# Non-Linear Impact of Income Inequality on Economic Growth: Role of Credit Markets

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Abstract:

I estimate the non-linear impacts of income inequality on economic growth. I use panel data from 98 countries from 1970-2018. I use ordinary least squares (OLS) regression to estimate 5-year overlapping differences in periods to estimate the impact of inequality on growth using time and country-fixed effects. I develop and constructed a novel control variable, dpTWWI, to account for foreign income shock to growth. I find that there is a non-linear correlation between income inequality, as measured by the Gini coefficient, and economic development, as measured by GDPpc, that is dependent on the country's initial level of income. Adding to the literature, I directly estimate the effect of inequality on growth through the imperfect credit market channel by including a measure of financial development. I find the effect of income inequality to be dependent on the level of financial development to a greater extent than the level of income.

Motivation:

In the political sphere, discussions around income inequality remain unanchored. Without any common foundational evidence on what level of income inequality is *good*, everyone can make their own explanation: "Inequality supports innovation," "Inequality hurts the foundations of democracy," or "Inequality is just a given of society." European Union's Transitions Performance Index (TPI), for example, says inequality has a linear effect: inequality is generically bad for a country. The real answer can be a lot more dynamic and factor-dependent in nature. This work hopes to move the discussion closer to the debates around optimal inflation, interest rates, and unemployment levels. Identifying the potentially causal relationship between income inequality and economic growth could ground the debate, allowing for policies targeting a specific inequality level.

Prior Literature:

The correlation between income inequality and economic growth is unclear in the literature. While there has been much research on the topic, the results do not converge to a particular answer. The direction of the causality is not even clear. The *Literature review on income inequality and economic growth* looked at thirty papers that, in most ways, came to different conclusions using various techniques (Mdingi & Ho, 2021). Common among most papers on the topic, especially later papers, is an acceptance of the mechanisms through which income inequality impacts economic growth. Mdingi and Ho compile a list of the most common mechanisms referenced in other papers: social-political unrest, political economy and institutions, technological change, savings rates, and imperfect credit markets. Most obviously, high levels of inequality can cause discontent within the populace, which can destabilize countries and hurt growth (Wilkinson & Pickett, 2010). Displays of discontent, from peaceful

strikes to riots, can all reduce general productivity. High inequality can become entrenched in the political and bureaucratic system, reducing government effectiveness and, therefore, dampening growth (Panizza, 2002). Those with wealth can use their power to gain political power. Once in power, they have the potential to manipulate the economy for their own benefit and not for the greater country's. (Perotti, 1993) In the extreme of an oligarchy, where the very few control both the wealth and government of a country, the government is not designed to develop a nation, but rather only those with wealth already. Additionally, effective lobbying and bribery is more likely in countries with large wealth discrepancies. (Persson & Tabellini, 1991).

In a different vein, the effect of technological change blurs the direction of causality between economic development and inequality. As theorized by Galor and Tsiddon (1997), technological change impacts both inequality and growth. As technology is quickly implemented, incomes increase disproportionately for those with the skills and opportunities adjacent to the technology. As a result, income inequality increases temporarily until labour shifts to equalize wages across industries. In this case, development and inequality increases happen concurrently. As summarized by Baselgia and Foellmi (2022), "The neoclassical theory of distribution argues that with perfect markets, technology, and factor endowments, the level of output and its distribution among the factors of capital and labour are determined simultaneously." As such, it is difficult to pull out the causal impact of income inequality on growth through other mechanisms.

While the impact of the previous mechanisms are not quite measurable, the savings rate and imperfect credit market effects are. Through the savings rate channel, higher income inequality causes higher economic

growth. As those with higher incomes have higher savings rates, higher inequality implies a higher net savings rate (Aghion, Caroli & Garcia-Penalosa, 1999). Higher savings rates are associated with higher long-run growth. Galor and Zeira's (1993) work, widely cited in this research area, lays out the reasons for potential differentiation in the effects of inequality at different income levels. They argue that the differences in credit markets (banks, government support, financial infrastructure, etc.) will mean different impacts of inequality on growth. Given fixed costs for investments and limited access to credit in low-income countries, the accumulation of resources to the very few allows for more investment than before. For two countries with the same low average income level, the country with higher inequality will have more people meet the minimum requirement to invest in education, companies, etc. The reverse holds for high-income countries. As most people already have either the minimum fixed costs to invest or at least access to good credit markets to borrow, the concentration of resources reduces the number of people that can invest.

A vast majority of these papers are fairly homogenous, using the same datasets, the same explanatory mechanisms (as noted above), and the same regression techniques. Despite this, the studies yield contradictory results. Even similar studies focusing on rich vs poor countries, as I do in this paper, find different results. Brueckner and Lederman's paper *Inequality and economic growth: the role of initial income* (2018) identifies differences in effect resulting from a country's level of development. They find that linearly, over five years, inequality is bad for rich countries and good for poor countries, with an indeterminate effect for middle-income countries. This paper also introduces an instrumental variable (IV) to eliminate dual causality bias noted later in my analysis. Papers like

Shen and Zhao's *How does income inequality affect economic growth at different income levels?* (2023) find that income inequality impedes growth in poor countries but is negligible otherwise. Fawaz, Rahnama, and Valcarcel (2014) find the opposite of Brueckner and Lederman, a negative effect of inequality in poor countries and a positive effect in rich countries over five years. Their findings are more consistent with past findings ([Deininger & Squire, 1998], [Barro, 2000], [Castello-Climent, 2010]). Shen and Zhao and Fawaz, Rahnama, and Valcarcel both use generalized method of moments (GMM) and claim it solves the dual causality problem. It is clear from the contradictions in even these more similar papers and the many other papers on this topic that the measured effect of inequality on growth is highly dependent on parameterization and data choice.

The papers *Income Inequality and Economic Growth: Heterogeneity and Nonlinearity* (Hailemariam & Dzhumashev, 2020) and *On the Dynamic Relationship between Inequality and Economic Growth* (Moon & Kim, 2022)as well as Chen (2003) and Banerjee and Duflo (2003), conclude a non-linear relationship between income inequality and growth. Specifically, they all find an inverted U-shaped correlation between income inequality and growth. This is because inequality is beneficial for growth up to a certain level and then hurts growth at higher levels. The theoretical support for these findings is strong, as all the transmission mechanisms described prior can be in effect. For example, the savings rate effect (positive) can be dominant at lower levels of inequality, while the socio-political effects (negative) can be dominant at higher levels of inequality. In their estimation of this relationship, Hailemariam and Dzhumashev limit the shape of the correlation between income inequality and growth

to a quadratic, as shown in the equation.

$$y_{it} = \alpha_i + \lambda_t + \beta_1 g_{it-5} + \beta_2 g_{it-5}^2 + \beta_3 y_{it-5} + \beta_4 (y_{it-5} \times g_{it-5}) + X_{it}\gamma + u_{it}$$

Where $g$ is inequality, and y is the level of income. However, this is only their base model; they move on to using a pooled mean group (PGM) estimate in their analysis. Moon and Kim allow the correlation to take any shape using a general nonlinear regression model. This paper will take some middle ground on parameterization, allowing basic non-linearization.

