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How Does Income Inequality Affect the Growth of U.S. Counties?

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Abstract

This paper aims to conduct a precise test of the political economy hypothesis linking income inequality and economic growth. By choosing covariates from a detailed county-level dataset and assuming that U.S. counties experience perfect capital mobility, I shut off the four possible channels linking inequality and growth other than political economy. I believe this to be a first in an empirical literature that has reported conflicting findings with observations of states and countries. I also present thematic maps to illustrate the cross-county variation in key growth determinants that is masked by state-level studies. My econometric tests find a negative association between the initial skewness of a county's income distribution and subsequent growth, as predicted by guiding theory: A one-unit increase in mean-to-median income ratio decreases growth from 1977 to 2000 by at least 5.6% and as much as 24.1%, depending on model specification. I also find evidence of county-level convergence.

1 Introduction

The link between income inequality and growth has been a long-standing subject of economic research. Kuznets (1955) motivated future research in the area by proposing that both undeveloped and developed countries have low levels of income inequality, with an inverted U-shaped relation between income inequality and per-capita income during the transition period. Okun (1975) takes this same position, citing the tradeoff between equity and growth as a central concern for policymakers. After having success modeling the performance of OECD nations through the 1970s (Ahluwalia, 1976), the Kuznets curve's validity has been called into question in recent decades due to two surprising events. First, developing Latin American nations with high levels of income inequality had much flatter growth paths than developing East Asian nations, who experienced rapid growth despite low levels of inequality. Second, substantial rises in income inequality have been observed in the highly developed United States, whose transition period has long since passed (Yellen, 2006). This paper is concerned with the second phenomenon; it examines the relationship between inequality and economic growth for U.S. counties from 1977 to 2000.

There are five general channels through which income inequality can impact economic growth (Barro, 2000):

1. Savings in Keynesian models
2. Imperfect credit markets in the presence of increasing returns to investment
3. Imperfect credit markets in the absence of increasing returns to investment
4. Political economy
5. Sociopolitical unrest

Channels 1 and 2 imply a positive relationship between inequality and economic growth; channels 3, 4, and 5 predict a negative relationship. The competing effects proposed by these inequality-growth channels may account for the lack of a consistent relationship between inequality and growth in the empirical literature (Barro, 2000). This presents a challenge for a new inequality-growth investigation: Conduct an empirical test that eliminates some of these channels and can identify the impact of only those that predict a clear relationship between the two variables.

As I describe in §2.3, my study shuts off all the inequality-growth channels except #4, the theory of political economy. This happens for two reasons. First, I assume that all U.S. counties operate under the same general set of American institutions, experience the free flow of capital, and thus have perfectly integrated capital markets; this dismisses the influence of #1. Second, I measure inequality as the skewness of an income distribution and take covariates from a rich county-level dataset to defuse the influences of channels #2, #3, and #5. This paper thus conducts a precise test of the political economy hypothesis, a first in the empirical inequality-growth literature.

This paper is organized as follows. Section 2 surveys the theoretical literature, discusses the implications of assuming perfect capital mobility, and develops this paper's formal theoretical model along with its guiding regression equation. Section 3 presents an overview of past empirical research on the inequality-growth relationship and pinpoints the gap filled by this paper. Section 4 describes the county-level dataset. Section 5 discusses possible estimation issues, presents the results of several growth regressions, and conducts checks for their robustness. Section 6 concludes.

2 Theory

2.1 The Solow Model

The Solow model allows us to conceptualize the important factors driving economic growth, although it is designed to model closed national economies. In its original form, the Solow model predicts that exogenous changes in savings, population growth, and technological growth uniquely determine a country's rate of income growth (Solow, 1956). An excellent overview and extension of the model to include the effects of human capital are given in Mankiw, Romer, and Weil (1992). I will refer to this paper as MRW and I summarize its model in Appendix A.

The last equation in Appendix A, (21), predicts that the growth rate of per-capita income is positively related to an economy's savings rates and its population's human capital attainment. Between counties within the United States, it is reasonable to assume that the growth of technology and depreciation of capital, two other determinants of steady-state income level, are constant across counties. This is due to costless transmission of technological innovations and capital stock between county lines.

2.2 Past Theoretical Literature and the Measurement of Inequality

Five general theoretical models linking inequality and growth have been developed. Two of these theories propose positive links between inequality and growth.

First, Keynesian models emphasize that the marginal propensity to save is positively related to an individual's income level. In this setting, the concentration of wealth among a small group of high-income individuals provides a higher level of aggregate savings than when wealth has a more equitable distribution. Since the degree of income inequality has a positive association with the amount of income available for investment, it also has a positive relationship with growth (Barro, 2000).

Second, in the presence of increasing returns to investment, imperfect credit markets produce a positive relationship between inequality and economic growth. Imperfect credit markets encourage a high concentration of capital among the rich, who have disproportional access to credit, and thus inequality (Galor & Zeira, 1993). When a country's businesses require high start-up costs and exhibit increasing returns to investment, inequality enhances growth. This is because the economy rewards sustained funding from the rich with rising firm productivity and income (Barro, 2000).

Three other theories, however, suggest a negative relationship between inequality and growth: imperfect credit markets in the absence of increasing returns, the theory of political economy, and the theory of sociopolitical unrest.

When firms do not exhibit increasing returns to investment, credit-market imperfections imply that inequality hinders growth. This is because restricted access to credit prevents the poor from investing in high-return human capital at the level that occurs when income distribution is more equitable. In the absence of increasing returns to investment, it is likely that this increase in high-return investment in education would have resulted in higher overall growth than firm investment by the wealthy (Aghion et al., 1999; Barro, 2000).

The political economy theory focuses on the incentives faced by the median voter. This economic actor wields the same power in a democratic election as a wealthier individual, but may harbor different voting preferences. If the median voter feels poorer than the average citizen, he or she will favor policies that redistribute the income of a society to increase his or her relative wealth. These policies decrease a society's growth rate (Alesina & Rodrik, 1994).

This redistribution will occur whenever "the distribution of political power is uniform – as in a one-person/one-vote democracy – and the allocation of economic power is unequal" (Barro, 2000). As my empirical data show in §4, the income distribution of counties in the United States is almost always skewed to the right; that is, each county's mean income exceeds its median. Since the United States is also a democracy, its counties experience income inequality that encourages wealth redistribution through the political process. A successful equality-enhancing redistribution of wealth from the rich to the poor has the effect of closing the gap between mean and median income.

