bank Enterprise Surveys.[6] Yet, to our knowledge no other studies have exploited this wealth of individual-level data and related it to macroeconomic outcomes. In addition, ours is the only study thus far to attempt to construct a synthetic, micro-based measure of financial inclusion capturing both access to and intensity of use of a broad range of financial

[6] see Demirguc-Kunt and Klapper (2012) for a description of the database and descriptive statistics of financial inclusion worldwide.

services. Even the studies using the disaggregated Findex data (Allen and others 2012; Demirguc-Kunt, Klapper and Singer 2013), tend to look at the drivers of financial inclusion measures one by one - e.g. having an account, and, conditional on having an account, saving and borrowing.

Notwithstanding the advantages and contributions of the Findex data, they have some limitations. First of all, the lack of a time dimension greatly limits the possible econometric methodologies and plausible controls for endogeneity, as well as an analysis of how financial inclusion changes over time and how these changes affect macroeconomic outcomes. It will be some time until a sufficient number of waves of the Findex survey will be available to researchers, and if individuals may become traceable over time in future surveys. Another limitation is that the Gallup polls did not include household-level information in addition to the basic individual characteristics (age, gender, education, income and formal employment status). For example, data on marital status, whether the person surveyed is head of household, number of dependents in the household would have allowed for a much more in-depth analysis of the drivers and impacts of financial inclusion world-wide.

Constructing Novel Indices of Financial Inclusion[7]

We use the Findex micro-level information to construct country-aggregates of financial inclusion. We start by constructing individual-level scores of financial inclusion using correspondence analysis, the principal component analysis equivalent for categorical data. In particular, we select 12 questions from the set of Findex questions which fulfil the following criteria: First, they are directly related to financial access. Second, they do not include information on individuals' personal characteristics or environment to not later bias the empirical estimations. Importantly, the questions selected capture access to and use of formal financial services.[8] Table 1 depicts the questions which enter the index.

[7] Aslan and others (forthcoming) provide a detailed description of the methodology used to construct the individual financial inclusion scores and country-level financial inclusion indices.

[8] Further work will explore further the relationship between formal and informal financial inclusion, and the extent to which these two forms of inclusion are substitutes or complements, particularly in developing countries. It would be also important to investigate whether similar macroeconomic benefits are linked with the use of informal as compared to formal financial services.

Table 1. Questions used to construct the financial inclusion index

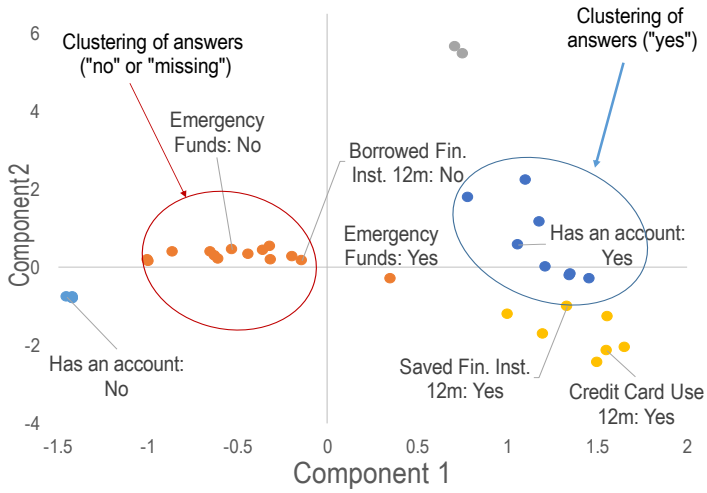
Questionnaire Number	Question	Possible Responses
Q1	Has an account	Yes/No/missing
Q3	If has a debit card, card is in own name	Yes/No/missing
Q4	If has a debit card, used card in the last 12 months	Yes/No/missing
Q6	If has a credit card, used card in the last 12 months	Yes/No/missing
Q9	If has an account, made deposit into account in the last 12 months	Yes/No/missing
Q11	If has an account, made withdrawal in the last 12 months	Yes/No/missing
Q14	If has an account, made transaction with mobile phone	Yes/No/missing
Q16	Made Internet Payments	Yes/No/missing
Q18a	Saved at financial institution in the last 12 months	Yes/No/missing
Q20	Borrowed from financial institution in the last 12 months	Yes/No/missing
Q21a	Has loan from financial institution for house, apartment, or land	Yes/No/missing
Q24[9]	Possibility of coming up with emergency funds	Very possible/Somewhat Possible/Not very possible/Not at all possible/missing

The individual scores are clustered around the use of particular financial services. Figure 2 highlights the variation of responses to answers in Table 1 along the two main principle axes according to the correspondence analysis. The main axis is the horizontal one, in which the different questions is wide-spread around the center zero. The further away from the center, the larger the share of the particular answer in determining the index. Note that answers to the

[9] We used a modified version of Q24. The responses "Very possible" and "Somewhat Possible" were combined as a category "Very or somewhat possible", while "Not very possible" and "Not at all possible" were combined as "Not very or at all possible".

right (more inclusive) are clustered around answers around answers of "yes" to the use of financial services, while "missing" and "no" answers are clustered on the left-hand side. This principal axis helps explain about 90 percent of the variation in the data. On the other hand, the second principal axis (the vertical axis in Figure 2), only explains an additional 5 percent of the variation, and is therefore not relevant for our analysis.

Figure 2. Components of Financial Inclusion according to Correspondence Analysis



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The distribution of individual scores is highly skewed towards low-level scores, while country level scores appear to be highly scattered across countries' income groups. Figure 3 highlights the distribution of individual scores across bins, with higher value bins representing higher financial inclusion for the respective individual. It highlights that, while

the intensity of financial inclusion is relatively equally distributed at higher levels of financial inclusion, it is concentrated in two bins on the low inclusion side, mainly driven by low-income countries, in particular sub-Saharan African ones. At the aggregate level, Figure 4 highlights that countries' financial inclusion level is clustered at countries' income levels, with low-income countries at lower financial inclusion scores, and high-income countries at higher levels of financial inclusion.

