MONASH BUSINESS SCHOOL

DEPARTMENT OF ECONOMICS

ISSN 1441-5429

DISCUSSION PAPER 18/16

Inequality, Financial Development and Economic Growth in the OECD, 1870-2011

Jakob B. Madsen[a], MD. Rabiul Islam[b], and Hristos Doucouliagos[c]

Abstract:

Inequality's effect on growth remains elusive, largely due to endogeneity, complex interactions, and lead-lag relationships. We revisit this issue by examining the four main channels through which inequality transmits to growth: savings, investment, education, and knowledge production. We construct new panel data for 21 OECD countries spanning 142 years. External communist influence is used as a new time-varying instrument for inequality and the effects of inequality on the outcome variables are made conditional on the stage of financial development. Our results show that inequality hampers growth at low to moderate levels of financial development but promotes growth at advanced levels.

Keywords: inequality, financial development, transmission channels

JEL Classification Numbers: E20, O15, O40

[a] Department of Economics, Monash University, 900 Dandenong Road, Caulfield East, Victoria 3145, Australia (e-mail: Jakob.Madsen@monash.edu)
[b] Department of Economics, Monash University, 900 Dandenong Road, Caulfield East, Victoria 3145, Australia (e-mail: Md.Rabiul.Islam@monash.edu)
[c] **Corresponding author**: Department of Economics, Deakin University, 221 Burwood Hwy, Burwood, Victoria 3125, Australia (e-mail: douc@deakin.edu.au)

1. Introduction

One of the long-standing questions in macroeconomics is whether income inequality impairs or augments growth. Despite a burgeoning literature on the growth effects of inequality, the empirical evidence remains inconclusive and a definitive assessment of the effects of inequality on growth remains elusive.[1] This impasse is not surprising given that: the relationship between inequality and growth is masked by various channels that transmit to growth with markedly varying lags, inequality may have growth as well as level effects, and the growth effects of inequality are likely to depend on moderating factors, such as the stage of financial development.

In this paper we extend previous research by examining school enrollment, ideas production, saving, and investment, as potential channels through which inequality impacts growth. These are the key drivers of economic growth in standard economic growth models. All four transmission channels relate to the saving-investment decision and are, henceforth, referred to as 'saving'. We pay particular attention to the interaction between financial development and inequality, since credit is arguably the most important channel through which inequality affects growth (see Aghion and Bolton, 1997; Banerjee and Newman, 1993; Galor and Zeira, 1993; Piketty, 1997). Inequality is potentially harmful to growth in financially underdeveloped economies because investment in education, R&D, and fixed capital are often indivisible with high sunk costs, as discussed in detail below. Numerous empirical studies have found financial development to be a major driver of growth and development (e.g., Levine *et al*., 2000; Bordo and Meissner, 2015; Madsen and Ang, 2016), suggesting that financial development is likely to be a key channel which compounds the growth-effects of inequality. Moreover, our empirical estimates show that the coefficient on inequality is implausible unless the interaction between inequality and financial development is included in the models.

This paper makes three contributions to the literature on growth and income inequality. First, the paper seeks to overcome the inherent problems of regressing growth directly on inequality by instead exploring the effects of inequality on the key drivers of growth (saving, investment, ideas production, and school enrollment at the primary, secondary and tertiary levels). This approach has several advantages: it provides a much deeper understanding of how inequality transmits to growth, it enables inequality to have growth or level effects depending

[1] Recent studies that investigate the relationship between inequality and growth include Barro (2000), Forbes (2000), Panizza (2002), Banerjee and Duflo (2003), Easterly (2007), Berg *et al*. (2012), and Halter *et al*. (2014). Most studies conclude that the empirical evidence is ambiguous.

on the specific channel, and it allows education to affect growth with a considerable time-lag that cannot easily be captured from reduced-form regressions. While some studies have investigated the investment and saving channels, there has been relatively little attention on the innovation and the education channels. Moreover, prior studies have largely ignored the moderating role of financial development. In contrast, we specifically examine the interaction between inequality and financial development to test the hypothesis that inequality is potentially more harmful for growth in financially underdeveloped economies than in economies with fully developed financial systems.

Our second contribution is to assemble a new macroeconomic panel for 21 OECD countries spanning 142 years from 1870 to 2011. These data have several salient benefits. OECD economies provide a more nuanced sample, diminishing the unobserved heterogeneity that would arise from larger country samples with a short time-dimension (Alesina *et al*., 2016). Since the available inequality data for the poorest countries often consist of only two or three data points, little is gained from a larger panel of countries and the associated point estimates are likely to be estimated with low precision. As Johnson *et al*. (2013) note: "in general, annual data from non-OECD countries should be treated with caution" (p. 273). Using the long historical data we are able to trace transitions from significant financial underdevelopment in the earlier years through to the highly sophisticated financial systems that today characterize OECD countries. We are then able to identify the effects on growth through the interaction between inequality and financial development. Econometrically, the benefits of using long panel data are that the fixed effects estimator becomes more consistent as the sample grows, and the instrumental variable parameter estimates can be severely biased in small samples (Davidson and MacKinnon, 2006).

Our third contribution relates to the identification of the effect of inequality on the outcome variables. Prior studies rarely use time-varying external instruments; instead they use OLS or internal instruments that exploit orthogonality conditions of the independent variables. A common external instrument for inequality in cross-country regressions is the *time-invariant* ratio of land suitable for wheat and sugarcane production (Easterly, 2007). We here propose an identification strategy that uses the strength of communist rule in culturally similar countries as a new time-varying instrument for inequality.