Figure 1 shows hypothetical density functions of income and pinpoints the type of inequality relevant to the political economy hypothesis:

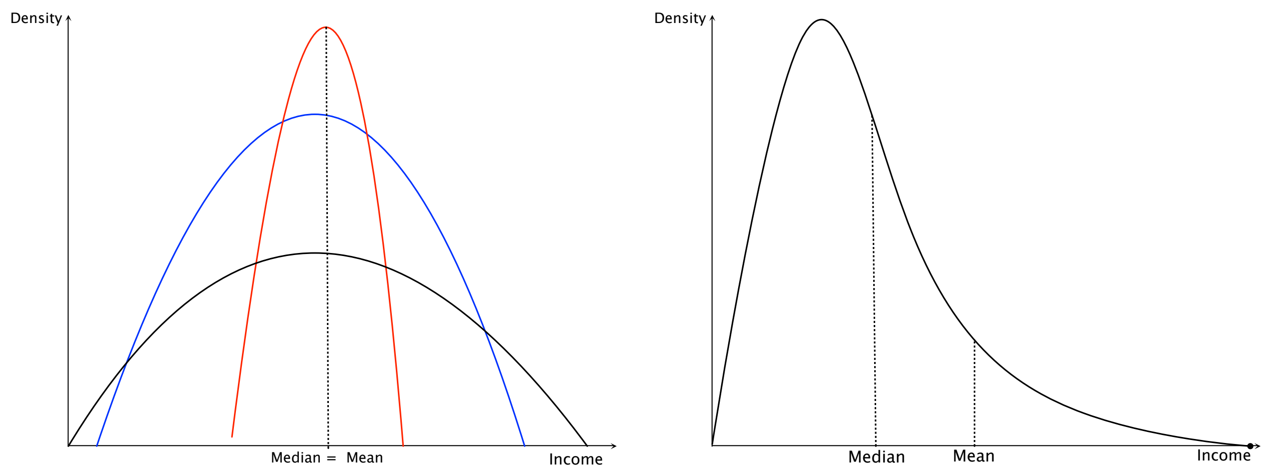

Figure 1: Hypothetical Density Functions of Income

The densities on the left belong to a fully equitable society under the definition of political economy: The income held by the median earner is equal to the area's mean income. This median earner has no motivation to vote for higher redistributive taxes, since he or she does not feel "relatively poor." This state can be preserved when the variance of the density function changes. In contrast, the right-skewed density on the right gives the median voter an incentive to vote for redistributive taxes, since these taxes rearrange the area underneath the density curve to bring the median closer to the mean and make the individual feel less "relatively poor." The inequality relevant to the political economy theory is thus the discrepancy between the mean and median per-capita incomes in a society.

Barro (2000) suggests using the ratio of mean income to median income to gauge the skewness of the income distribution and the pressure faced by the median voter to support redistributive policies. This inequality ratio stands in contrast to metrics that detect mean-preserving increases in the variance of an income distribution, such as the Gini coefficient. Changes in the variability of income distribution do not, *ceteris paribus*, have any impact on the pressure facing the median voter.

Alesina and Perrotti (1996) present a fifth and final theory linking inequality and growth, the theory of sociopolitical unrest, and test it empirically using cross-country data. The theory proposes that income inequality stimulates social discontent and criminal behavior, which in turn threaten property rights and increase investment uncertainty. Decreased investment then reduces economic growth. In their empirical investigation, the authors measure inequality as the dispersion of a country's wealth across the five quintiles of earners in a society. In contrast to the appropriate measure for the political economy hypothesis, this type of inequality is measured by the variance of income distribution, not its skewness.

2.3 The Implications of Perfect Capital Mobility

As discussed, the five general theories linking inequality and growth propose conflicting relationships between the two variables. Past empirical tests of this relationship, which I will describe more fully in §3, report conflicting results linking inequality and growth (Table 1).

I argue that, at the U.S. county level, it is reasonable to assume perfect capital mobility, while the free flow of capital across units of observation is a less valid assumption for either cross-state or cross-country analysis. I further assume that U.S. counties are "small" so they do not exert any influence on the interest rate prevailing in the national financial market.

To show the utility of perfect capital mobility, consider the theory of disproportional savings rates. Figure 2 illustrates the impact of inequality-fueled redistribution on a small, open U.S. county with perfect capital mobility.

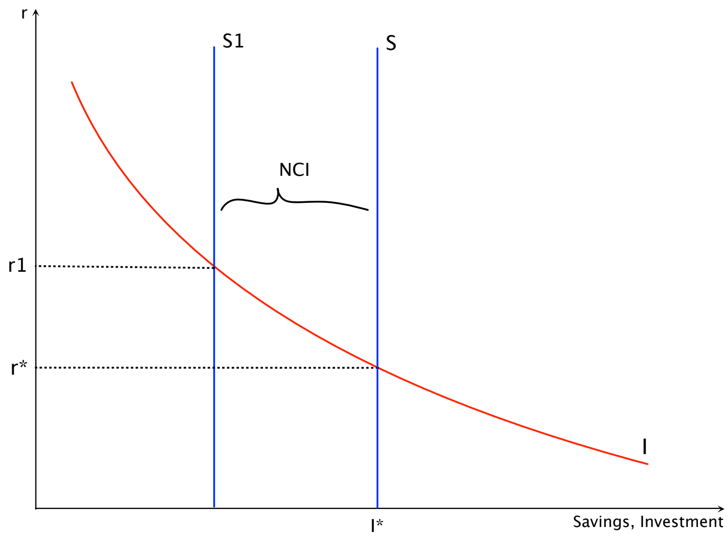

Figure 2: A small, open U.S. county's market for loanable funds.

When decreased total savings from redistributive policies causes the county's interest rate to rise above the autarky rate ($r^* \rightarrow r1$), individuals in nearby counties take advantage of the higher rate by channeling their savings into the county's economy. This results in a net capital inflow (NCI) that lowers the interest rate and brings the quantity of investment spending back to its original level. Under the assumption that U.S. counties are small, open economies with perfect capital mobility, savings and investment are delinked and a fall in the former does not constrain the latter. The inequality-growth relationship proposed by Keynesian savings rates thus has no impact on the growth of a U.S. county.

The theory of credit-market imperfections implies that the interest rate in the market for loanable funds lies above the level at which the supply of funds (savings) is exhausted by its demand (investment). Hence, there is credit rationing and not all borrowers who wish to access funds at the prevailing interest rate are able to obtain them. Although its credit markets may be imperfect, a county should still experience perfect capital mobility because it is small and capital controls are illegal in the United States. Due to the threat of NCI, the market for loanable funds in a U.S. county will never support an interest rate above the national equilibrium level caused by a shift in the savings schedule. Shifts in a county's investment function still have the power to influence the interest rate, especially if redistributive policies lower the MPK of a county. In view of this, my empirical specification includes two variables – proxies of public and private investment spending – to control for a county's level of investment demand.

I have now used perfect capital mobility and covariates for investment demand to dismiss the influence of inequality-growth channels #1, #2, and #3. This leaves only channels #4 and #5, theories of political economy and sociopolitical unrest.

Although each of these hypotheses predicts an unambiguous negative relationship between inequality and growth, sociopolitical unrest operates through the dispersion of income across a society, not its skewness (Alesina and Perrotti, 1996). I control for the inequality-growth link proposed by sociopolitical unrest, channel #5, by including a proxy of an income distribution's variance in my guiding regression equation.

Observations of U.S. counties thus allow my empirical test to measure the impact of inequality and growth as proposed by only channel #4, the theory of political economy.

2.4 The Formal Political Economy Model

I proceed with the political economy theory since it drives the inequality-growth relationship at the county level. I adopt the model of political economy as formalized by Persson and Tabellini (1994). The authors assume that individuals share the same preferences and live for two periods. The lifetime utility, U, of an individual born in period t-1 is given by:

$$v_t^i = U(c_{t-1}^i, d_t^i) \tag{1}$$

where c is consumption when young and d is consumption when old.