Figure 3. Distribution of Individual Financial Inclusion Scores

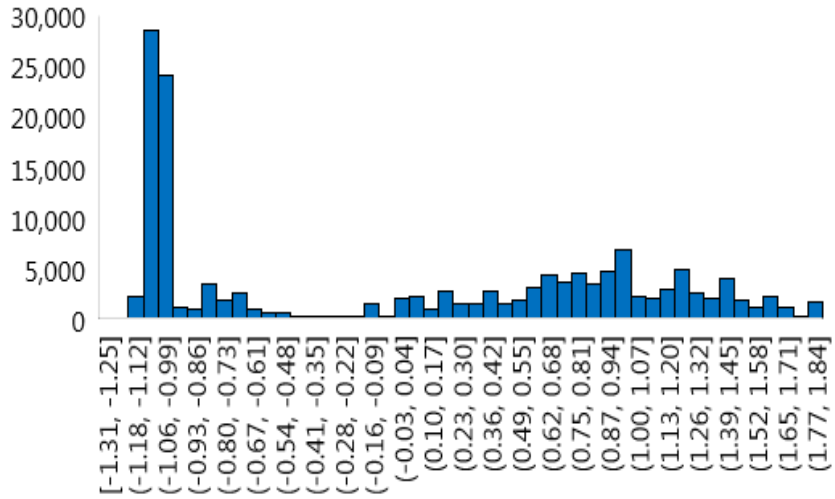
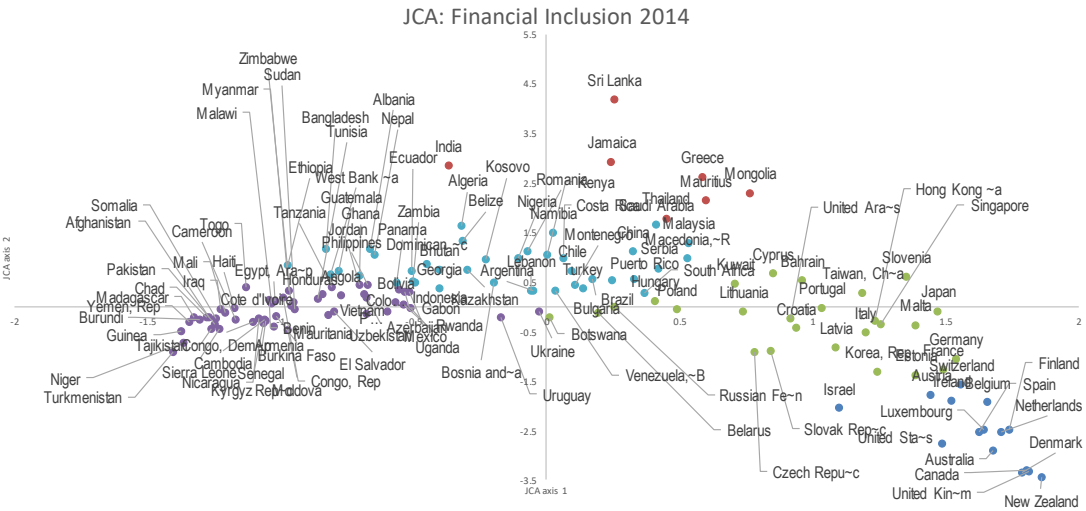
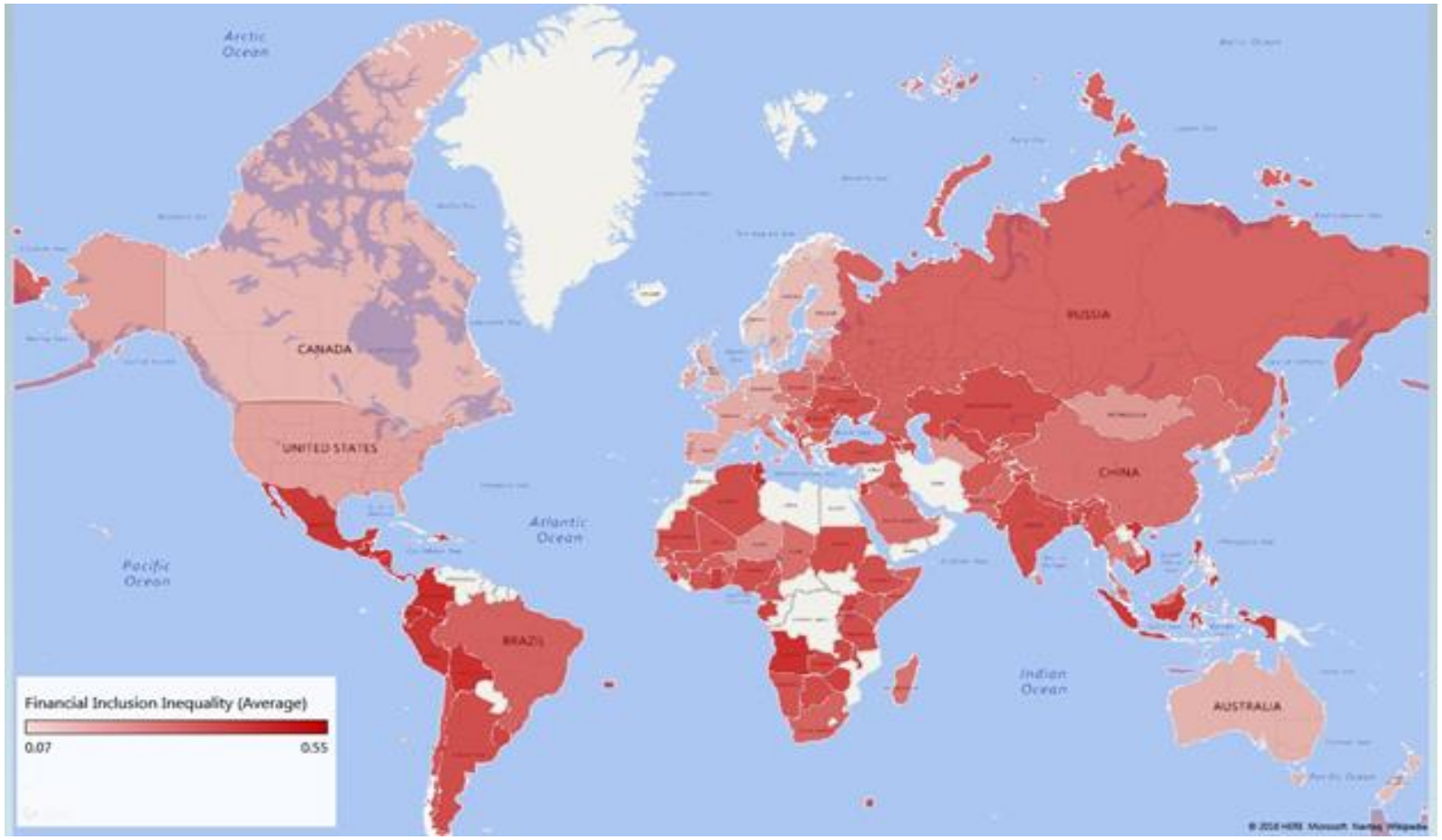


Figure 4. Distribution of Individual Financial Inclusion Scores



We derive the inequality in financial access from the standard Gini-coefficient calculation. We use the individual financial access scores which are calculated from Global Findex 2011 survey data from Aslan and others (forthcoming) to calculate a Gini index of financial inclusion. The procedure covers covariance-based expressions for the generalized Gini and concentration coefficients are particularly convenient for calculations from unit-record data (Box 1). Figure 5 shows that this inequality in financial access varies strongly across countries, with darker shades in red and higher levels of the Gini depict higher levels of inequality of financial access.

Figure 5. Inequality in Financial Access 2014



Sources: Global Findex, and authors' calculations.

Box 1. Deriving a Gini-Index of Financial Access

Covariance-based Gini coefficient as mentioned by Yitzhaki (1998) are derived as follows:

$$GINI(X) = -2Cov\left(\frac{X}{\mu(X)}, (1 - F(X))\right)$$

Where X is a random variable of interest with mean $\mu(X)$ and $F(X)$ is its cumulative distribution function. The Concentration coefficient measures the association between two random variables and can be expressed as

$$CONC(X,Y) = -2Cov\left(\frac{X}{\mu(X)}, (1 - G(Y))\right)$$

Where $G(Y)$ is the cumulative distribution function of Y. $CONC(X,Y)$ reflects how much X concentrated on observations with high ranks in Y.

A single-parameter generalization of the Gini coefficient has been proposed by Donaldson & Weymark (1980, 1983) and Yitzhaki (1983). The generalized Gini coefficient (S-Gini, or extended Gini coefficient) can also be expressed as a covariance:

$$GINI(X;v) = -vCov\left(\frac{X}{\mu(X)}, (1 - F(X))^{v-1}\right)$$

Where v is a parameter tuning the degree of 'aversion to inequality'. The standard Gini corresponds to v=2

The fractional ranks are calculated as follows:

Consider a sample of N observations on a variable Y with associated sample weights: $\{(y_i, w_i)\}_{i=1}^{N}$. Lek K be the number of distinct values observerd on Y, denoted $y_1^* < y_2^* < \cdots < y_k^*$, and denote by π_k^* the corresponding weighted sample proportions:

$$\pi_k^* = \frac{\sum_{i=1}^{N} w_i 1(y_i = y_k^*)}{\sum_{i=1}^{N} w_i}$$

(1(condition) is equal to 1 if condition is true and 0 otherwise). The fractional rank attached to each y_k^* is given by

$$F_k^* = \sum_{j=0}^{k-1} \pi_j^* + 0.5\pi_k^*$$

where $\pi_0^* = 0$ (Lerman & Yitzhaki, 1989, Chotikapanich & Griffiths, 2001). Each observation in the sample is then associated with the fractional rank

$$F_k^* = \sum_{k=1}^{K} F_k^* 1(y_i = y_k^*)$$

This procedure ensures that tied observations are associated with identical fractional ranks and that the sample mean of the fractional ranks is equal to 0.5. $\{(F_i, y_i, w_i)\}_{i=1}^{N}$ can then be plugged in a standard sample covariance formula. This makes the resulting Gini coefficient estimate independent on the sample/population size.