The papers with the most convincing evidence focus on one region (Ncube et al., 2014) or country (Mdingi & Ho, 2023). The focus allows them to include significantly more variables without losing data. These smaller-scale and more precise estimations are necessary for income inequality to ever be used in the policy decision processes. However, these estimates lose generalizability. As noted, the general theory has not been proven so far.

Hypothesis:

Accepting the evidence of the non-linearity provided by Hailemariam and Dzhumashev, I build my theory of an inverted-U correlation between income inequality and growth. The support for this theory follows from previous literature ([Hailemariam & Dzhumashev, 2020], [Moon & Kim, 2022], [Chen, 2003], [Banerjee and Duflo, 2003]) and the logical implications of all the transition mechanisms. In high-income countries, the savings rate effect is eventually dominated by the socio-political and institutional effect, as well as the credit market effect, once inequality rises over a certain threshold. More generically, the absolute concentration of wealth can be easily

considered bad for economic growth. With so much concentration of resources, there would likely be political and institutional manipulation and a higher chance of social unrest. The credit market channel would also imply less investment within rich countries as only a few have the credit minimum requirements to invest. At extremely low levels of inequality, we approach the ideas of perfect redistribution and minimal incentives to work and innovate. We assume people are less productive when all their income above the mean is taken away. Given that we have some higher levels of growth today at some moderate levels of inequality, we can put all the points together and draw an inverted-U correlation. This same correlation could also be applied to poor countries, but it would potentially contradict past results and theories concerning the imperfect credit market mechanism. Higher inequality is theorized to allow for more investments in poor countries. This could simply mean that the peak of the inverted-U occurs at a higher inequality level or that there is a positive correlation between income inequality and growth. To be more extreme, and taking the ideas from the book "Capitalism Alone," very low inequality through communism was an effective tool to transition to higher growth for low-income countries (Milanovic, 2019). Countries that were essentially feudalistic saw benefits to communism as it was a rapid way to redistribute and move quickly into an industrialized economy. According to Milanovic, countries under communism grew faster than they would have otherwise, even if it was not sustainable in the long run, and set the stage for them to become productive capitalist countries in the future. The strange combination of a positive low-income correlation and a positive credit market effect could result in an upright-U correlation. However, this is less likely. More likely is that the optimal level of inequality in poor countries is to the right of rich countries.

Hypothesis 1: An inverted U-shape correlation exists between Income Inequality and growth in all countries.

Hypothesis 2: An inverted U-shape correlation exists between Income Inequality and growth in rich countries (Figure 1).

Hypothesis 3: There is an upright U-shape correlation between Income Inequality and growth in poor countries (Figure 1). This also implies no effect of income inequality on growth for some middle-level income countries if hypothesis 2 holds. The result of hypothesis 3 being true could be visualized as a monkey saddle in Figure 2. As countries become richer, the correlation between income inequality and growth flips. The visualizations are purely for demonstrational purposes.

Hypothesis 4: There is only a linear correlation between Income Inequality and growth in poor countries.

**Figure 1**

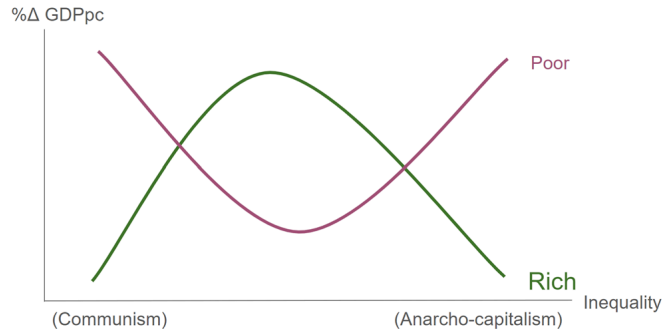
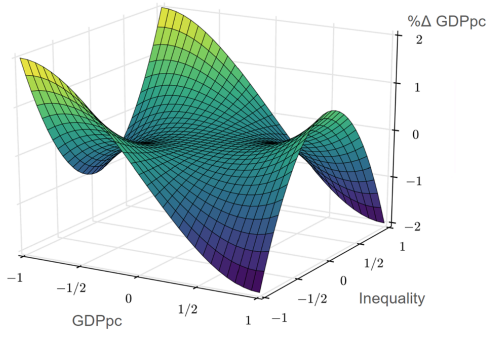



**Figure 2**



It would be ideal to estimate the effect of inequality on economic growth using wealth values instead of income values. The mechanisms listed above mostly rely on ideas on how the concentration of wealth, rather than income, can affect economic growth. However, data on wealth inequality is simply unavailable, primarily due to the difficulties of identifying tangible asset values, especially those passed down through generations (Saez & Zucman, 2020). However, this supports the reasoning of why a five-year lag is appropriate for assessing the impact of inequality on growth. Sustained income inequality is a proxy for wealth inequality as those with higher incomes build up and deplete their wealth over time.

Though there are many mechanisms for the impact of income inequality on income growth, they are not all directly measurable. Fixed effects on countries are used to capture at least some of the variation due to institutions. However, this will leave out the interaction between income inequality and institutions. Potential errors in the results can be partially attributed, therefore, to how the political system and bureaucracy are able to handle income inequality. As a control, I will include a proxy for democratic freedoms.

Since the measure of income is a level, growing current day poor countries will eventually be at the same as rich countries today. Do we expect that the then higher-income but still comparatively poor countries will have the same growth response to inequality as rich countries today? Or is the effect dependent on a country's relative level of income? The latter is supported by theory. Though poorer countries will increase their average incomes in the future, so will the cost of investment in new technologies. Since the relative investment cost remains the same, the imperfect credit market channel effect would not change for these poorer countries. A separate analysis will be

performed using relative income in place of real income. Every country's income will be normalized relative to the highest income level that year.

Out of all the mechanisms, the imperfect credit market channel is the only measurable one. The level of income is used in most papers as an appropriate proxy for financial development as they are highly correlated. However, we can directly assess the impact of income inequality through the credit market channel by using a measure of financial development. The use of financial development data in this way has never been done in previous literature. I assess all the previously noted hypotheses, replacing the level of income with the level of financial development.