This utility function is constrained by

$$y_{t-1}^i = c_{t-1}^i + k_t^i \quad \text{and} \quad d_t^i = r[(1 - \theta_t k_t^i) + \theta_t k_t] \tag{2}$$

where: y_{t-1}^i is an individual's income when young; k^i is an individual's accumulation of physical and human capital; k is society's per-capita stock of physical and human capital with knowledge spillovers on the young; r is the rate of return on capital; and $0 < \theta < 1$ is the redistributive policy variable, where a value of 1 indicates full income redistribution and 0 indicates no income redistribution in a society. It is instructive to view θ as a property tax levied by county governments.

The constraint for consumption in period $t-1$ indicates that an individual's income is devoted either to accumulation of capital or to consumption. In period t, consumption is fueled by the return on the portion of individual capital that was not redistributed through taxation and the amount of societal capital distributed through policy.

Persson and Tabellini (1994) solve for the income growth rate of a society operating under political and economic equilibrium:[1]

$$g^* = G(w, r, \theta^*(w, r, e^m)) \tag{3}$$

where w is the exogenous average level of fundamental skills in the population, and θ^* is the level of redistributive policy favored by the median voter, who holds the endowment of individual-specific skills (and associated earned income) denoted by e^m. An $e^m = 0$ indicates that the median and mean incomes in a society are equal, while $e^m < 0$ ($e^m > 0$) tells us that the median income lies below (above) the mean, where. The g^* function implies that

$$\frac{dg^*}{de^m} = \frac{\partial G}{\partial \theta} \cdot \frac{\partial \theta}{\partial e^m}. \tag{4}$$

Here, $\frac{\partial \theta}{\partial e^m}$ is strictly negative because the endowment of skill held by an individual relates positively to his or her income. Since income has an inverse relationship with desired tax rate, a higher income is associated with demand for a lower θ, an indicator of the redistributive features of an economy's taxation policy. The authors also define $\frac{\partial G}{\partial \theta}$ to be strictly negative, so

[1] A political equilibrium is a state of policy such that no competing policy will be chosen by a majority of voters in a democratic election. In economic equilibrium, all citizens make optimal economic decisions subject to existing policies and markets always clear.

$\frac{dg^*}{de^m}$, the change in equilibrium growth rate with respect to an increase in the endowment of skill held by the median voter (or, equivalently, an increase in median income), is strictly positive. This asserts that a more equal distribution of income ($e^m \to 0$ from the left-hand-side) will *increase* a society's growth rate (Persson & Tabellini, 1994). Hence, income inequality and growth have an unambiguous negative association.

2.5 Constructing the Guiding Equation

I now present the guiding specification for the empirical model:

$$\begin{aligned} \text{GROWTHRATE}_i = &\beta_0 + \beta_1 \text{INEQUALITY}_i + \beta_2 \text{VARIANCE}_i + \\ &\beta_3 \text{INVESTMENT}_i + \beta_4 X_i + \sigma_i, \end{aligned} \tag{5}$$

where INEQUALITY is the ratio of a county's mean income to its median income and X_i is a vector of regional control variables that will be tailored to the type of growth regression being estimated.

The political economy hypothesis, built upon the fundamental role of savings proposed by Solow, is the guiding theory for my empirical investigation. Its proposed link between inequality and growth-restricting income redistribution at the county level leads me to predict a negative coefficient on INEQUALITY, measured as the mean-to-median income ratio, on growth.

This, however, is not the only channel through which inequality exerts an influence on a county's growth path. Imperfect capital markets and sociopolitical unrest can still influence the link between inequality and growth if investment demand and the spread of income distribution are free to vary across counties. In view of this, I include INVESTMENT and VARIANCE covariates to ensure that the coefficient estimate on INEQUALITY is purely a measure of the impact of political economy on growth.

3 Past Empirical Literature

Since surprising inequality-growth trends were first documented at the national level and fundamental theoretical work has implications for cross-country behavior, many empirical tests of the link between inequality and growth have used countries as their units of observation.

Barro (2000) finds a negative impact of inequality on growth for poor countries and a positive relationship in wealthy countries that are both statistically significant.[2] Regional dummy variables for African and Latin American countries, to Barro's surprise, were essential in generating the significance of the coefficient on inequality and themselves significant. He acknowledged that this points to a distinct regional influence on growth for which he cannot account. The sensitivity of his regression results supports his assertion that the competing inequality-growth theories may have dampening effects on each other's explanatory power.

Deininger and Squire (1998) run a similar cross-country growth regression whose inequality measure, the Gini coefficient, is initially negative and significant at the 99% level.[3] Inequality, however, loses its statistical significance when South American, African, and Asian continental dummy variables are included. These regional variables also increase the explanatory power of the model by nearly a third. Other cross-country models that first report a negative relationship between inequality and growth later find this same result (Persson & Tabellini, 1994; Birdsall et al., 1995; Forbes, 2000). For instance, Forbes (2000) reports that her base results linking inequality and growth are dependent on whether country-specific fixed effects are included in the model.

These findings suggest that there exists an inherent omitted-variable bias for country-level studies caused by missing characteristics that differentiate between the regions within a study's sample. This has contributed to inconclusive cross-country studies linking inequality

[2] Barro estimates the following equation, adding regional control variables to further account for the development stage of each nation in his sample: $\text{GDPGrowth}_i = \beta_0 + \beta_1\text{GINI}_i + \beta_1\text{InitialGDP}_i + \beta_3\text{EDUCATION}_i + \beta_4\text{INVESTMENT}_i + \beta_5\text{INFLATION}_i + \beta_6\text{DEMOCRACYINDEX}_i + \beta_7\text{FERTILITY RATE}_i + \beta_8\text{OPENNESS}_i + \epsilon_i$.

[3] Using growth in land ownership as the response variable, the authors estimate: $\text{GROWTH}_{it} = \beta_0 + \beta_1\text{GINI}_{it} + \beta_2\text{INITIALGDP}_{it} + \beta_3\text{EDUCATION}_{it} + \beta_4\text{INVESTMENT}_{it} + \epsilon_{it}$

and growth.

Due to evidence that omitted regional factors bias the coefficient estimates of cross-country studies, researchers in the late 1990s and early 2000s began to examine the inequality-growth relationship at the U.S. state level, where observations share more similar institutions. The results of these studies suggest a common problem: Some of the variance in growth rate may be determined by regional, within-state variation of explanatory variables included in a growth regression (Partridge, 1997; Panizza, 2002; Frank, 2009).[4]

I assert that there is substantial within-state variation in inequality and growth that is masked in these studies. Hence, it is more appropriate to treat institutions as a constant for observations of counties than for states. This is due in part to eased geographic constants; transportation networks, for instance, are much stronger between counties than between states.[5]

Despite this, only Kim (2004) examines the inequality-growth relationship at the more detailed U.S. county level; his data use observations of Florida's 61 counties in 1979 and 2000. Conducting a factor analysis, Kim searches for region-specific characteristics within Florida that are associated with changes in county growth over time, controlling for the Gini coefficient of inequality. His identified regional factors are jointly significant at the 90% level in the negative direction, but his study provides no conceptual economic model that predicts an unambiguous relationship between income inequality and subsequent economic growth. His results are also specific to the state of Florida, reporting influences such as orange production and size of the shellfish catch, limiting their applicability to the entire country.