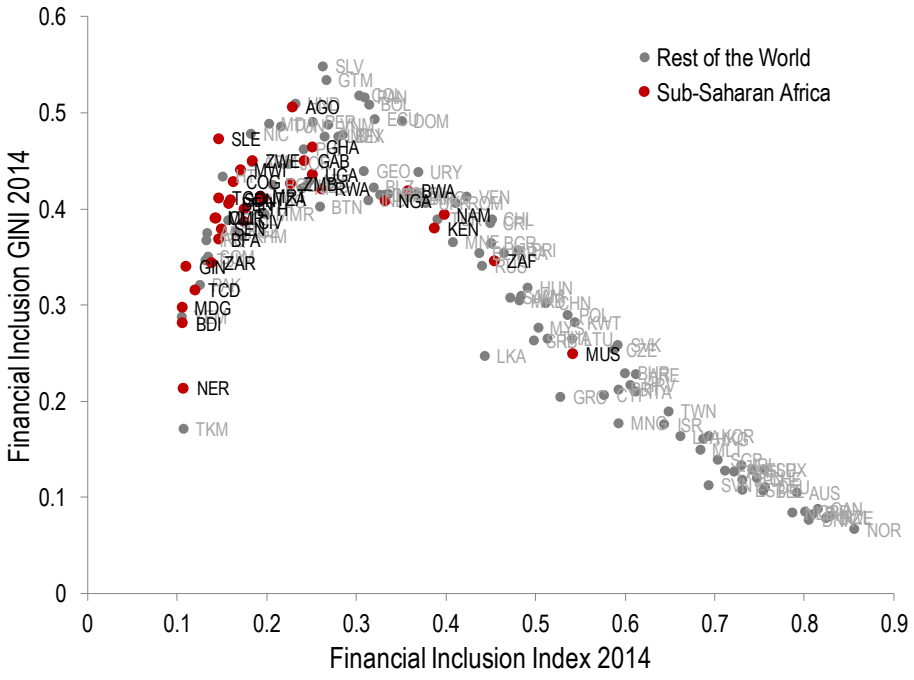
Inequality in financial access follows a Kuznets-type relationship, and is strongly driven by different access levels by men and women in some countries. Figure 6 plots the average financial inclusion score by country against the level of inequality in financial inclusion at the country level. It shows that, at lower levels of financial inclusion, increases in the country's average financial inclusion scores, increases in these scores appear to be mainly driven by a smaller group of individuals intensifying their use of financial services, inequality of financial inclusion therefore increases. At later stages of financial inclusion, once a turning point is reached, increases in average financial inclusion scores seem to be mainly driven by additional people joining the financial system, and this increase in the extensity of financial inclusion decreases inequality in financial access. Finally, a decomposition of this inequality in financial inclusion shows that it is driven by up to 30 percent by inequality in financial access across genders (Figure 7), derived according to the following decomposition (Equation 1)

$$G = \frac{\sum_{i=1}^{n} w_i \sum_{j=1}^{n} w_j |y_i - y_j|}{2 \sum_{i=1}^{n} w_i \sum_{i=1}^{n} w_i y_i} = G_w + G_{nb} + G_t \qquad (1)$$

Where,

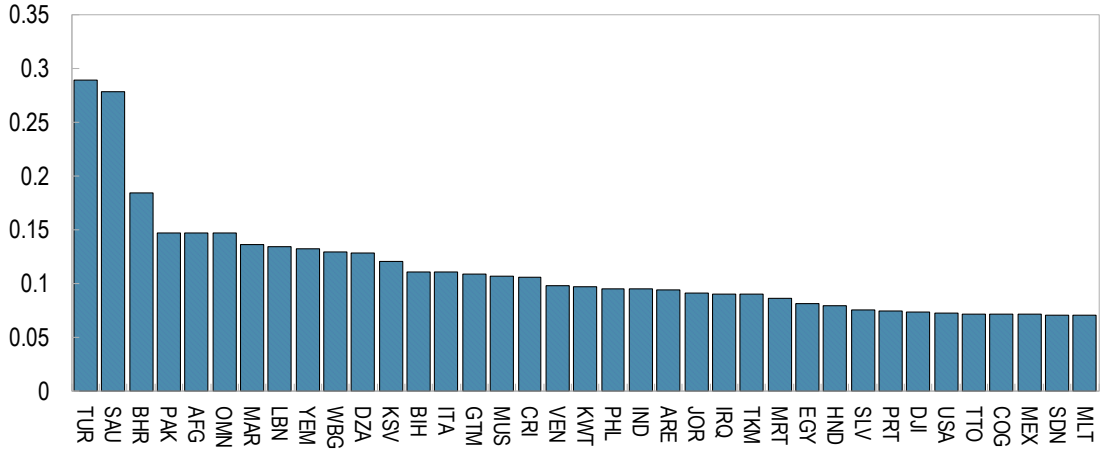
- G_w is the within (inequality among males + inequality among females)
- G_{nb} is the net between component capturing the contribution of gender inequality
- G_t represents the transvariation contribution

Figure 6. Financial Inclusion and Inequality in Financial Inclusion



Sources: Global Findex and own calculations.

Figure 7. Selected Countries: Proportion of Gender Contribution to Inequality in Financial Access



IV. Gender Gaps in Financial Inclusion and Income Inequality: Empirical Strategy

A. Specification

This section assesses the potential impact of inequality in financial access on income inequality. With financial inequality likely to be associated with differences in income according to the theoretical literature, and gender equality driving a substantial part of this inequality, this section estimates the association between inequality in financial access and income inequality in general, and gender gaps in financial access and income inequality in particular. The estimated relationship is given in equation (2) below:

$$Gini_i = FinInequality_i + Structural_i + Policies_i + \epsilon_i \quad (2)$$

In which

- $Gini_i$ refers to the level of income inequality as measured by the World Bank's Gini coefficient of income inequality in country *i* (World Bank Development Indicators 2016). As availability of these data is relatively scarce, particularly for low-income countries, we take four-year averages (2010-13) of these index.
- $FinInequality_i$ depicts our measure of overall inequality of financial inclusion and gender inequality in financial inclusion, respectively. We expect that inequality in financial access both overall and by gender is positively associated with income inequality.
- $Structural_i$ represents structural country characteristics, such as the log of income per capita and the share of agricultural production in total production. In line with the labor intensity of this sector, we expect the share of agricultural output in total production to be negatively associated with income inequality. We also test for the effect of the share of the rural population as well as the growth in the dependency ratios in robustness checks.
- *Policies* capture country level policies, such as the openness to trade, the quality of macroeconomic management (proxied by the level of inflation) and the level of infrastructure (measured by the percent of the rural population having access to electricity). We expect all of these factors to be negatively associated with income inequality. To capture the fact that at low levels of overall human capital in an economy, increases in

human capital could exacerbate income inequality but decrease income inequality at higher levels, we include the average years of schooling both with its level and a squared term into the regressions. To capture other inequalities at the gender level, we in addition control for an aggregate measure of gender inequality in the regressions which is expected to be positively associated with income inequality and the level of financial sector development which could be associated positively with income inequality since credit may be concentrated and financial inclusion may not keep pace with financial deepening.[10] We use ordinary least squares to estimate the above relationship.

B. Empirical Results

Inequality in financial access, and gender inequality in access in particular are strongly associated with income inequality. Table 2 highlights the results of the OLS regressions:

- Inequality in access to financial services is positively and significantly related to inequality of income, on top of standard drivers of income inequality highlighted in the literature (columns 1-2), while higher ratios of female to male access in financial inclusion are associated with lower income inequality (columns 3-4).
- As gender inequality in financial access is partially driving overall inequality in financial access—as discussed above—the significance of the gender gap in financial inclusion may be reflecting gender equality merely representing a proxy. To test for the effect of gender inequality separately, we therefore eliminate the gender-relevant part from overall inequality in financial access by regressing overall inequality in financial access on the gender gap in financial access, and including the residual from this equation jointly with the gender gap in financial access into the regression. Columns 5-6 highlight that greater gender inequality in financial access is strongly associated with higher income inequality beyond other drivers which may explain inequality in financial access.
- Finally, columns 7-8 highlight that the results hold when including other controls into the regression. In addition, we find that it is indeed the degree of inequality—rather than the level—in the access of financial services which matters for income inequality since the level of financial inclusion does not enter our specification significantly (not shown).[11]

[10] The index captures both inequities in outcomes as well as opportunities. In particular, it captures the gap between male and female labor force participation, the share of female seats in parliament, the gender gap in secondary completion rates, the maternal death ratio as well as adolescent fertility rates).