Data / Variables:

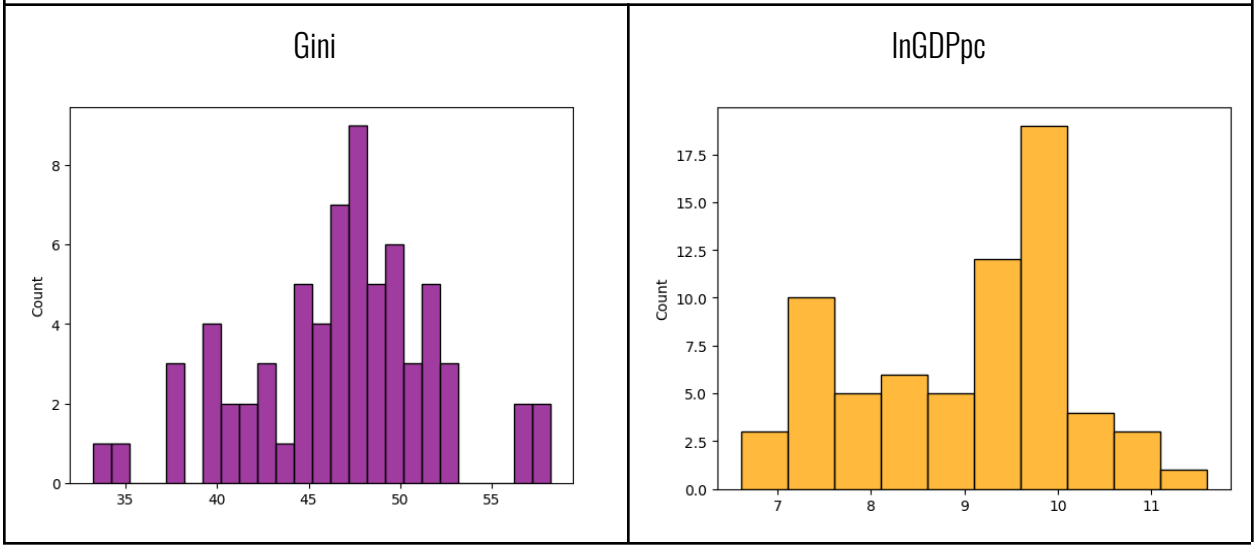
Many of the control variables used in other studies will be left out for two reasons: One is the inclusion of some variables removes a transition mechanism through which inequality works. For example, education is effectively a form of redistribution in most countries and is highly correlated with the level of inequality (Abdullah, Doucouliagos, & Elizabeth Manning, 2013). Including education level will bias the coefficient on inequality to zero. Any other variable regarding social safety nets and public in-kind transfers would have a similar effect. Countries attempting to identify optimal levels of inequality for themselves can use these additional variables. Two is gaps in data. Most additional variables that could be included have data for only highly developed countries. Including many

of these variables would essentially remove poor countries from the analysis due to missing data. However, this research hopes to focus on the different effects of inequality on poor vs rich countries.

In the estimation, economic development is measured as GDP per capita. Y in the equation represents the natural log of GDP per capita. By adding the lagged value of Y as a regressor, we estimate the percentage of GDP per capita over five years as the difference in $Y_{t+5}$ and $Y_t$.

The measure of income inequality used is the Gini coefficient (G) based on the Lorenz curve. The Gini coefficient takes on values between 0 and 1 (this will be scaled by 100 for interpretability). A value of 0 means perfect equality, and a value of 1 means perfect inequality; one person collects all the income. The Standardized World Income Inequality Database (SWIID), by Solt (2016), combines the strengths of the most popular income inequality data sets, the Luxembourg Income Study (LIS) database or the World Income Inequality Database (WIID). "The SWIID dataset utilizes all the available data with full geographic and population coverage." It, therefore, provides greater comparability, which is necessary for cross-country, cross-time studies (Hailemariam and Dzhumashev, 2019). Compared to WIID, which uses only tax records, SWIID has significantly less data. However, SWIID makes up for it in terms of consistency and comparability. Because of measurement issues due to differences in tax administration, most researchers opt to use SWIID instead. SWIID also provides data for pre-redistribution (at market) and post-redistribution. Data for economic development, Y, measured by GDP per capita adjusted for inflation in US dollars PPP, comes from the Penn World Tables (PWT). Relative GDPpc (relY) divides all values of GDPpc by the max of GDPpc in their respective year.

Data Distributions in 2013




There are quite a few flaws in the way inequality is measured by the Gini coefficient, specifically by SWIID. Apart from not measuring wealth inequality, most starkly, is that it only accounts for citizens. Countries like the UAE have large "foreign" labour forces that are, at best, not given the same resources as citizens and, at worst, exploited (Strabac, Valenta, & Al Awad, 2018). This means that, as measured, the UAE's Gini coefficient is low, even though it is high if one accounts for everyone who lives there. Additionally, market income inequality (pre-tax, pre-redistribution) is not necessarily how people feel post-redistribution. Although SWIID does attempt to account for this separately in its post-redistribution measure, it is nearly impossible to account for and measure in-kind transfers and public goods. In practice, the absence of post-redistribution inequality in estimation means that the social unrest channel is not being properly accounted for. Countries with high pre-redistribution inequality but lower post-redistribution inequality will bias the net effect of inequality through the social unrest channel to zero. I partially eliminate this unrest channel by removing years with significant conflict, internal or external. However, this

does not account for smaller strikes, protests, etc. Lastly, the Gini coefficient measures across generations, not within generations. Arguably, the inequality between the average 20-year-old and 40-year-old is not of concern. It is expected that the 40-year-old has a higher income, and this inequality is perfectly acceptable. What is of concern is the large differences between 40-year-olds, i.e., people within the same generation. Countries with rapid development in recent years, such as Singapore, will have a biased Gini coefficient measurement as a result. The elderly in the country grew up in a poor country but are expected to retire with the same savings in a now rich country. Compared to other similar income-level countries, countries that experienced rapid economic development will have older generations with lower incomes, squashing the inter-generational Gini but not the intra-generational Gini. Although an age-adjusted Gini could be calculated, as has already been attempted by Almas (2012), large time-series datasets are not currently available. All of these combined, along with other unlisted issues, significantly affect the ability to measure how inequality, the inequality that we care about, affects growth.

Financial Development (FD) data comes from the IMF on a scale from 0-100. “The Financial Development Index is a relative ranking of countries on the depth, access, and efficiency of their financial institutions and financial markets” (IMF, 2024). It is an objective aggregate index of six sub-variables relating to financial institutions and financial markets.

Additional controls are population growth (n), urban ratio (Ur), elderly population percentage (pOld), Political Rights (PR), Oil Price Shocks (OPS), Trade-Weighted World Income (TWWI), and Foreign income shocks (dpTWWI).