The potential benefits of county-level studies of inequality and growth deserve more investigation than what the available literature provides. Measures such as starting income and the gap between mean and median earnings, both with the theoretical foundation to impact

[4] Partridge, for instance, estimates the effect of inequality on growth in a panel of U.S. states: $\text{INCOMEGROWTH}_{it} = \beta_0 + \beta_1\text{GINI}_{it} + \beta_2\text{INITIALINCOME}_{it} + \beta_3\text{EDUCATION}_{it} + \beta_4\text{GOVT}_{it} + \beta_5\text{TAXES}_{it} + \beta_6\text{INDUSTRIALMIX} + \beta_7\text{EMPLOYMENT}_{it} + \beta_8\text{SOUTH}_{it} + \beta_9\text{MIDWEST}_{it} + \beta_10\text{WEST}_{it} + \epsilon_{it}$

[5] For one example, consider how people often travel across county lines when commuting to work, but exhibit this mobility between states less frequently.

economic growth, experience substantial variation within countries and within states. This is suggested by the sensitivity of past results linking inequality and growth to regional dummy variables and fixed effects.

Further evidence of this is given by the thematic maps presented in Figures 3 and 4. These illustrate the variation of inequality and per-capita income in 1977, the starting year of this study's growth period. Each map contains nine different shades of its color; darker shades correspond to higher values of the variable. Changes in shade occur at the 99^{th}, 95^{th}, 90^{th}, 75^{th}, 50^{th}, 25^{th}, 10^{th}, and 5^{th} percentiles.

My paper contributes to the empirical inequality-growth literature by studying the impact of political economy on the growth of the 3,117 counties that make up the continental United States (Figure 5).

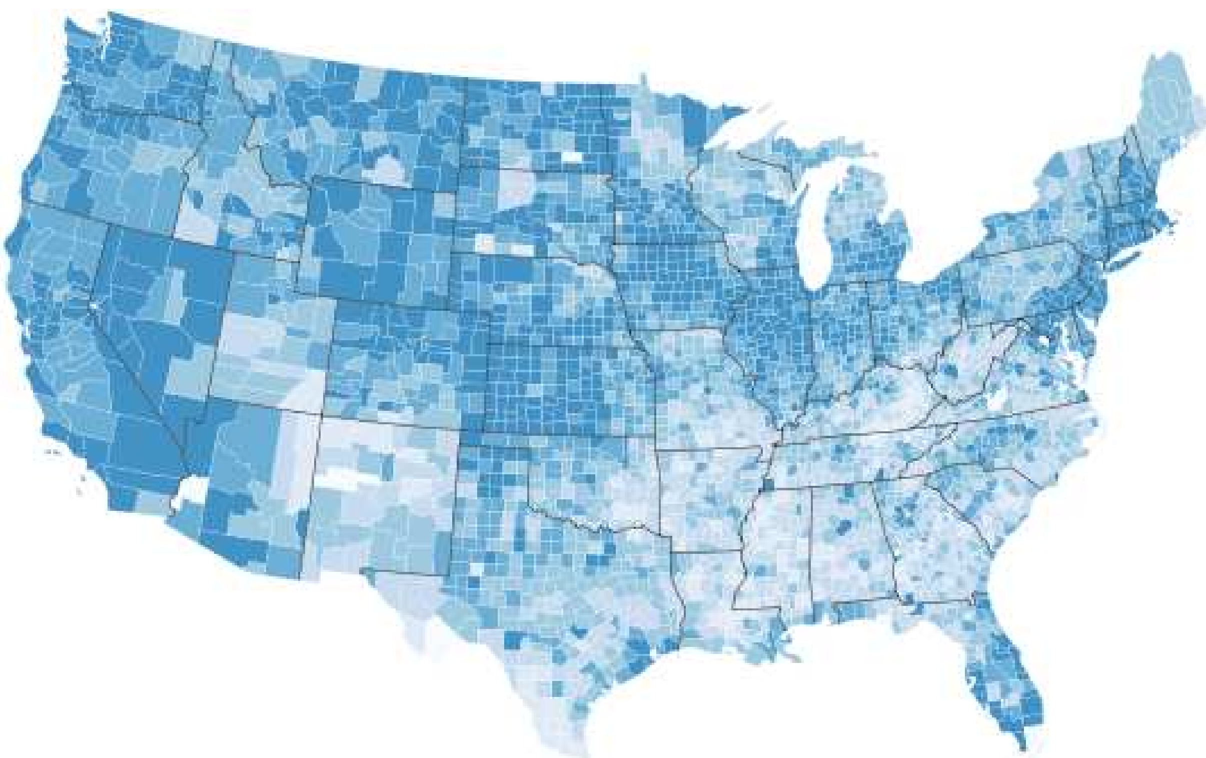

Figure 3: The per-capita income of U.S. counties in 1977, the beginning of the 23-year growth period studied in this paper.

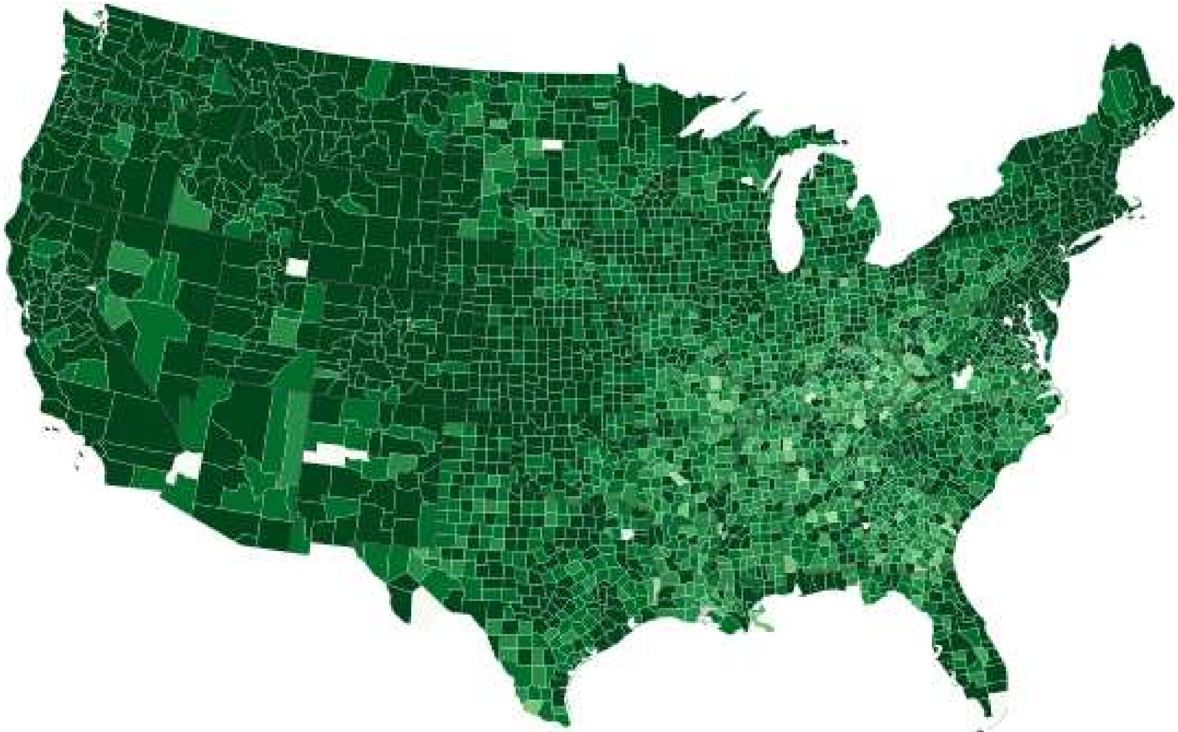

Figure 4: The distribution of INEQUALITY across U.S. counties in 1977.