Other determinants enter the regression with the correct sign but some with limited significance, likely also reflecting the small size of the sample. Consistently with the labor intensity in this sector, a higher share of agriculture in GDP is associated with lower income inequality. Higher human capital levels are associated with lower levels of income inequality when human capital levels reached a critical size, while higher levels of overall gender inequality are positively related to income inequality. Better macroeconomic management, as proxied by the inflation rate, is associated with lower levels of income inequality. Other variables, such as openness to trade, access to electricity or financial development enter with the expected signs but are not significant at standard levels, likely partly reflecting the small size of the sample.

Robustness checks. The robustness check included introducing regional fixed effects, and regional and income-level interactions, the inclusion of separate dimensions of gender inequality (education gaps, labour force participation gaps), other and additional structural country characteristics (oil exporter dummy, squared GDP term, output per worker), and additional policy variables, such as the level of government spending. In all these specifications, inequality in financial access remained positively related to income inequality.

Table 2. Determinants of Income Inequality

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Measures of financial inequality								
Inequality in financial access	0.324***	0.346***					0.266***	0.271***
	(0.069)	(0.063)					(0.069)	(0.071)
Female/male ratio of financial access			-0.155**	-0.153**	-0.195***	-0.196***		
			(0.075)	(0.073)	(0.063)	(0.060)		
Inequality in financial access (purged from gender					0.306***	0.329***		
					(0.069)	(0.063)		
Structural country characteristics								
Log real GDP per capita	-0.096	-0.080	0.074	0.097	-0.110	-0.094	-0.215*	-0.048
	(0.096)	(0.084)	(0.095)	(0.093)	(0.095)	(0.083)	(0.116)	(0.150)
Log real GDP per capita squar	0.002	0.001	-0.007	-0.008	0.003	0.002	0.010	0.001
	(0.005)	(0.005)	(0.005)	(0.005)	(0.005)	(0.004)	(0.006)	(0.008)
Share of agriculture in GDP	-0.004***	-0.004***	-0.004**	-0.004**	-0.004***	-0.004***	-0.004***	-0.004***
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
Policies								
Openness to trade	-0.000*	-0.000	-0.000*	-0.000*	-0.000*	-0.000	-0.000	-0.000
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Inflation		-0.003***		-0.002**		-0.003***	-0.002	-0.002
		(0.001)		(0.001)		(0.001)	(0.002)	(0.002)
Human capital							0.183*	0.194*
							(0.106)	(0.110)
Human capital squared							-0.041**	-0.042**
							(0.018)	(0.019)
Gender inequality index							0.237**	0.211**
							(0.094)	(0.094)
Financial development							0.066	0.079
							(0.065)	(0.065)
Access to electricity, rural								-0.081
								(0.051)
Constant	1.014**	0.961**	0.523	0.442	1.408***	1.365***	1.166**	0.393
	(0.439)	(0.381)	(0.438)	(0.426)	(0.463)	(0.394)	(0.542)	(0.662)
Observations	84	84	84	84	84	84	76	76
R-squared	0.42	0.45	0.32	0.34	0.43	0.47	0.61	0.62

Robust standard errors in pare
*** p<0.01, ** p<0.05, * p<0.1

V. Conclusions and Policy Recommendations

Beyond the drivers of income inequality identified in the existing literature, this study finds a particularly important role for inequality in access to financial services, with a significant share of that inequality driven by gender differences in financial access. In particular, our results suggest at least a strong association between inequality of access in formal financial inclusion, and in particular of gender gaps in financial inclusion and income inequality. The analysis is limited by the lack of a time series dimension and the relatively small size of the sample, but results are nonetheless consistent with other empirical findings (Batuo et al., 2010, Mockerjee and Kalipioni, 2011). This study's particular contribution is to highlight that, more than the level of financial development or overall financial inclusion, it is the distribution of financial access in the population that matters for income inequality. Furthermore, we show that a significant share of that distribution in financial access is driven by systematic differences across genders. The policy implications are important: policies that can foster broad-based access to a range of financial services across the population, and policies aiming at reducing the gender gap in financial access, would also promote greater income equality.

Much work however remains to be done to better understand the channels through which gender inequality in financial access affect income inequality. Going back to individual-level data would help understand the drivers of financial inclusion and exclusion, and the linkages between gender gaps in financial inclusion and other gender gaps, such as education and labor force participation. We aim to address some of this questions in further research (Deléchat and others, forthcoming).

References

Aghion, Philippe, Patrick Bolton, 1997, "A Theory of Trickle-Down Growth and Development," *The Review of Economic Studies*, Vol. 64, No. 2, pp. 151-172.

Allen, Franklin, Asli Demirguc-Kunt, Leora Klapper, Maria Soledad Martinez Peria, 2012, "The Foundations of Financial Inclusion: Understanding Ownership and Use of Formal Accounts," *Policy Research Working Paper WPS6290*, (Washington D.C.: The World Bank Group).

Amin, Mohammad, Veselin Kuntchev, Martin Schmidt, 2015, "Gender Inequality and Growth," *Policy Research Working Paper WPS7172*, (Washington D.C.: The World Bank Group).

Aterido, Reyes, Thorsten Beck, Leonardo Iacovone, 2013, "Access to Finance in Sub-Saharan Africa: Is There a Gender Gap?," *World Development*, Vol. 47, pp. 102-120.

Barro, Robert J., 2000, "Inequality and Growth in a Panel of Countries," *Journal of Economic Growth*, Vol. 5, pp. 5-32.

Batuo, Michael Enowbi, Francesco Guidi, Kupukile Mlambo, 2010, "Financial Development and Income Inequality: Evidence from African Countries," *MPRA Paper No. 25658*, (Munich: Munich Personal RePEc Archive).

Baum, Christopher F., Arthur Lewbel, Mark E. Schaffer, Oleksandr Talavera, 2013, "Instrumental variables estimation using heteroscedasticity-based instruments," *German Stata Users Group Meeting*, (Potsdam: DESUG).

Beck, Thorsten, Asli Demirguc-Kunt, Ross Levine, 2002, "Law and Finance: Why Does Legal Origin Matter?," *NBER Working Paper No. 9379*, (Cambridge, MA: National Bureau of Economic Research).

Beck, Thorsten, Asli Demirguc-Kunt, Maria Soledad Martinez Peria, 2007, "Bank Financing for SMEs around the World: Drivers, Obstacles, Business Models, and Lending Practices," *Policy Research Working Paper WPS4785*, (Washington D.C.: The World Bank Group).

Beck, Thorsten, Asli Demirguc-Kunt, Ross Levine, 2007, "Finance, inequality and the poor," *Journal of Economic Growth*, Vol. 12, pp. 27-49.

Beck, Thorsten, Ross Levine, Alexey Levkov, 2007, "Big Bad Banks? The Impact of U.S. Branch Deregulation on Income Distribution," *NBER Working Paper No. 13299*, (Cambridge, MA: National Bureau of Economic Research).

Beck, Thorsten, Asli Demirguc-Kunt, 2008, "Access to Finance: An Unfinished Agenda," *The World Bank Economic Review*, Vol. 22, No. 3, pp. 383-396.

Carvalho, Laura, Armon Rezai, 2014, "Personal Income Inequality and Aggregate Demand," *Working Paper Series No. 2014-23,* (Sao Paulo: University of Sao Paulo FEA-USP).

Chotikapanich, Duangkamon, William Griffiths, 2001, "On Calculation of the Extended Gini Coefficient," *Review of Income and Wealth,* Vol. 47, No. 4.

Claessens, Stijn, Enrico Perotti, 2007, "Finance and Inequality: Channels and Evidence," *Journal of Comparative Economics,* Vol. 35, No. 4, pp. 748-773.

Corak, Miles, 2013, "Income Inequality, Equality of Opportunity, and Intergenerational Mobility," *IZA Discussion Paper Series No. 7520,* (Bonn: Institute for the Study of Labor).