Population growth (n) rate, Urban population ratio (Ur), and elderly population (pOld) data come from the World Bank. The urban population ratio variable is included to account for growth differences between more urban and more rural countries. The elderly population variable, the percentage of the population older than 65, attempts to account for the negative impacts of aging populations. Older populations are typically less productive (Maestas, Mullen, & Powell, 2023)

The Political Rights (PR) dummy variables come from Freedom House. Freedom House ordinally ranks the political rights of countries from 1-5. Effectively, this variable controls for differences due to the level of democracy.

As oil is one of the most important commodities in many economies, the oil price shock variable is meant to capture the effects of oil price changes on countries that export oil. OPS is calculated in two parts. ω is the relative importance of oil exports to an economy over the past five years. If ω is high, it is expected that the country's income is more dependent on oil exports and, therefore, more sensitive to oil price changes. OPS is then the percentage change in oil prices weighted by ω. If OPS is negative, growth is expected to be less than it would otherwise be. Oil export data comes from the World Bank (% of merchandise oil), and oil price data comes from OPEC crude oil price data.

$$\omega_j = \frac{\left(\sum_{t=1}^{5} \frac{OilExports_t}{GDP_t}\right)}{5}$$

$$OPS_j = \omega_j \Delta lnP$$

Trade Weighted World Income and my modification to it, dpTWWI account for domestic income shocks due to changes in foreign income. It follows the same logic as OPS except in terms of general trade. Countries' domestic incomes will be affected by recessions and booms in foreign countries via changes in demand for their exports. However, not all countries are equally important in exporting income. To account for this, Ψ is the relative importance of a foreign country's trade for the domestic economy over the past five years. TWWI is, therefore, the level of foreign income weighted by Ψ, and dpTWWI is the percentage change in foreign income weighted by Ψ. TWWI is a proxy for the magnitude of trade in a year. dpTWWI takes into account the effects of foreign income shock on domestic export income. Data comes from the International Monetary Fund (IMF) Direction of Trade statistics.

$$\psi_i = \frac{\sum_{t=1}^{5} \frac{Exports_{it}}{Dom.GDP_{jt}}}{5}$$

$$TWWI_j = \sum_{i}^{Countries} \psi_i For.GDP_i$$

$$dpTWWI_j = \sum_{i}^{Countries} \psi_i \Delta ln(For.GDP_i)$$

Based on data from the Uppsala Conflict Data Program, years with conflict levels of 2 were removed from the dataset. Countries with less than 10 years of data and years with less then 50 countries worth of data are removed. In the end, there are 98 countries with data from 1970-2018.

Regression:

All hypotheses can be simultaneously tested using the regression parameterization below, where the effect of income inequality depends on income level. I allow the effect of inequality to be non-linear by including the square of the Gini coefficient along with its interaction with Y. Taking the difference in Y, ln(GDPpc), I estimate the percentage change in GDPpc.

$$Y_t = \beta_1 G_{t-5} + \beta_2 G_{t-5}^2 + \zeta_1 (G_{t-5} * Y_{t-5}) + \zeta_2 (G_{t-5}^2 * Y_{t-5}) + \phi Y_{t-5}$$

All additional controls are listed above and are lagged the same five years. Only OPS, TWWI, and dpTWWI are averaged over the five years as they are volatile, and their effects in any given year affect growth over the entire five-year period. I estimate using 5-year overlapping differences in periods. Therefore, each variable observation is only used once, with the exception of Y, which is used twice at either end of the timeframe, and the three averaged variables, which are observed five times. For the coefficient on $Y_{t-5}$, we test if $\Phi$ differs significantly from 1. I use country-fixed effects and time-fixed effects. All coefficient standard errors are bootstrapped.

Addressing Duel Causality:

There is a concern about two-way causality, mainly identified through the effects of technological change, as noted before. That is, the income growth due to technological change in a country can also affect the level of inequality. I attempt to use a two-stage least squares (2SLS) estimate to account for this potential bidirectional causality. The instrumental variables used are Trade Weighted World Income (TWWI) and Oil Price Shocks (OPS).

The first stage of the regression:

$$G_{t-5} = lnGDPpc_{t-5} + TWWI_{t-5} + OPS_{t-5} + X$$

Where X is all additional control variables and fixed effects. Since TWWI and OPS are used as instrumental variables in the first stage, they are then excluded in the second stage, including dpTWWI. These three variables are still used as control variables in the OLS regression.

These instruments were developed and used by Brueckner and Ledderman (2018). Their process differs from the standard practice in that they use a ratio of the covariances to determine the coefficients of the first stage. They suggest that the estimation of the first stage through OLS is biased. Additionally, these variables violate an assumption for instrumental variables in that they are not directly correlated with the dependent variable. Foreign income and oil price shocks arguably directly affect the income growth of a country. Due to the apparent weakness in this methodology, I leave the 2SLS regression results and adjusted equations in the appendix (Table 1 Alt.). 2SLS is applied to initial regression setups using lnGDPpc, which shows a weak first stage.

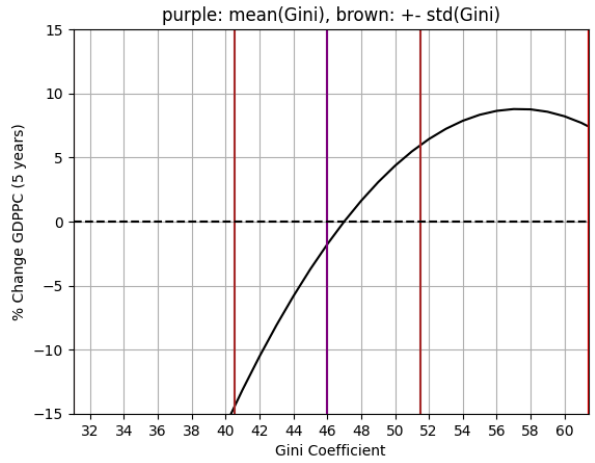
Model with GDPpc:

| **Table 1** | | | Political Rights (PR) Included | |
|---|---|---|---|---|
| Variable | Coefficient | Standard Deviation | Coefficient | Standard Deviation |
| Gini | +2.26e-1 ** | (0.104) | +0.255 * | (0.134) |
| $Gini^2$ | -1.80e-03 * | (1.12e-3) | -2.26e-3 | (1.45e-3) |
| Gini * lnGDPpc | -1.90e-2 * | (0.0114) | -.0218 | (0.0149) |
| $Gini^2$ * lnGDPpc | +1.42e-4 | (1.23e-4) | +1.82e-4 | (1.61e-4) |
| lnGDPpc | +1.32 | (0.265) | +1.35 | (0.345) |
| # Countries | 98 | | 98 | |
| # Observations | 2,347 | | 1,948 | |
| Residual SE | .0917 | | .0896 | |
| Continued in Appendix. | | | | |