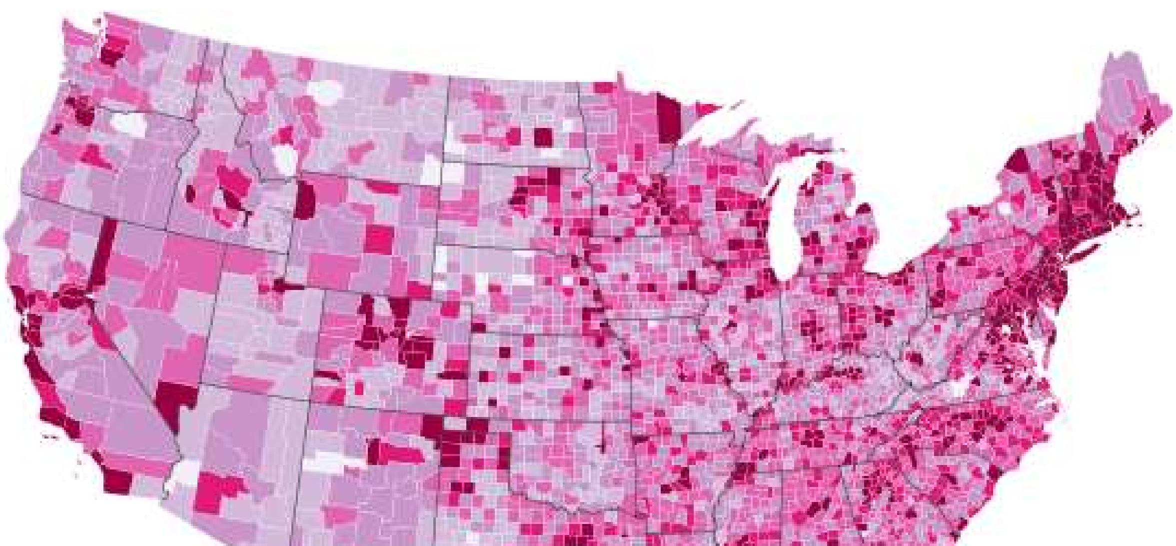

Figure 5: The change in per-capita income in U.S. counties between 1977 and 2000.

4 Summary Statistics

The United States is composed of 3,141 counties or county-equivalents. At this level, I collect data on income-per-capita growth, income inequality, and additional covariates to isolate the effect of inequality on growth through the political economy channel.

I take my data from the U.S. Census Bureau. The U.S. Census began publishing its County Data Books (CDBs) in 1947 and has since issued a new edition at intervals ranging from two to six years. I restrict my analysis to only those years for which full data for my guiding equation are available: 1977, 1983, 1988, 1994, and 2000.[6]

The Census of Governments measures the percent of residents holding a college degree (COLLEGE); per-capita housing units constructed during the 1970s as a proxy for private investment (PRIVATE); and local government spending on public welfare, highways, health, and education as a gauge for public investment (PUBLIC). I also gather voter turnout, the percentage of eligible voters voting in the 1980 presidential election (TURNOUT) from this source. Although the U.S. Census reports the data, some information is compiled by outside agencies.[7] The BEA publishes its estimates of per-capita income and median income from administrative records. The BLS provides estimates of the unemployment rate (UNEMP) from its monthly surveys.

To proxy the variance of a county's income distribution, I collect the percentage of a county's households that earned less than \$10,000 in 1979 (UNDER10), and between \$20,000 and \$29,999 in 1979 (UNDER30). The average county-level median household income was \$14,239 with a standard deviation of \$3,287, so I expect that a higher percentage of households with income either under \$10,000 or above \$30,000 to suggest a larger variance of income in a county. Hence, I expect the coefficient estimates on both variables to have a negative sign, since variance of income is negatively linked to growth under the theory of sociopolitical

[6]The Census Bureau began compiling its economic census in 1967 after a Congressional mandate; this eliminates the 1947, 1949, 1952, 1956, and 1962 CDBs from my dataset."Appendix A: Source Notes and Explanations." *U.S. Census County and City Data Book 2007.* Detailed data on per-capita income were not collected in 1967 and 1972.

[7]Appendix B: Limitations of Data and Methodology *U.S. County and City Data Book: 2007.*

unrest.

I converted all values reported in nominal dollars to real 2000 dollars using the historical CPI index reported by the Federal Reserve Bank of St. Louis. I omitted all of the observations from Alaska's 19 county-equivalents and Hawaii's 5 counties due to missing data for key variables across all years of my sample. In all, there are 3,033 cross-sectional observations fit for regression.

In line with Barro (2000), I calculate this study's income inequality metric, INEQUALITY, as a county's mean income divided by its median income.

Following the empirical specification in MRW, I construct my dependent variable, GROWTHRATE, as the logged difference of county-level income per-capita between 1977 and 2000. In a departure from MRW, I use the value for each explanatory variable from its initial year of availability in the dataset, instead of an average across the growth period. This follows the approach of Forbes (2002) and Partridge (2006) to weaken the threat of endogeneity between inequality and growth across the years of my sample by using predetermined levels of included variables.

I report the final list of these variables in Tables 2, along with their sample means, standard deviations, minimums, and maximums.

The coefficient of variation (CV) for GROWTHRATE is 0.10 and for INEQUALITY it is 0.28. These CVs suggests a good degree of variation within the data. Further, only 10 counties, 0.33%, have an INEQUALITY below 1. This supports a key assumption I made in §2.4: Redistribution brings $e^m \to 0$ from the left-hand side because virtually all regions in the U.S. have a mean income that lies above the median.

The minimum logged 23-year income-per-capita growth rate is the 3.398 recorded by Parmer, Texas, a very poor county with a large uneducated population.[8] The most rapid growth from 1977-2000 is New York, New York's 10.884. The statistics for the sample of 3,033 counties correspond to an average annual growth rate of 0.37, a minimum of 0.15, and a

[8]U.S. Census Bureau, *American Fact Finder.*

maximum of 0.47. These values are similar to those reported by MRW (1992) for their sample of 98 countries.

5 Analysis

5.1 The Empirical Model

I take my specification from MRW (1992), an estimate of the explanatory power of the Solow model with logged difference of per-capita income from 1960-1985 as the dependent variable. The authors also investigate whether poorer countries tend to grow faster than richer ones, the convergence hypothesis, by estimating the effect of a nation's logged initial level of income per-capita, ln(STARTING), on its growth path. In addition, the authors examine the effect of human capital on subsequent economic growth.