Cuberes, David, Marc Teignier, 2014, "Aggregate Costs of Gender Gaps in the Labor Market: A Quantitative Estimate," UB Economics Working Papers 2014/308, (Barcelona: Universitat de Barcelona).

Dabla-Norris, Era, Kalpana Kochhar, Hujin Suphaphiphat, Frantisek Ricka, Evridiki Tsounta, 2015a, "Causes and Consequences of Income Inequality: A Global Perspective," *IMF Staff Discussion Note 15/13,* (Washington: International Monetary Fund).

Dabla-Norris, Era, Yan Ji, Robert M. Townsend, D. Filiz Unsal, 2015b, "Distinguishing Constraints on Financial Inclusion and Their Impact on GDP, TFP, and Inequality," *NBER Working Paper No. 20821* (Cambridge, MA: National Bureau of Economic Research).

Deléchat, Corinne Monique Newiak, Fan Yang, and Goksu Aslan (forthcoming), "*Measuring the Intensity of Financial Inclusion Across Countries and Individuals".*

Deléchat, Corinne, Monique Newiak, Rui Xu, Fan Yang, and Goksu Aslan (forthcoming), "*What is Driving Financial Inclusion Across Countries".*

Demirguc-Kunt, Asli, Leora Klapper, 2012a, "Financial Inclusion in Africa" An Overview," *Policy Research Working Paper WPS6025,* (Washington D.C.: The World Bank Group).

Demirguc-Kunt, Asli, Leora Klapper, 2012b, "Measuring Financial Inclusion: The Global Findex Database," *Policy Research Working Paper WPS6088,* (Washington D.C.: The World Bank Group).

Demirguc-Kunt, Asli, Leora Klapper, Dorothe Singer, 2013, "Financial Inclusion and Legal Discrimination Against Women: Evidence from Developing Countries," *Policy Research Working Paper WPS6416,* (Washington D.C.: The World Bank Group).

Dollar, David, Roberta Gatti, 1999, "Gender Inequality, Income and Growth: Are Good Times Good for Women?," *Policy Research Report Working Paper Series No. 1,* (Washington D.C.: The World Bank Group).

Donaldson, David, John A. Weymark, 1980, "A Single-Parameter Generalization of the Gini Indices of Inequality," *Journal of Economic Theory*, Vol. 22, pp. 67-86.

Donaldson, David, John A. Weymark, 1983, "Ethically Flexible Gini Indices for Income Distributions in the Continuum," *Journal of Economic Theory*, Vol. 29, pp. 353-358.

Elborgh-Woytek, Katrin, Monique Newiak, Kalpana Kochhar, Stefania Fabrizio, Kangni Kpodar, Philippe Wingender, Benedict Clements, Gerd Schwartz, 2013, "Women, Work, and the Economy: Macroeconomic Gains from Gender Equity," *IMF Staff Discussion Note 13/10*, (Washington: International Monetary Fund).

Galor, Oded, Joseph Zeira, 1993, "Income Distribution and Macroeconomics," *The Review of Economic Studies*, Vol. 60, No. 1, pp. 35-52.

Galor, Oded, Omer Moav, 2004, "From Physical to Human Capital Accumulation: Inequality and the Process of Development," *Review of Economic Studies*, Vol. 71, pp. 1001-1026.

Gine, Xavier, Robert M. Townsend, 2004, "Evaluation of financial liberalization: a general equilibrium model with constrained occupation choice," *Journal of Development Economics*, Vol. 74, pp. 269-307.

Gonzales, Christian, Sonali Jain-Chandra, Kalpana Kochhar, and Monique Newiak, 2015a, "Fair Play: More Equal Laws Boost Female Labor Force Participation," *IMF Staff Discussion Note 15/02*, (Washington: International Monetary Fund).

Gonzales, Christian, Sonali Jain-Chandra, Kalpana Kochhar, Monique Newiak, Tlek Zeinullayev, 2015b, "Catalyst for Change: Empowering Women and Tackling Income Inequality," *IMF Staff Discussion Note 15/20*, (Washington: International Monetary Fund).

Greenwood, Jeremy, Boyan Jovanovic, 1990, "Financial Development, Growth, and the Distribution of Income," *The Journal of Political Economy*, Vol. 98, No. 5, pp. 1076-1107.

Hakura, Dalia, Mumtaz Hussain, Monique Newiak, Vimal Thakoor, Fan Yang, 2016, "Inequality, Gender Gaps and Economic Growth: Comparative Evidence for Sub-Saharan Africa," *IMF Working Paper 16/111*, (Washington D.C.: International Monetary Fund).

Han, Rui, Martin Melecky, 2013, "Financial Inclusion for Financial Stability: Access to Bank Deposits and the Growth of Deposits in the Global Financial Crisis," *Policy Research Working Paper WPS6577*, (Washington D.C.: The World Bank Group).

Honohan, Patrick, 2007, "Cross-Country Variation in Household Access to Financial Services," *Prepared for the Conference Access to Finance*, (Washington D.C.: The World Bank Group).

International Monetary Fund (IMF), 2016, "Financial Development and Sustainable Growth." *Chapter 3, Regional Economic Outlook: Sub-Saharan Africa,* (Washington D.C.: International Monetary Fund).

International Monetary Fund (IMF), 2015, "Inequality and Economic Outcomes in Sub-Saharan Africa," *Chapter 3, Regional Economic Outlook: Sub-Saharan Africa,* (Washington D.C.: International Monetary Fund).

Kazandjian, Romina, Lisa Kolovich, Kalpana Kochhar, Monique Newiak, 2016, "Gender Equality and Economic Diversification," *IMF Working Paper 16-140,* (Washington D.C.: International Monetary Fund).

Klasen, Stephan, 1999, "Does Gender Inequality Reduce Growth and Development? Evidence from Cross-Country Regressions," *Policy Research Report Working Paper Series No. 7,* (Washington D.C.: The World Bank Group).

Klasen, Stephan, Francesca Lamanna, 2009, "The Impact of Gender Inequality in Education and Employment on Economic Growth: New Evidence for a Panel of Countries," *Feminist Economics,* Vol. 15, No. 3, pp. 91-132.

Konte, Maty, 2015, "Gender-based Financial Discrimination and Economic Growth in Developing Countries," forthcoming in the *UNU-Merit Working Paper Series.*

La Porta, Rafael, Robert Vishny, 1998, "Law and Finance," *Journal of Political Economy,* Vol. 106, No. 6, pp. 1113-1155.

La Porta, Rafael, Florencia Lopez-de-Silanes, Andrei Shleifer, Robert Vishny, 1999, "The Quality of Government," *The Journal of Law, Economics, and Organization,* Vol. 15, No. 1, p. 222-279.

La Porta, Rafael, Florencia Lopez-de-Silanes, Cristian Pop-Eleches, Andrei Shleifer, 2004, "Judicial Checks and Balances," *Journal of Political Economy,* Vol. 112, No. 2, pp. 445-470.

Lazear, Edward P., Sherwin Rosen, 1981, "Rank-Order Tournaments as Optimum Labor Contracts," *Journal of Political Economy,* Vol. 89, No. 5, pp. 841-864.

Lerman, Robert I., Shlomo Yitzhaki, 1989, "Improving the Accuracy of Estimates of Gini Coefficient," *Journal of Econometrics,* Vol. 42, pp. 43-47.

Mehrotra, Aaron N., James Yetman, 2015, "Financial Inclusion- Issues for Central Banks," *BIS Quarterly Review,* (Basel: Bank for International Settlements).

Mookerjee, Rajen, Paul Kalipioni, 2010, "Availability of financial services and income inequality: The evidence from many countries," *Emerging Markets Review,* Vol. 11, pp. 404-408.

Ostry, Jonathan D., Andrew Berg, Charalambos G. Tsangarides, 2014, "Redistribution, Inequality, and Growth," *IMF Staff Discussion Note 14-02,* (Washington: International Monetary Fund).

Perotti, Enrico, Paolo Volpin, 2007, "Politics, Investor Protection and Competition," *Finance Working Paper No. 162/2007,* (Brussels: European Corporate Governance Institute).

Sahay, Ratna, Martin Cihak, Papa N'Diaye, Adolfo Barajas, Srobona Mitra, Annette Kyobe, Yen Nian Mooi, Seyed Reza Yousefi, 2015, "Financial Inclusion: Can It Meet Multiple Macroeconomic Goals," *IMF Staff Discussion Note 15/17,* (Washington, D.C.: International Monetary Fund).