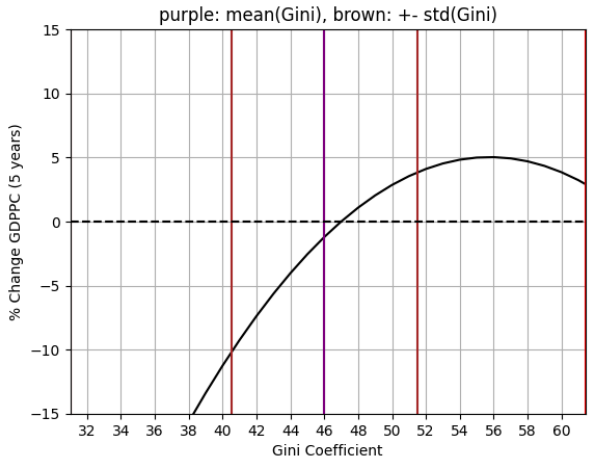
From table 1, we see that the effect of inequality on growth is positive but increasingly negative as the country's income level increases. Higher inequality is generally correlated with higher growth in poorer countries (ln(GDPpc) < 9) and generally correlated with lower growth in richer countries (ln(GDPpc) > 10). A few selected examples with graphs are provided. The graph is centered on the mean of the Gini coefficient. The edges of the graphs are the minimum and maximum of the dataset. From these results, hypotheses 1, 2, 3, and 4 are all shown to be directly false.

**Figure 3** left & right bound = min & max Gini

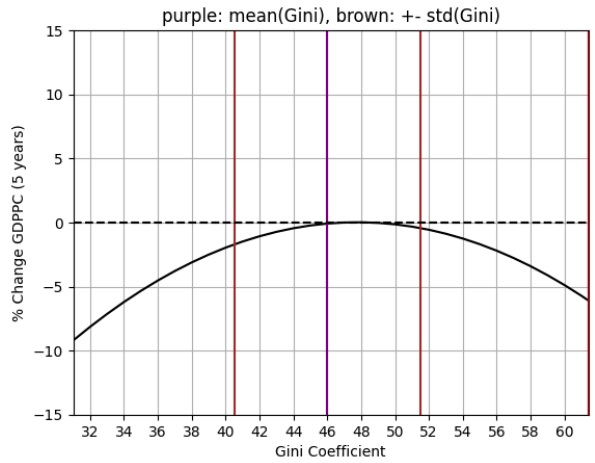
lnGDPPC = 7 (Poor Country)
Gini 40 to 50 predicted +3.6% growth per year



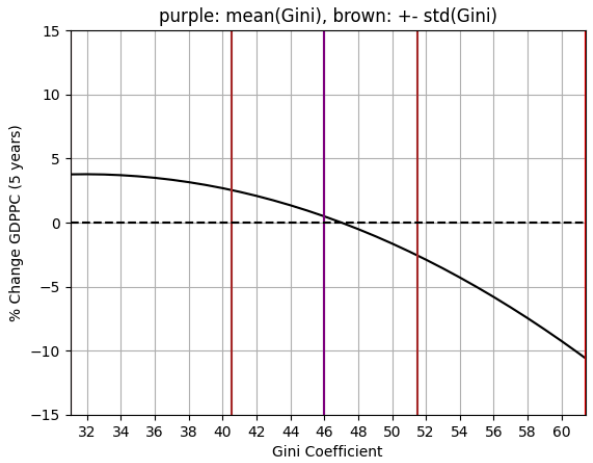

lnGDPPC = 8
Gini 40 to 50 predicted +2.6% growth per year




lnGDPPC = 10 (Middle Income Country)
Gini 40 to 50 predicted +0.4% growth per year