I present the basic MRW regression equation, extended to my county-level observations, below:

$$\begin{aligned}\mathrm{GROWTHRATE}_i &= \beta_0 + \beta_1 \ln\left(\mathrm{STARTING}\right)_i + \beta_2 \mathrm{INEQUALITY}_i + \beta_3 \mathrm{COLLEGE}_i \\ &\quad + \beta_4 \mathrm{PUBLIC}_i + \beta_5 \mathrm{PRIVATE}_i + \epsilon_i. \end{aligned} \tag{6}$$

Equation (6) follows the form of MRW with three notable exceptions. First, I use PUBLIC and PRIVATE as proxies for investment's share of GDP (I/Y) used in MRW, since (I/Y) is not available at the county level. These variables also control for the position of investment demand, as mentioned in §2.5. Second, I take COLLEGE as my education metric instead of the total school enrollment variable used in MRW. Third, I add INEQUALITY and do not include a measure of population growth.

Equation (6) is nested in equation (7). Equation (7) contains additional explanatory measures that make it more appropriate for studying growth at the county level; it is this paper's preferred regression specification.

$$
\begin{aligned}
\text{GROWTHRATE}_i = \beta_0 + \beta_1 \ln{(\text{STARTING})_i} + \beta_2\text{INEQUALITY}_i \\
+ \beta_3\text{COLLEGE}_i + \beta_4\text{PUBLIC}_i + \beta_5\text{PRIVATE}_i + \beta_6\text{UNDER10}_i \\
+ \beta_6\text{UNDER30}_i + \beta_7\text{UNEMP}_i + \beta_8\text{TURNOUT}_i + \gamma_i. \qquad (7)
\end{aligned}
$$

I use UNEMP to pinpoint the conditions of a county's economy brought about by its position in the business cycle; the variable acts as a cyclical control. I include TURNOUT because the political economy theory proposes a link between inequality and growth that requires participation in the democratic process. All of my independent variables take their values from their first year of availability in my growth period: 1977 for STARTING, PUBLIC, UNEMP, TURNOUT and PRIVATE; 1979 for UNDER10 and UNDER30; and 1980 for COLLEGE.

5.2 Estimation Issues

I tested regression equations (6) and (7) for multicollinearity using Variance Inflation Factors (VIF) tests. The mean VIFs were 1.31 and 3.29, below the threshold of 5 that indicates severe multicollineariy. I also inspected a pair-wise correlation matrix and found that only the intersection between UNDER10 and UNDER30 had a value exceeding 0.70. Due to the theoretical importance of these variables and the encouraging mean VIFs of both equations, I did not take any action to correct for potential multicollinearity in my regression results.

To check for heteroskedasticity, I conducted a post-estimation Cook-Weisburg test on both regression equations. The test found sufficient evidence to reject the null hypothesis that each equation had a constant variation in its error term. Believing that my sample size of 3,033 is sufficient to rely on their large-sample characteristics, I use robust standard errors to reduce the overstating of t-scores in my coefficient estimates.

5.3 Regression Results

I present the final OLS regression results, corrected for heteroskedasticity, in Table 3. Column (i) estimates equation (6); column (ii) reports the estimation of equation (7).

This paper's variable of interest, INEQUALITY, has the expected negative sign and is statistically significant at the 99% level in both specifications. A one-unit increase in a county's inequality ratio causes an 8.6% decrease in the observed growth rate in column (i) and a 5.6% drop in growth rate with the more detailed controls used in column (ii).

I also find evidence for county-level convergence. The negative coefficient on ln(STARTING) achieves significance at the 99% level in both regressions. A one-percent increase in a county's starting level of per-capita income decreases its 1977-2000 growth rate by 0.72%, holding the most detailed set of covariates fixed.

Column (i) replicates the cross-country findings of MRW for private investment and educational attainment, finding COLLEGE and PRIVATE to be statistically significant in the positive direction. PUBLIC, however, has an estimated negative coefficient that lacks statistical significance. Since this is also a proxy for investment, this negative sign is unexpected.

The coefficients on all variables, except for PRIVATE, retain their signs and levels of significance from equation (6) to equation (7). In particular, the negative coefficient on INEQUALITY remains significant at the 99% level, though its magnitude drops to -0.56. The coefficient on UNDER10 is statistically significant in the negative direction while the estimate on UNDER30 is not statistically significant. An F-test reveals that these variables are jointly significant at the 99% level, so the insignificance of UNDER30 may be due to its high correlation with UNDER10.

5.4 Robustness Checks

For my first robustness check, I construct two-year averages (of 1972 and 1977 values) for INEQUALITY and ln(STARTING), the explanatory variables in equations (6) and (7) available for both years. This is done to see the sensitivity of my findings to a change in initial conditions. Table 4 shows updated summary statistics and I present regression results, adjusted for heteroskedasticity, in Table 5. I report findings for the basic MRW model in column (i) and findings for the more detailed specification in column (ii).

INEQUALITY has a statistically significant negative impact on growth rate in both specifications; in fact, its magnitudes are nearly triple the size of the estimates in the original specification. With the exception of ln(STARTING), all explanatory variables retained their signs and significance levels from the original specification. When I estimate equation (6) with two-year averages, ln(STARTING) has a negative coefficient that is just short of 95% significance; it is statistically significant at the 99% level when I estimate equation (7).

Table 6 estimates my growth regression with regional dummy variables included.[9] The coefficient on each regional indicator indicates the change in a county's growth rate, relative to the omitted Pacific region, based on its geographic location in the United States, holding all other included factors fixed. An F-test reveals that these regional dummies are jointly significant at the 99% level. In addition, the model's adjusted R^2 rises from 0.28 to 0.32 in the regression using 1977 values of explanatory variables. Using 1972-1977 values, the inclusion of regional dummies increases adjusted R^2 by 12%, from 0.23 to 0.28. The coefficient estimate and significance level of INEQUALITY are virtually unchanged after these dummies are added. These results compare favorably to past findings in cross-country and cross-state tests in the literature (Table 7). It is troubling, however, that the coefficient estimates of the regional dummy variables achieve statistical significance, and increase the explanatory power of the model.

[9] I classify states by 9 regional divisions provided by the U.S. Census Bureau: New England (Maine, New Hampshire, Vermont, Massachusetts, Rhode Island, and Connecticut); Middle Atlantic (New York, Pennsylvania, New Jersey); East North Central (Wisconsin, Michigan, Illinois, Indiana, Ohio); West North Central (Missouri, North Dakota, Nebraska, Kanas, Minnesota, Iowa); South Atlantic (Delaware, Maryland, Virginia, West Virginia, North Carolina, South Carolina, Georgia, Florida); East South Central (Kentucky, Tennessee, Mississippi, Alabama); West South Central (Oklahoma, Texas, Arkansas, Louisiana); Mountain (Idaho, Montana, Wyoming, Nevada, Utah, Colorado, Arizona, New Mexico); and Pacific (Alaska, Washington, Oregon, California, Hawaii).