Seguino, Stephanie, 2010, "Gender, Distribution, and Balance of Payments Constrained Growth in Developing Countries," *Review of Political Economy,* Vol. 22, No. 3, pp. 373-404.

Swamy, Vighneswara, 2014, "Financial Inclusion, Gender Dimension, and Economic Impact on Poor Households," *World Development,* Vol. 56, pp. 1-15.

Townsend, Robert M., Kenichi Ueda, 2006, "Financial Deepening, Inequality, and Growth: A Model-Based Quantitative Evaluation," *Review of Economic Studies,* Vol. 73, pp. 251–293.

World Bank, 2012, "Gender Equality and Development," *World Development Report,* (Washington D.C.: The World Bank Group).

World Bank, 2016, *World Bank Development Indicators,* (Washington D.C.: The World Bank Group).

Yitzhaki, Shlomo, 1983, "On an Extension of the Gini Inequality Index," *International Economic Review,* Vol. 24, No. 3, pp. 617-628.

Yitzhaki, Shlomo, 1998, "More than a Dozen Alternative Ways of Spelling Gini," *Research on Economic Inequality,* Vol. 8, pp. 13-30.

Annex I: List of Countries

Whole Sample:

Albania, Algeria, Angola, Argentina, Armenia, Australia, Austria, Azerbaijan, Bahrain, Bangladesh, Belarus, Belgium, Benin, Bolivia, Bosnia and Herzegovina, Botswana, Brazil, Bulgaria, Burkina Faso, Burundi, Cambodia, Cameroon, Canada, Chad, Chile, China, Colombia, Congo, Dem. Rep., Congo, Rep., Costa Rica, Croatia, Cyprus, Czech Republic, Denmark, Dominican Republic, Ecuador, Egypt, Arab Rep., El Salvador, Estonia, Finland, France, Gabon, Georgia, Germany, Ghana, Greece, Guatemala, Guinea, Haiti, Honduras, Hong Kong, SAR, China, Hungary, India, Indonesia, Iraq, Ireland, Israel, Italy, Jamaica, Japan, Jordan, Kazakhstan, Kenya, Korea, Rep., Kuwait, Kyrgyz Republic, Latvia, Lebanon, Lithuania, Luxembourg, Macedonia, FYR, Madagascar, Malawi, Malaysia, Mali, Malta, Mauritania, Mauritius, Mexico, Moldova, Mongolia, Montenegro, Nepal, Netherlands, New Zealand, Nicaragua, Niger, Nigeria, Pakistan, Panama, Peru, Philippines, Poland, Portugal, Romania, Russian Federation, Rwanda, Saudi Arabia, Senegal, Serbia, Sierra Leone, Singapore, Slovak Republic, Slovenia, South Africa, Spain, Sri Lanka, Sudan, Sweden, Tajikistan, Tanzania, Thailand, Togo, Turkey, Turkmenistan, Uganda, Ukraine, United Arab Emirates, United Kingdom, United States, Uruguay, Uzbekistan, Venezuela, RB, Vietnam, Yemen, Rep., Zambia, Zimbabwe

Emerging and Developing Markets

Albania, Algeria, Angola, Argentina, Armenia, Azerbaijan, Bahrain, Bangladesh, Belarus, Benin, Bolivia, Bosnia and Herzegovina, Botswana, Brazil Bulgaria, Burkina Faso, Burundi, Cambodia, Cameroon, Chad, Chile, China, Colombia, Congo, Dem. Rep., Congo, Rep., Costa Rica, Croatia, Dominican Republic, Ecuador, Egypt, Arab Rep., El Salvador, Gabon, Georgia, Ghana, Guatemala, Guinea, Haiti, Honduras, Hungary, India, Indonesia, Iraq, Jamaica, Jordan, Kazakhstan, Kenya, Kuwait, Kyrgyz Republic, Lebanon, Macedonia, FYR, Madagascar, Malawi, Malaysia, Mali, Mauritania, Mauritius, Mexico, Moldova, Mongolia, Montenegro, Nepal, Nicaragua, Niger, Nigeria, Pakistan, Panama, Peru, Philippines, Poland, Romania, Russian Federation, Rwanda, Saudi Arabia, Senegal, Serbia, Sierra Leone, South Africa, Sri Lanka, Sudan, Tajikistan, Tanzania, Thailand, Togo, Turkey, Turkmenistan, Uganda, Ukraine, United Arab Emirates, Uruguay, Uzbekistan, Venezuela, RB, Vietnam, Yemen, Rep., Zambia, Zimbabwe

Sub-Saharan Africa:

Angola, Benin, Botswana, Burkina Faso, Burundi, Cameroon, Chad, Congo, Dem. Rep., Congo, Rep., Gabon, Ghana, Guinea, Kenya, Madagascar, Malawi, Mali, Mauritius, Niger, Nigeria, Rwanda, Senegal, Sierra Leone, South Africa, Tanzania, Togo, Uganda, Zambia, Zimbabwe

Annex II. List of Variables

	Explanation	Source
Structural Characteristics		
Gini coefficient	Net inequality	SWIID 5.0
World Bank Gini coefficient	WB Gini coefficient	World Bank
Log of real GDP per capita	Log of real GDP divided by population	Penn World Table 8.0
Agriculture to GDP	Agriculture, value added (% of GDP)	World Bank
Policies		
Trade to GDP	Sum of import and exports as share of GDP	World Bank
GII	Gender Inequality Index	UNDP and Gonzales and others (2015b)
Government consumption expenditure to GDP	General government final consumption expenditure (% of GDP)	World Bank
ICRG composite risk rating	International Country Risk Guide	Composite Political, Financial, Economic Risk Rating for a country (CPFER) = 0.5 ((Political Risk + Financial Risk + Economic Risk) Ranging from Very High Risk (00.0 - 49.5) to Very Low Risk (80.0 - 100). The higher the points, the lower the risk.
Infrastructure		
Electricity access	Access to electricity (% of population)	World Bank
Rural electricity acces	Access to rural electricity (% of rural population)	World Bank
Financial variables		
Intensity of financial inclusion within country	Correspondence-analysis constructed index of financial inclusion, covering 12 dimensions of financial inclusion as described in the main text	IMF staff calculation from World Bank Findex 2014 dataset
Inequality of financial access	Within-country gini-coefficient of the intensity of financial inclusion	IMF staff calcluation from the calculated individual financial inclusion scores using World Bank Findex 2014 dataset
Financial Development	Financial Development Index covering financial markets and institutions in their depth, access and efficiency	Sahay and others (2015).

Annex III. Details on the Construction of the Financial Inclusion Index

In this section, we will give a very brief and simple overview of the central concepts in Correspondence Analysis (CA). The nature of categorical data is that variables often do not have comparable scale and distance properties that lend observations to being conceivable as points in a Euclidean space. For example, a questionnaire may have a question that asks interviewees to rate their preference for a television program on a 1-3 rating score (or "dislike", "neutral", and "like"), yet another may be a simple Yes-No question on political beliefs. The analyst may be interested in knowing if people who answered "Yes" to the second question may be more likely to have a rating above 2. Clearly, in a two question case, this can be easily achieved by constructing a 3x2 contingency table and looking at frequencies. Yet when the number of questions (and thus dimensions) get larger, it quickly becomes difficult to simultaneously analyze the entire dataset with simple frequencies, while visualization becomes impossible. Correspondence Analysis is able to achieve this by ingeniously giving nominal variables a notion of distance. The foundations of CA had its origins in biometrics and psychometrics in the earlier half of the 20th century, and are associated with such names as R.A. Fischer, Karl Pearson, and Louis Guttman. Although quantitative Eigen-analysis techniques are ubiquitous in economics, the applications of Correspondence Analysis are perhaps better known – and established in the fields of biometrics, psychometrics, marketing, ecology, and the interdisciplinary fields of the computational sciences.