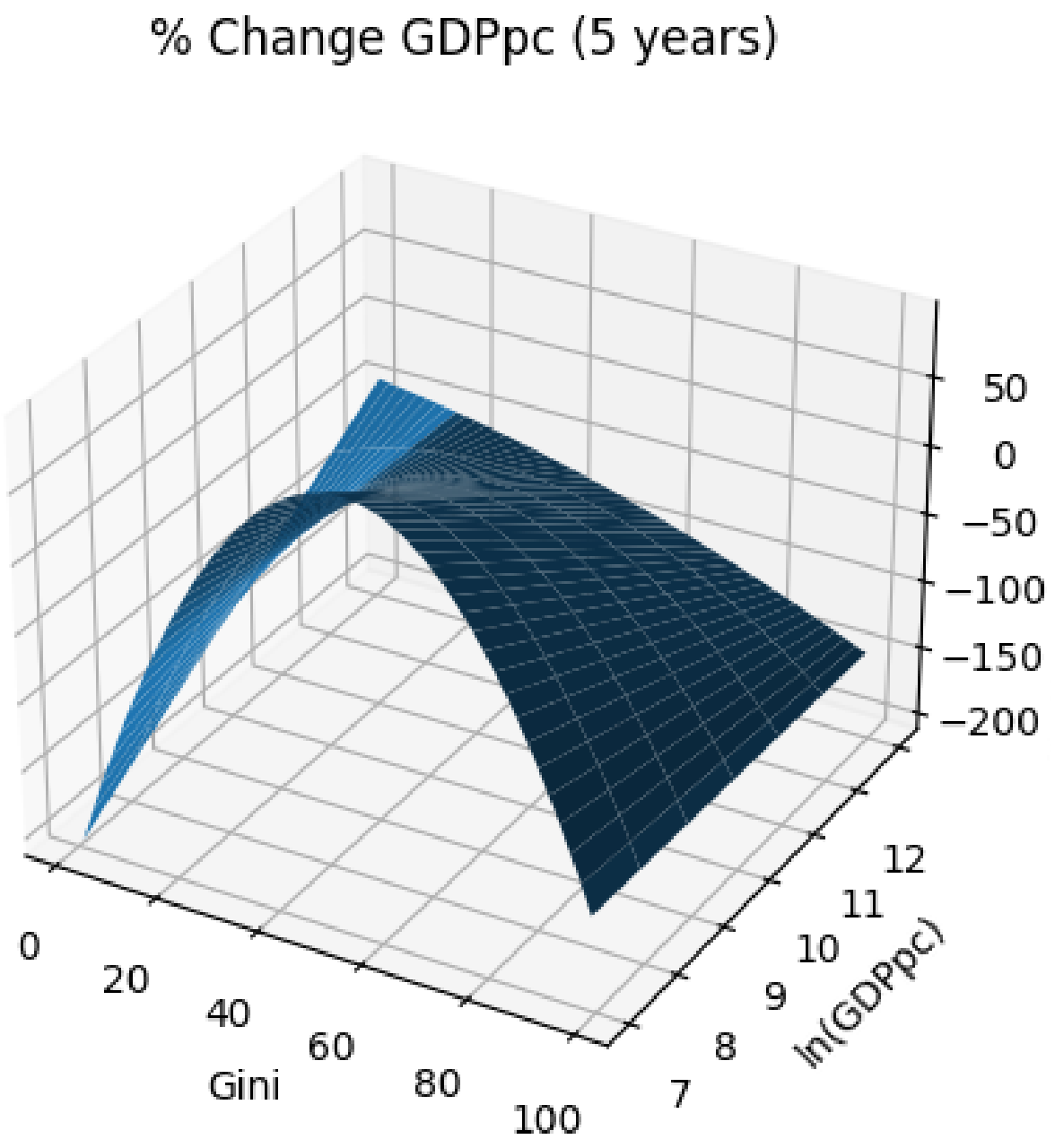



lnGDPPC = 11 (Rich Country)
Gini 40 to 50 predicted -0.9% growth per year




Taking the summation of the graphs in figure 3, a 3D representation of the the effect of inequality on growth over the level of income can be created. Something akin to the monkey saddle proposed in hypothesis 3 is shown in figure 4.

**Figure 4**


% Change GDPpc (5 years)
50
0
−50
−100
−150
−200
0
20
40
60
80
100
Gini
7
8
9
10
11
12
ln(GDPpc)

Model with Relative GDPpc:

An important question: Is the effect dependent on absolute income or relative income? Did Norway in 1970, ln(GDPpc) = 9.7, experience the same impacts of inequality as Thailand in 2013, ln(GDPpc) = 9.6? Does it make more sense to think about it in relative terms and power? This would imply that rich countries, in all eras, have a set effect. I estimate this effect using the equation:

$$Y_t = \beta_1 G_{t-5} + \beta_2 G_{t-5}^2 + \zeta_1 (G_{t-5} * relY_{t-5}) + \zeta_2 (G_{t-5}^2 * relY_{t-5}) + \zeta_3 relY_{t-5} + \phi Y_{t-5}$$

As seen in table 2, I find that these results do not hold when using relative GDPpc. Therefore, it is not that relatively rich countries in any time period have a negative correlation between inequality and growth; it is that countries have this negative correlation once they meet a certain threshold of average wealth. This suggests that the correlation between income inequality and growth will become more negative for all countries in the future.

| **Table 2** | | |
|---|---|---|
| Variable | Coefficient | Standard Deviation |
| Gini | +0.0590 *** | (0.0197) |
| $Gini^2$ | -5.32e-4 ** | (2.10e-4) |
| Gini * relGDPpc | -0.0348 | (0.0634) |
| $Gini^2$ * relGDPpc | +2.38e-4 | (6.86e-4) |
| relGDPPC | +1.24 | (1.47) |

| | | |
|---|---|---|
| lnGDPpc | +0.744 *** | (0.0204) |
| # Countries | 91 | |
| # Observations | 2,245 | |
| Residual SE | 0.0917 | |
| Continued in Appendix | | |

Model with Financial Development:

In theory, we expect that inequality will affect economic development through the imperfect credit market channel. The effect is negative in financially developed countries / rich countries and positive in financially undeveloped countries / poor countries. In the initial regression, lnGDPPC is essentially used as a proxy for financial development when looking at this impact channel because of the strong correlation between financial development and income level (my estimate corr(FD, Y) ~= .794). By looking directly at the level of financial development, the effect of imperfect credit market channels can be isolated. The theory argues that inequality positively affects growth in financially undeveloped / low-income countries because people are unable to borrow, so the concentration of income is required for investments to take place. As noted by Fawaz (2022), the ability to borrow is also a function of available collateral, not just financial infrastructure and processes. GDPpc can serve as a proxy for the amount of collateral in an economy and will still be included as an independent variable in the regression.

$$Y_t = \beta_1 G_{t-5} + \beta_2 G_{t-5}^2 + \nu_1(G_{t-5} * FD_{t-5}) + \nu_2(G_{t-5}^2 * FD_{t-5}) + \nu_3 FD_{t-5} + \phi Y_{t-5} \zeta_1(G_{t-5} * Y_{t-5}) + \zeta_2(G_{t-5}^2 * Y_{t-5}) + \phi Y_{t-5}$$

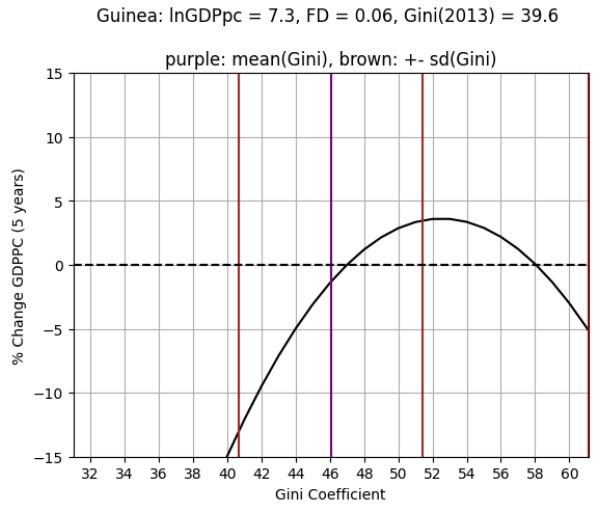
As seen in table 3, the results mirror those of the model with only lnGDDPc, except to a greater extreme in either direction. Low financial development is associated with a positive impact of inequality on growth and vice versa.

| **Table 3** | | | Political Rights (PR) Included | |
|---|---|---|---|---|
| Variable | Coefficient | Standard Deviation | Coefficient | Standard Deviation |
| Gini | +0.0484 | (0.145) | +0.0495 | (.194) |
| $Gini^2$ | -1.93e-5 | (0.00157) | -4.51e-4 | (2.09e-3) |
| Gini * FD | -0.241 ** | (0.0839) | -0.3598 ** | (0.127) |
| $Gini^2$ * FD | +2.46e-3 ** | (8.55e-4) | +0.003597 ** | (0.00132) |
| FD | +5.46 ** | (2.05) | 8.51 ** | (3.03) |
| Gini * lnGDPpc | +0.0131 | (0.0177) | +0.0137 | (0.0246) |
| $Gini^2$ * lnGDPpc | -1.59e-4 | (1.91e-4) | -1.41e-4 | (2.63e-4) |
| lnGDPpc | +0.451 | (.415) | +0.360 | (0.578) |
| # Countries | 94 | | 94 | |
| # Observations | 2,018 | | 1,709 | |
| Residual SE | .0816 | | 0.0768 | |
| Continued in Appendix | | | | |