6 Conclusion

This paper has analyzed the link between inequality and growth at a level that allows guiding political economy theory to predict an unambiguous negative relationship between inequality and economic growth. This a first in the empirical inequality-growth literature. My county-level results provide strong support for the political economy theory that links these two measures. Across all of my specification and robustness checks, the coefficient estimates on INEQUALITY are negative and statistically significant at the 99% level. Moreover, these coefficient estimates carry economic significance: A one-unit increase in INEQUALITY, holding other included factors constant, leads to a decrease of at least 5.6% in a county's growth rate. In the empirical specification that controls for extreme observations in 1977 and includes detailed regional covariates, column (ii) of Table 5, a one-unit increase in INEQUALITY is associated with a 24.1% drop in growth rate.

By using initial-period values of my explanatory variables to model subsequent growth, I was able to treat their between-period changes as exogenous. Unfortunately, it is likely that initial-period levels of INEQUALITY and GROWTHRATE are still, to some extent, jointly determined. While I have weakened the threat of endogeneity in my regression results, future work in this area will need to provide more detail on these causal effects.

My results also demonstrate the importance of examining region-specific factors to tell the full story of the historical growth path of the United States. My robustness checks find that the inclusion of nine regional dummies left the magnitude and significance of the coefficients on INEQUALITY virtually unchanged. Nonetheless, it is unsettling that the coefficient estimates of these dummies are statistically significant in my regression model. A primary goal of this study was to construct a growth model at a level that eliminates regional differences across observations, and my investigation has failed in this regard. A more detailed study on the link between institutional strength (a factor that these dummies may be measuring) and growth would be enlightening. My inquiry also provides further motivation to study the effects of regional policies within the United States that may shape the development of counties.

Table 1: Selected Econometric Literature

Study	Dependent Variable	Observations	Effect of Inequality
Persson & Tabellini (1994)	Growth of per-capita GDP	Countries	Negative
Partridge (1997)	Growth of per-capita GDP	U.S. states	Positive
Panizza (1999)	Growth of per-capita income	U.S. states	Negative
Barro (2000)	Growth of per-capita income	Countries	Ambiguous
Forbes (2000)	Growth of per-capita income	Countries	Positive
Kim (2004)	Growth of per-capita GDP	Florida counties	Positive
Partridge (2006)	Growth of employment	U.S. states	Positive
Frank (2009)	Growth of per-capita income	U.S. states	Positive

Table 2: Summary Statistics (1977 Values)

Variable	Mean	Std. Dev.	Min.	Max.
GROWTHRATE	8.51	0.81	3.40	10.88
ln(STARTING)	9.31	0.24	8.42	10.50
INEQUALITY	2.21	0.62	0.80	6.88
UNDER10	36.01	9.32	8.99	67.13
UNDER30	19.26	4.73	5.27	38.16
COLLEGE	6.64	3.08	0.68	31.92
PUBLIC	0.49	0.59	0	13.57
PRIVATE	0.10	0.04	0.01	0.70
UNEMP	4.41	2.31	0	18
TURNOUT	40.39	7.94	3.46	82.35

Observations: 3033

Table 3: Regression Results (1977 Values)

	Coefficients	
Variables	(i)	(ii)
ln(STARTING)	-0.263^{**}	-0.724^{**}
	(6.99)	(14.73)
INEQUALITY	-0.086^{**}	-0.056^{**}
	(7.23)	(4.85)
COLLEGE	0.063^{**}	0.059^{**}
	(22.76)	(21.75)
PUBLIC	-0.003	-0.003
	(0.97)	(0.91)
PRIVATE	0.585^{**}	0.297
	(3.28)	(1.74)
UNDER10	–	-0.016^{**}
	–	(7.53)
UNDER30	–	-0.001
	–	(0.04)
TURNOUT	–	-0.004^{**}
	–	(4.31)
UNEMP	–	-0.024^{**}
	–	(8.09)
Constant	11.292^{**}	16.406^{**}
	(33.37)	(33.49)
Observations	3035	3033
Adjusted R^2	0.18	0.28

NOTE. — Robust standard errors in parentheses.

* p-value significant at 5%. ** p-value significant at 1%.

Table 4: Summary Statistics (1972-1977 Averages)

Variable	Mean	Std. Dev.	Min.	Max.
GROWTHRATE	8.51	0.81	3.40	10.88
ln(STARTING)	9.27	0.24	8.41	10.11
INEQUALITY	1.74	0.32	1.09	4.06
UNDER10	36.01	9.32	8.99	67.13
UNDER30	19.26	4.73	5.72	38.16
COLLEGE	6.64	3.08	0.68	31.92
PUBLIC	0.64	3.65	0	15.23
PRIVATE	0.10	0.04	0.01	0.70
UNEMP	0.05	0.02	0	0.15
TURNOUT	40.39	7.97	3.46	82.35

Observations: 3033

Table 5: Regression Results (1972-1977 Averages)

	Coefficients	
Variables	(i)	(ii)
ln(STARTING)	-0.079	-0.263^{**}
	(1.76)	(4.19)
INEQUALITY	-0.272^{**}	-0.241^{**}
	(9.69)	(6.01)
COLLEGE	0.055^{**}	0.052^{**}
	(20.65)	(4.29)
PUBLIC	-0.003	-0.024
	(1.09)	(0.86)
PRIVATE	0.849^{**}	0.008^{**}
	(4.88)	(4.41)
UNDER10	–	-0.007^{*}
	–	(2.32)
UNDER30	–	0.002
	–	(0.30)
TURNOUT	–	-0.008^{**}
	–	(7.21)
UNEMP	–	-0.22^{**}
	–	(5.11)
Constant	9.895^{**}	12.21^{**}
	(24.37)	(17.67)
Observations	3033	3033
Adjusted R^2	0.17	0.23

NOTE. — Robust standard errors in parentheses.

* p-value significant at 5%. ** p-value significant at 1%.

Table 6: Regression Results (With Regions)

	Coefficients (1977 Values)		**Coefficients (1972-1977 Averages)**	
Variables	(i) No Regions	(ii)Regions	(iii) No Regions	(iv) Regions
ln(STARTING)	-0.724^{**}	-0.652^{**}	-0.263^{**}	-0.212^{**}
	(14.73)	(7.56)	(4.19)	(3.38)
INEQUALITY	-0.056^{**}	-0.057^{**}	-0.241^{**}	-0.223^{**}
	(4.85)	(4.34))	(6.01)	(5.97)
COLLEGE	0.059^{**}	0.062^{**}	0.052^{**}	0.055^{**}
	(21.75)	(17.67)	(4.29)	(16.43)
PUBLIC	-0.003	-0.001	-0.002	-0.001
	(0.91)	(0.60)	(0.86)	(0.50)
PRIVATE	0.003	0.003^{*}	0.008^{**}	0.007^{**}
	(1.74)	(1.99)	(4.41)	(4.43)
UNDER10	-0.016^{*}	-0.015^{**}	-0.007^{*}	-0.008^{**}
	(7.53)	(5.28)	(2.32)	(2.56)
UNDER30	-0.001	0.001	-0.765	0.002
	(0.04)	(0.15)	(0.30)	(0.42)
TURNOUT	-0.004^{**}	-0.003^{*}	-0.008^{**}	-0.005^{**}
	(4.31)	(2.26)	(7.21)	(4.94)
UNEMP	0.024^{**}	-0.015^{**}	-0.223^{**}	-0.010^{*}
	(8.09)	(3.92)	(5.11)	(2.04)
New England	–	0.166^{**}	–	0.235^{**}
	–	(4.01)	–	(5.73)
Middle Atlantic	–	0.168^{**}	–	0.254^{**}
	–	(3.88)	–	(6.13)
East North	–	0.010^{**}	–	0.149^{**}
	–	(2.85)	–	(4.17)
West North Central	–	0.186^{**}	–	0.237^{**}
	–	(5.18)	–	(6.44)
South Atlantic	–	0.22^{**}	–	0.294^{**}
	–	(5.85)	–	(7.99)
East South Central	–	0.214^{**}	–	0.294^{**}
	–	(5.81)	–	(8.06)
West South Central	–	0.04	–	0.131^{**}
	–	(1.02)	–	(3.31)
Mountain	–	-0.036	–	-0.001
	–	(0.87)	–	(0.02)
Constant	16.406^{**}	15.47^{**}	12.21^{**}	11.36^{**}
	(33.49)	(17.39)	(17.64)	(16.35)
Observations	3033	3033	3033	3033
Adjusted R^2	0.28	0.32	0.23	0.28