Concepts in Simple Correspondence Analysis

Similar to Principal Components Analysis, CA allows us to analyze the relationships of observations and perform dimension reduction of variables by using the information contained in matrices that describe some notion of similarity. This paper utilized Joint Correspondence Analysis, one of many methods in the class of CA. Yet in all of these approaches, the central concept is to construct a point-cloud using some metric, ultimately allowing us to treat all variables simultaneously and agnostically through Singular Value Decomposition (SVD). In the following, we will provide a simple step-by-step example of Simple Correspondence Analysis to develop the basic concepts used in CA.

Suppose we have two questions in a questionnaire of interest, each with three possible responses – "yes", "no", and "missing". The questionnaire would take on the following form:

Question	Possible Responses
Rate the television program XTV on a scale of 1, 2, or 3	1, 2, or 3 (else Missing)
Do you have a political affiliation with party ABC?	Yes or No (else Missing)

Next, suppose we have our completed set of questionnaires and now wish to look at the associations between responses. We can begin by formatting the raw data into a contingency table, where the entries are tallied number of responses to both row *i* and column *j*. For example, if 50 questionnaires were marked "Dislike" for Q1 and "Yes" for Q2, then n_{11} would be 50.

Table 1. Example Contingency Table

	Q2 (Yes)	Q2 (No)	Q2 (Missing)	Row Totals
Q1 (Dislike)	n_{11}	n_{12}	n_{13}	n_{1+}
Q1 (Neutral)	n_{21}	n_{22}	n_{23}	n_{2+}
Q1 (Like)	n_{31}	n_{32}	n_{33}	n_{3+}
Q1 (Missing)	n_{41}	n_{42}	n_{43}	n_{4+}
Column Totals	n_{+1}	n_{+2}	n_{+3}	n_{++}

Note: n_{rc} is the number of respondents who made response *r* and *c*. n_{r+} and n_{+c} are the sums of the row and column values, respectively. For all *r* and *c*, $n_{rc} = n_{cr}$. The grand total n_{++} is equal to the sums of the row totals, and thus also that of the column totals.

With some simple processing of the above table, we can produce an MxN matrix that describes N objects in R^M, where the row values of each column is a coordinate value[12]. Thus, the answer "Yes" could be imagined to take on a vector in the space of the TV show ratings, and likewise for the answer "No"; an interesting question would be how far or independent these vectors are within that space. Consider two extreme cases. First, suppose that the rows and columns are completely independent. Then if we perform the usual chi-squared test of independence (H0: no difference between distributions), we would not reject; this will happen if questions are answered completely as expected based on row and column marginal totals. Although this would be an interesting result in itself, we would find little interesting associations between Questions 1 and 2 as posited in our hypothetical question. On the other hand, we might reject H0 and find a (large) statistic that signify significant deviations from expectation. Then the

[12] One can also consider rows as objects in the column space, and will find symmetrically identical results.

conditional distributions of answers would be “unexpected” and would suggest the existence of interesting associations. With correspondence analysis, we can pinpoint these associations. To do this, we normalize Table 1 and calculate several important quantities: the row and column profiles. Table 2A is an example of a possible contingency table, and normalizing its entries (on the grand total) yields Table 2B. In addition, we calculate the “mass” of rows and columns by dividing the row and column totals by the grand total. The other tables are the contingency table normalized by row totals and column totals respectively; Table 3 entries are calculated as n_{ij}/n_{i+} and Table 4 as n_{ij}/n_{+j}. In this annex, we will focus on Table 4. Returning to the notion of column profiles in the row space, the normalized column vectors in Table 4 can be considered coordinates of the column point cloud in R^M, where each response (1, 2, 3, or missing) is a “facet” of this vector – a coordinate axis. However, the distances between points in this space are not the usual Euclidean distance.

Table 2A. Contingency Table

	y	n	m	R Total
1	50	105	5	160
2	75	75	0	150
3	150	15	5	170
m	15	5	5	25
C Total	290	200	15	505

Table 2B. Normalized Contingency Table

	y	n	m	R Mass
1	0.1	0.21	0.01	0.32
2	0.15	0.15	0	0.3
3	0.3	0.03	0.01	0.34
m	0.03	0.01	0.01	0.05
C Mass	0.57	0.4	0.03	1

Table 3. Row Profiles

	y	n	m	R Total
1	0.31	0.66	0.03	1.00
2	0.50	0.50	0.00	1.00
3	0.88	0.09	0.03	1.00
m	0.60	0.20	0.20	1.00
C Total	0.57	0.40	0.03	1.00

Table 4. Column Profiles

	y	n	m	R Total
1	0.17	0.53	0.33	0.32
2	0.26	0.38	0.00	0.30
3	0.52	0.08	0.33	0.34
m	0.05	0.03	0.33	0.05
C Total	1.00	1.00	1.00	1.00

Clearly the tables above contain several crucial pieces of information in the analysis of correspondence. From the contingency table, we have some idea of what the most popular answers were. We also have a notion of the distribution of responses based on row and column masses, and the conditional distributions (profiles) tells us how each response of one question corresponds that of another. This information is sufficient introduce a notion of distance such as the weighted chi-square distance that was used in this paper. For example, the weighted chi-square distances between two individual columns can be found by applying the following formula over the values in Table 1:

$$d_{\chi^2}(c, c') = \sqrt{\sum_{r=1}^{R} \frac{n_{++}}{n_{r+}} \left(\frac{n_{rc}}{n_{+c}} - \frac{n_{rc'}}{n_{+c'}} \right)^2},$$

where *r* is the row index and *c* is the column index. The intuition of this measure can be seen by considering if "Yes" and "No" to Question 2 are "independent". The distance between the two responses (columns) would be zero if they are identical across all responses to Question 1, and something greater than zero if not.

If we consider the column variables being instances of a type of row space, then there is a "average" column profile, from which each point deviates. Or more simply, this is akin to an "average" response to Question 2. Each response to Question 2 thus has a chi-square distance to this "average" response, and can be calculated with the same formulas as above, but in the last term, we are subtracting the entries in the right-most column of Table 2B (which we denote as c*):

$$d^2_{\chi^2}(c, c^*) = \sum_{r=1}^{R} \frac{n_{++}}{n_{r+}} \left(\frac{n_{rc}}{n_{+c}} - \frac{n_{r+}}{n_{++}} \right)^2.$$

Since we are interested in deviations from expectation for a particular response, we must also modify the distance from the "center of gravity" by weighing it with the column mass (last row of Table 3) to obtain a weighted distance from the center called *inertia*. Responses with greater total volumes hold more leverage for that particular point's measure of deviation. The formula for inertia of columns in this artificial point-cloud in the row space is thus:

$$\text{Inertia} = \sum_{c=1}^{J} \frac{n_{+c}}{n_{++}} d^2_{\chi^2}(c, c^*),$$

where *J* is the number of columns. If column variables are completely independent – or completely "expected", all of our column points will be identical, and the data cloud would be a single point. On the other extreme, every point would be quite "distal" from each other.

Obtaining Principal Components from Contingency Tables

We can now proceed by treating the point-cloud in a similar way as we would in conventional PCA. Analogous to PCA, we are interested in finding a lower dimensional subspace (of our row space in this example) that maximizes total inertia. Of course, the same application of the SVD is used to find the best least squares approximation of a rank $K \leq \min(M-1, N-1)$ subspace in CA; this is done by preprocessing the contingency matrix as follows:

1) Use the contingency table to construct the centered and standardized chi-square matrix **S**:

$$\boldsymbol{S} = D_r^{-\frac{1}{2}}(Z - rc^T)D_c^{-1/2},$$

where D_r is the MxM diagonal matrix of row masses, where D_c is the NxN diagonal matrix of column masses, r is the row vector of row masses, c is the row vector of column masses, and Z is the contingency table normalized by the grand total (for example, divide every entry in Table 1 divided by n++). This is analogous to a centered variance-covariance matrix in ordinary PCA.

2) Execute SVD on **S**:

$$\boldsymbol{S} = UDV^T,$$

where U and V are unitary matrices of dimension M and N respectively, and D is the MxN diagonal matrix of positive singular values in descending order of magnitude.

3) Obtain Principal (row) Components (for the columns) $\boldsymbol{P}$:

$$\boldsymbol{P} = D_c^{-\frac{1}{2}}VD,$$

Each principal component is associated with a proportion of inertia, or explained variation. These are precisely the corresponding eigenvalues from entries of the matrix D; due to normalization, the eigenvalues will take on values between 0 and 1. Since principal components are orthogonal, with two components we are able to draw plots of individuals and variables in the lower dimensional space. The calculated coordinates allow us to conveniently visualize Euclidean approximations of the chi-square distances described above.