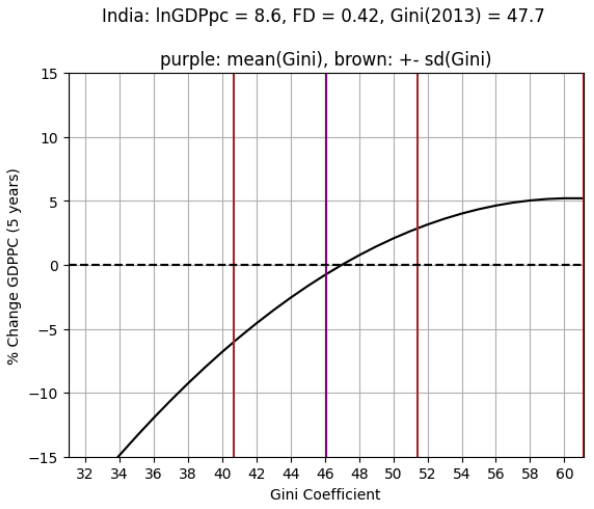
Figure 5 shows some example countries. The general results from the model with only lnGDPpc still hold. The U-shaped correlation in Canada and other high income countries is likely just overfitting. All high-income countries (lnGDPpc > 10) have a Gini coefficient of less than 52. Therefore, the net effect of inequality on high-income countries is expected to be negative.

**Figure 5** left & right bound = min & max Gini

Gini 40 to 50 predicted +3.3% growth per year




Gini 40 to 50 predicted +1.7% growth per year




Gini 40 to 50 predicted +1.0% growth per year

Gini 40 to 50 predicted -0.6% growth per year

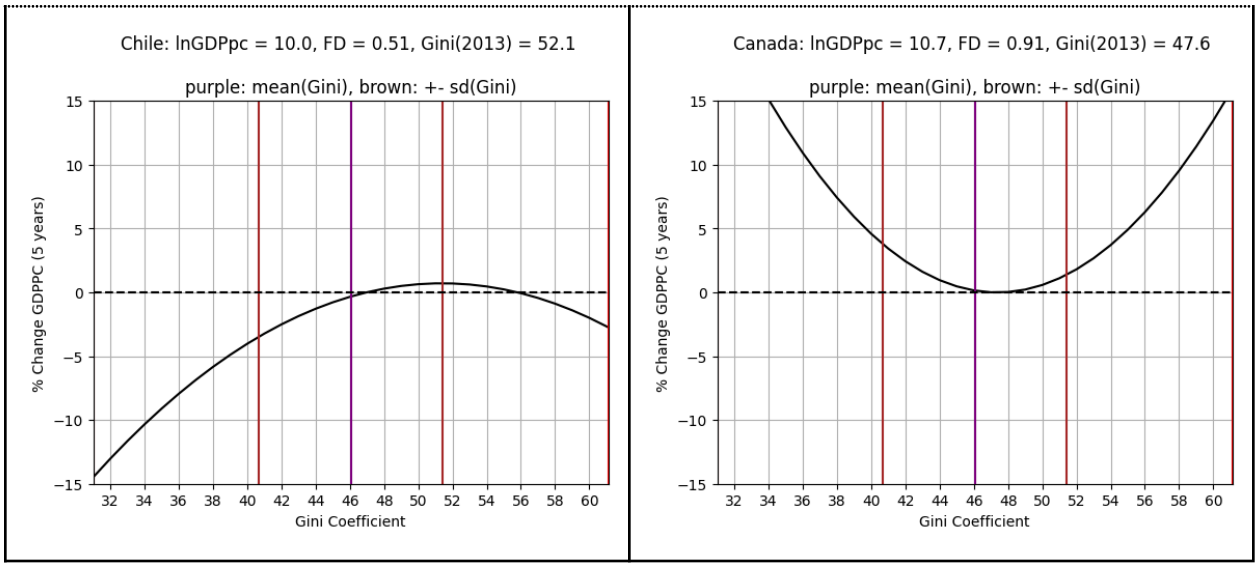
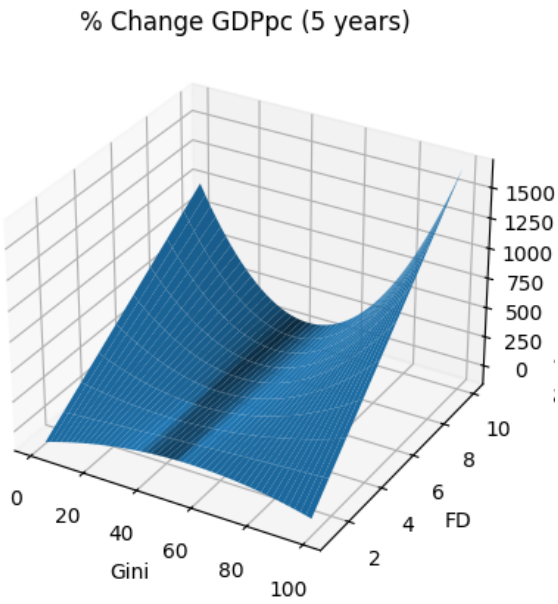
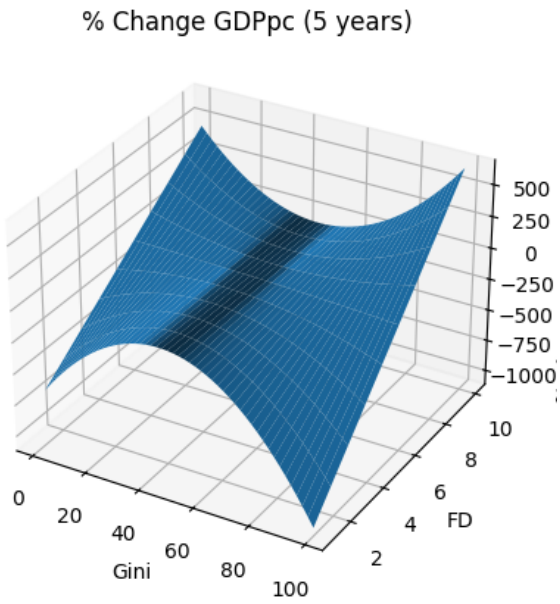



Figure 6 shows the 3D projection of the effect of income inequality on growth as the level of financial development changes, holding the income level constant. The shape is similar to figure 2, the resulting prediction of hypothesis 3, except flipped. My estimates predict that there is actually an inverted-U-shaped correlation in low-income rather than high-income countries, as hypothesized. It is seen that the effect is more dependent on financial development than income level, providing evidence for the imperfect credit market channel being in effect.