NOTE. — Robust standard errors in parentheses.

* p-value significant at 5%. ** p-value significant at 1%.

Table 7: The Impact of Regional Controls

Study	**Observations**	**Dummies Added**	**Change in INEQUALITY**
Deininger & Squire (1998)	Countries	Latin, Africa, Asia	Negative and significant to negative and insignificant
Birdsall et al. (1995)	Countries	Asia (HPAE), Latin	"adding a [dummy] variable makes the inequality variable insignificant"
Persson & Tabellini (1994)	Countries	Democratic nation	Negative and insignificant to positive and significant
Forbes (2000)	Countries	Region and period	Negative and insignificant to positive and significant
Partridge (1999))	U.S. states	Region	Positive and insignificant to positive and significant
This paper	***U.S. counties***	***Region***	***Remains negative and significant***

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A Derivation of the Solow Model

A country's output at a time t is determined by its Cobb-Douglas production function with decreasing returns to capital:

$$Y(t) = (A(t)L(t))^{1-\alpha}K(t)^{\alpha}, \quad 0 < \alpha < 1, \tag{8}$$

where Y = output, K = capital, A = the level of labor-augmenting technology, and L = labor. $L(t)$ and $A(t)$ are assumed to be exogenous and grow exponentially at the rates n and g, respectively:

$$L(t) = L_0 e^{nt} \tag{9}$$

$$A(t) = A_0 e^{gt}, \tag{10}$$

where L_0 is the initial level of labor and A_0 is the initial stock of technology. It follows that the effective units of labor used as an input in production, $A(t) \cdot L(t)$, grows exponentially at the rate $n + g$.

We define the level of capital available for each effective unit of labor as $k = \frac{K}{AL}$ and the level of output per effective unit of labor as $y = \frac{Y}{AL}$. The change in k is given by

$$\begin{aligned} k'(t) &= sy(t) - (n + g + \delta)k(t) \\ &= sk(t)^{\alpha} - (n + g + \delta)k(t) \end{aligned} \tag{11}$$

where s is the fixed fraction of output that is invested and δ is the depreciation rate. The steady-state value of k is given by

$$k^* = \left(\frac{s}{(n + g + \delta)}\right)^{\frac{1}{1-\alpha}} \tag{12}$$

and the steady-state value of y is

$$y^* = \left(\frac{s}{(n + g + \delta)}\right)^{\frac{\alpha}{1-\alpha}}. \tag{13}$$

Substituting k^* into the Cobb-Douglas production function and taking the natural log of both sides yields a model for steady-steady income per capita:

$$\ln\left(\frac{Y(t)}{L(t)}\right) = \ln A_0 + gt + \frac{\alpha}{1-\alpha}\ln(s) - \frac{\alpha}{1-\alpha}\ln(n+g+\delta). \tag{14}$$

At a fixed time $t = 0$, this becomes

$$\ln\left(\frac{Y}{L}\right) = \alpha + \frac{\alpha}{1-\alpha}\ln(s) - \frac{\alpha}{1-\alpha}\ln(n+g+\delta) + \epsilon \tag{15}$$

where ϵ reflects differences in initial technological stock, A_0, between countries.

MRW expand the Solow model to include human capital, defining the production function as

$$Y(t) = K(t)^{\alpha} H(t)^{\beta} \left(A(t)L(t)\right)^{1-\alpha-\beta}, \tag{16}$$

where H is a country's stock of human capital and $\alpha+\beta < 1$. Letting s_k and s_h be the fraction of income invested in physical and human capital, respectively, the economy converges to the steady state defined by:

$$k^* = \left(\frac{s_k^{1-\beta} s_h^{\beta}}{n+g+\delta}\right)^{1/(1-\alpha-\beta)}$$

$$h^* = \left(\frac{s_k^{\alpha} s_h^{1-\alpha}}{n+g+\delta}\right)^{1/(1-\alpha-\beta)}. \tag{17}$$

By substituting Equation (17) into (16) and taking the log of both sides, income per capita has a similar definition as in (15), depending on the rate of population growth and the stock of physical and human capital:

$$\ln\left(\frac{Y(t)}{L(t)}\right)^* = \ln A(0) + gt - \frac{\alpha+\beta}{1-\alpha-\beta}\ln(n+g+\delta) + \frac{\alpha}{1-\alpha-\beta}\ln(s_k) + \frac{\beta}{1-\alpha-\beta}\ln(s_h). \tag{18}$$

The Solow model can now predict an economy's rate of convergence to the steady state level of income per effective worker, y^*. Setting $\lambda = (n+g+\delta)(1-\alpha-\beta)$,

$$\frac{d\ln(y(t))}{dt} = \lambda\left[\ln(y^*) - \ln y(t))\right]. \tag{19}$$

It follows that

$$\begin{aligned}
\ln(y(t)) &= (1-e^{-\lambda t})\ln(y^*) + e^{-\lambda t}\ln(y_0) \\
\ln(y(t)) - \ln(y_0) &= (1-e^{-\lambda t})\ln(y^*) - (1-e^{-\lambda t})\ln(y_0)
\end{aligned} \tag{20}$$

where y_0 is a country's initial level of income per effective worker.

Last, substituting our result from (18) for y^*:

$$\begin{aligned}
\ln(y(t)) - \ln(y_0) = {} & (1-e^{-\lambda t})\frac{\alpha}{1-\alpha-\beta}\ln(s_k) \\
& + (1-e^{-\lambda t})\frac{\beta}{1-\alpha-\beta}\ln(s_h) \\
& - (1-e^{-\lambda t})\frac{\alpha+\beta}{1-\alpha+\beta}\ln(n+g+\delta) - (1-e^{-\lambda t})\ln(y_0).
\end{aligned} \tag{21}$$

Equation (21) is the empirical specification suitable for OLS regression. It predicts that growth rate of per-capita income is positively related to an economy's savings rates and its human capital attainment (Mankiw, Romer, & Weil, 1992).