In this simple example, we used considered column vectors within the row space of the normalized contingency table[13]. The actual dataset we used in our paper had in excess of 10

[13] A similar analysis can be performed on the row vectors within the column space; the total inertia would obviously be identical, as would be the rank of D.

questions, each with typically 3 responses; the technique we used was a generalization of simple CA, wherein the steps described above were similarly applied to a modified version of the **S** matrix.

Suppose we had a questionnaire dataset of some number of questions such that the total number of possible responses is Q, and N individuals. One extension of the Simple Correspondence Analysis described thus far is Multiple Correspondence Analysis, where we first construct a complete disjunctive table -- an N x Q indicator matrix $\boldsymbol{Z}$. This table would have an expanded set of column variables that take on value 1 for having selected the question response and 0 otherwise. Again, analysis can be performed in two ways: to treat question responses as points in the row space of individuals (a projection of Q points in the space of R^N), or to treat individuals as points in the column space of question responses (a projection of N individual points in the space of R^Q). To draw a parallel with the simple case, the matrix $\boldsymbol{Z}$ can be cross multiplied with itself to form a Q x Q matrix $\mathbf{B} = \boldsymbol{Z}^{\mathbf{T}}\boldsymbol{Z}$ such that each possible response is to be cross tabulated with each other possible response in a pairwise fashion. This matrix is then centered and standardized (using marginal totals) to find $\boldsymbol{S}$, on which the algorithm described above is applied.

Finally, in the MCA case, clearly one problem is the influence of the meaningless diagonals of **B** on the measures of inertia. Joint Correspondence Analysis (JCA) was developed to address this problem, and is an iterative method of finding a best fit using only the off-diagonal values of **B**. In our paper we tried both MCA and JCA, with broadly similar results, but ultimately using JCA for the sake of robustness.

Index Interpretation

The interpretation of the outputs from CA are very similar to that of PCA, but one must keep in mind that charts are displaying chi-square distances. In PCA we are interested in decomposing a covariance matrix into transformations that rotate and scale a unit circle into an ellipsoid that best approximate the point-cloud; similarly, in CA we are interested in decomposing a matrix that describes a chi-square ellipsoid. Consequently, one should also remember that distances between points describe qualitative differences.

In the figures below, the origin is by design, the "center of gravity" of the point-cloud; it is the location that represents the "average" response. Figure 1 is the projection of the responses into the space of individuals. It is evident that responses that indicate having access of some kind are in the right half of the plane while those indicating the opposite appear on the left half. The procedure is agnostic on what "Yes" and "No" indicate; there is no information in the contingency table that encode what each variable means in terms of financial inclusion. For

example, having a credit/debit card appears on the far right of the x-axis because 1) relatively few individuals have them and 2) those who answered "Yes" to these questions also answered their entire questionnaire quite differently from the "average" questionnaire. In Figure 1, the radii of the bubbles are inversely proportional to the rarity of each question. Also, we can see that the "Yes" response to "Do you have access to emergency funds?" appears in between the origin and having access to credit cards. Following the same reasoning, this is the case because those who made this response generally had responses more similar to the center, and the response is also not extremely rare.

If there is only one Yes-No question, and half of the individuals responded "Yes" while the other half responded "No", the center of gravity would be a point halfway between the points representing the individuals. With the same principle, we can see how the "non-inclusive" responses are distributed on the left half of the plane. Since we defined an individual's inclusion score as being approximately the sum of the x-axis positions of the responses that the individuals made (as they appear in Figure 1), a higher inclusion score could be attributed to an individual having access to rarer services and having access to more services than those in the "center". Two responses can appear close together because they are often answered together; for example, one tends to answer "No" to having borrowed in the last 12 months if they also answered "No" to having an account. Different response options from the same question cannot appear together for an individual; for example, one cannot answer both "male" and "female" for the gender field. While these points are often far from each other, they need not be – gender being a good case in point. For categories in proximity, it implies that the questionnaire responses associated with these groups are similar, and vice versa for being dissimilar.

Clearly there are several assumptions in our definition of inclusion. First, relatively rarer services are implicitly assumed to be indicators of "higher" levels of financial inclusion. It is not necessarily the case that such services are indicators of greater inclusion, and including such categories may bias the results; higher technology services are correlated with higher average income, infrastructure, and capital[14]. Second, the origin and extreme values are completely arbitrary. The origin is defined as the location in the point-cloud centered by the normalized column totals; it is conceivable to create a synthetic dataset where the center corresponds to a completely different set of "average" responses. Likewise, although the extreme points in our dataset correspond to answering "Yes" or "No" to all questions, we can

[14] We tested for robustness to the inclusion and exclusion of such questions and found broadly similar results.

construct a dataset in which the least/most inclusive score are not as “extreme”. A corollary is that index values are properly comparable only if the questionnaires are comparable (identical questions and similar sampling procedures), and if the contingency matrices in question are centered and scaled in a comparable manner. Third, and related to the previous caveats, the input for our index is qualitative, and so is the output; the index is inherently qualitative, and thus it is difficult to make quantitative interpretations of the differences in “degree of inclusion”. While an individual with a score of 1 (all services) unambiguously has access to more services than one with a score of 0 (no services), comparing the distances of values between 0 and 1 only makes sense if we accept the assumptions imposed by the use of the chi-square metric and the aforementioned caveats.

In Figure 2 we can see the projection of the individual point-cloud that was used in our index. The PC vector that becomes the index is the linear combination of the columns (question responses) that contains the most inertia – the x-axis in this case. Just like in PCA, the coordinates of each individual represent their questionnaire responses; the positions are derived from correlations of each question with respect to principal axes. Although it is not technically correct to directly overlay Figure 1 with Figure 2, the positions of the points in Figure 2 are related to the positions of the question responses in Figure 1; for example, if an individual is at the origin of Figure 2, their questionnaire responses would be comprised of a set of questions such that the sum of their positions in Figure 1 would be approximately (0,0).

Figure 1. Projection of question responses

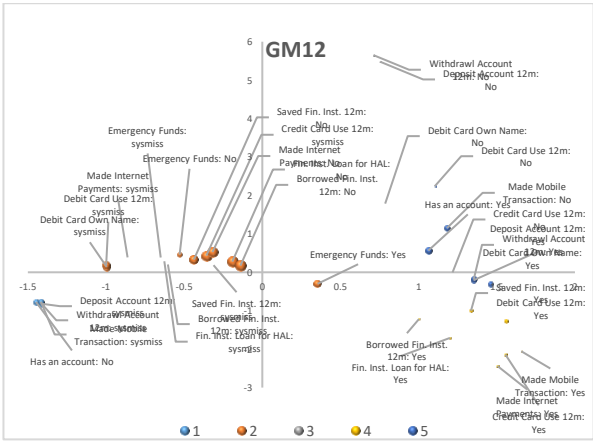
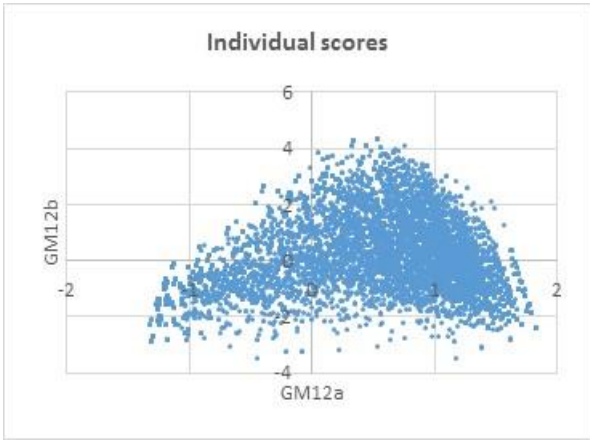


Figure 2. Projection of individual responses



The validity of this methodology is highly dependent on question responses selected. For the sake of robustness, many combinations were tested with broadly similar results. Since we did not see strong indications of bias, we ultimately chose to include several “rarer” responses in order to increase the resolution of our index.