**Figure 6**

| Low-Income (lnGDPpc = 7) | High-Income (lnGDPpc = 11) |
|---|---|
|  |  |





Conclusion:

The literature provides significant but contradicting evidence of a correlation between income inequality and economic growth. I estimated my own results using techniques from previous papers as well as my own additions, such as sing dpTWWI as a control variable and using a measure of financial development to isolate the credit market channel. I point out notable potential errors in my methodology. Our measure of inequality, the Gini coefficient, currently does not measure what we really want and has many biases. This significantly affects the interpretation of the results. In addition, there is concern about two-way causality that is not properly addressed. There is a likelihood that reverse causality will drive the results. It could simply be that there is higher inequality is

caused by rapid growth. In this case, the conclusion of this paper is that there is at least a correlation between income inequality and economic growth. Higher-income and more financially developed countries have a negative correlation between growth and income equality. The reverse also holds to a greater extreme for low-income countries. Middle-income countries have a negligible correlation between income inequality and growth. These results align with some similar estimates using cross-country panel data and allowing for non-linearity and income level dependencies such as Brueckner and Lederman (2018) and Fawaz, Rahnama, and Valcarcel (2014). The results suggest that the imperfect credit market channel is significant in inequality's impact on growth.

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Appendix:

| **Table 1 (continued)** | | | Political Rights (PR) Included | |
|---|---|---|---|---|
| Variable | Coefficient | Standard Deviation | Coefficient | Standard Deviation |
| Intercept | -4.16 * | (2.40) | -4.46 | (3.09) |
| Gini | +2.26e-1 ** | (0.104) | +0.255 * | (0.134) |
| $Gini^2$ | -1.80e-03 * | (1.12e-3) | -2.26e-3 | (1.45e-3) |
| Gini * lnGDPpc | -1.90e-2 * | (0.0114) | -.0218 | (0.0149) |
| $Gini^2$ * lnGDPpc | +1.42e-4 | (1.23e-4) | +1.82e-4 | (1.61e-4) |
| lnGDPpc | +1.32 | (0.265) | +1.35 | (0.345) |
| OPS | +2.25e+5 *** | (6.51e+4) | +2.07e+5 *** | (5.89e+4) |
| TWWI | -8.99e-8 *** | (2.72e-8) | -1.07e-7 *** | (2.43e-8) |
| dpTWWI | +2.11e+4 *** | (2.70e+3) | 2.27e+4 *** | (2.80e+3) |
| n | -1.99e-2 *** | (4.62e-3) | -0.0169 ** | (0.00749) |
| Ur | +1.65e-4 | (7.63e-4) | +2.18e-4 | (8.96e-4) |
| pOld | -1.10e-2 *** | (2.92e-3) | -0.00886 ** | (0.00355) |
| # Countries | 98 | | 98 | |
| # Observations | 2,347 | | 1,948 | |
| Residual SE | .0917 | | .0896 | |
| Adj $R^2$ | .994 | | .994 | |

| **Table 1 Alt.** | 2SLS | |
|---|---|---|
| Variable | Coefficient | Standard Deviation |
| Intercept | +7.05 * | (4.1) |
| Gini | -0.221 | (0.162) |
| $Gini^2$ | +4.42e-4 | (1.61e-3) |
| Gini * lnGDPpc | +0.0235 | (0.017) |
| $Gini^2$ * lnGDPpc | -2.90e-4 * | (1.74e-4) |
| lnGDPpc | +0.320 * | (0.411) |
| n | -0.01429 | (0.00989) |
| Ur | -0.00239 | (0.00339) |
| pOld | -0.00543 | (0.0101) |
| First Stage | | |
| Intercept | +7.05 * | (4.10) |
| lnGDPPC | +0.324 | (0.412) |
| OPS | -0.221 | (0.162) |
| TWWI | +2.54e-3 | (1.61e-3) |
| n | +0.02348 | (0.017) |
| Ur | -0.0143 | (0.0367) |
| pOld | -2.89e-4 * | (1.75e-4) |
| # Countries | 98 | |
| # Observations | 2,347 | |
| Residual SE | .085 | |

| | |
|---|---|
| Adj $R^2$ | .995 |

| **Table 2 (continued)** | | |
|---|---|---|
| Variable | Coefficient | Standard Deviation |
| Intercept | +13.24 * | (0.493) |
| Gini | +0.0590 *** | (0.0197) |
| $Gini^2$ | -5.32e-4 ** | (2.10e-4) |
| Gini * relGDPpc | -0.0348 | (0.0634) |
| $Gini^2$ * relGDPpc | +2.38e-4 | (6.86e-4) |
| relGDPPC | +1.24 | (1.47) |
| lnGDPpc | +0.744 *** | (0.0204) |
| OPS | +203e+5 *** | (6.34e+4) |
| TWWI | -6.25e-8 * | (2.93e-8) |
| dpTWWI | +1.83e+4 *** | (2.91e+3) |
| n | -0.0213 *** | (0.00464) |
| Ur | 2.42e-4 | (7.25e-4) |
| pOld | -0.01454 *** | (0.0032) |
| # Countries | 91 | |

| # Observations | 2,245 |
|---|---|
| Residual SE | 0.0917 |
| Adj $R^2$ | .993 |

| **Table 3 (continued)** | | | Political Rights (PR) Included | |
|---|---|---|---|---|
| Variable | Coefficient | Standard Deviation | Coefficient | Standard Deviation |
| Intercept | +1.44 | (3.33) | +1.58 | (4.53) |
| Gini | +0.0484 | (0.145) | +0.0495 | (.194) |
| $Gini^2$ | -1.93e-5 | (0.00157) | -4.51e-4 | (2.09e-3) |
| Gini * FD | -0.241 ** | (0.0839) | -0.3598 ** | (0.127) |
| $Gini^2$ * FD | +2.46e-3 ** | (8.55e-4) | +0.003597 ** | (0.00132) |
| FD | +5.46 ** | (2.05) | 8.51 ** | (3.03) |
| Gini * lnGDPpc | +0.0131 | (0.0177) | +0.0137 | (0.0246) |
| $Gini^2$ * lnGDPpc | -1.59e-4 | (1.91e-4) | -1.41e-4 | (2.63e-4) |
| lnGDPpc | +0.451 | (.415) | +0.360 | (0.578) |
| OPS | 1.38e+5 ** | (6.15e+4) | +7.98e+4 | (5.50e+4) |
| TWWI | -2.80e-8 | (2.27e-08) | -3.40e-8 | (2.24e-8) |
| dpTWWI | +1.95e+4 *** | (2.37e+3) | +2.29e+4 *** | (2.21e+3) |

| | | | | |
|---|---|---|---|---|
| n | -0.0106 * | (0.00505) | -0.008255 * | (0.00516) |
| Ur | +8.88e-4 | (9.55e-4) | +0.001107 | (0.00102) |
| pOld | -0.01053 *** | (0.00307) | -0.00359 | (0.00327) |
| # Countries | 94 | | 94 | |
| # Observations | 2,018 | | 1,709 | |
| Residual SE | .0816 | | 0.0768 | |
| Adj $R^2$ | .995 | | .996 | |