Culturally weighted foreign communist influence is a strong predictor of income distribution as workers' wage aspirations are more willingly accommodated by elites, governments, and employers, when there is an emerging or eminent communist threat. Revolutions often result from general discontent that is kept dormant until a significant event

triggers an outburst that can potentially spread internationally and result in regime change, unless the ruling elites take voluntary pre-emptive measures (Weyland, 2010). The historical record contains numerous examples of waves of pro-labor movements across the globe inspired by events in culturally neighboring countries, as discussed in detail in Section 4 below.

Why would elites accept increasing taxation and real wages in periods of communist upheaval in cultural neighboring countries when this reduces their after-tax income? The answer is that they may be forced to accept income redistribution concessions because of emerging threats of communist revolution. Communist threat contributes to polarization and class conflict, e.g., communist influence grows in parts of the trade union movement and other organizations. Labor movements and capitalists alike observe the ease at which regimes are overturned. For example, when Tsar Nicholas' II downfall in 1917 made other regimes suddenly look weak, labor movements across the industrializing countries gained confidence to act on these weaknesses. Furthermore, governments and elites considered a communist revolution to be a real threat and consequently redistributive reforms may be a low price to pay in exchange for a peaceful labor movement. Weyland (2010), for example, contends that fear of bolshevism induced pre-emptive suffrage reforms in Britain, Sweden, Germany, and Finland in the period 1917–1919. Similar preemptive measures have been identified in the democratization and expansion of franchise across the world by Acemoglu and Robinson (2000) and Aidt and Jensen (2014). While responses to external communist influence varied from nation to nation, and other factors such as the Great Depression were also instrumental, communist influence contributed to social-democratic reforms across the OECD, on average.

The approach taken in this study overcomes several of the problems that have faced most previous studies in which per capita growth is regressed directly on measures of income inequality without paying sufficient attention to possible transmission channels, endogeneity, unobserved country heterogeneity, the interaction between inequality and financial development, and lead-lag relationships. The nexus between inequality and growth is particularly masked when it comes to education. The influence of inequality on education takes several years to affect production because it can take up to two decades before students enter the labor force and the 65-year olds, a cohort whose education was also affected by inequality when they acquired their education, exits the labor force. Thus, the effect of inequality on income through education is highly unlikely to be captured by standard growth regressions. Furthermore, if the saving-effect of inequality is facilitated by financial development, then unconditional saving-regressions are unlikely to reveal much about the nexus between inequality and saving.

The rest of the paper is organized as follows. Section 2 discusses the transmission channels and model specifications. Section 3 discusses in detail the identification strategy and exclusion restriction, while the data are discussed in section 4. The empirical estimates and robustness checks are presented in Section 5 and simulations of the historical evolution of elasticities conditional on financial development are carried out in Section 6. The final section concludes and discusses the implications of our findings.

2. Transmission channels and model specifications

In this section we briefly demonstrate how saving, fixed investment, education, and innovative activity, relate to growth in a financially unconstrained economy, and the circumstances under which they have temporary and permanent growth effects. The model presented in this section is then used in simulations that trace the path from inequality to growth in Section V.

Consider the following constant returns to scale Cobb-Douglas production function:

$$(1) \qquad Y(t) = K(t)^{\alpha} H(t)^{\beta} (A(t)L(t))^{1-\alpha-\beta},$$

where *Y* is output, *A* is technology, *K* is capital, *L* is employment, and *H* is the stock of human capital. Following the spirit of the Solow model, Mankiw *et al.* (1992) show that in steady state the economy evolves as:

$$(2) \qquad \ln\left[\frac{Y(t)}{L(t)}\right] = \ln A(t) - \frac{\alpha+\beta}{1-\alpha-\beta}\ln(n+g+\delta) + \frac{\alpha}{1-\alpha-\beta} lns_k + \frac{\beta}{1-\alpha-\beta} lns_h,$$

where *n* is growth in the labor force, *g* is technological progress, δ is the depreciation rate of fixed capital stock, s_k is the fraction of income invested in fixed capital, and s_h is the fraction of income invested in education.

Technological progress is determined by the following ideas production function (Ulku, 2007; Peretto and Valente, 2011;Venturini, 2012a, b):

$$(3) \qquad g_A = \left(\frac{\dot{A}}{A}\right) = \lambda \left(\frac{X}{Q}\right)^{\sigma} A^{\phi-1}, \quad 0 < \sigma \leq 1, \ \phi \leq 1, \ \ Q \propto L^{\eta} \text{in steady state,}$$

where *X* is R&D researchers, *Q* is product variety, *L* is employment or population, λ is a research productivity parameter, σ is a duplication parameter (0 if all innovations are

duplications and 1 if there are no duplicating innovations), ϕ is returns to scale of knowledge, and η is the coefficient of product proliferation. The ratio X/Q is referred to as research intensity.

This ideas production function extends first-generation models of knowledge production to allow for product proliferation and decreasing returns to knowledge stock, as highlighted in second-generation models of economic growth (see Aghion and Howitt, 2006; and Peretto, 1998). R&D expenditure is divided by product variety following the Schumpeterian paradigm in which R&D spreads more thinly across the variety of products as the economy expands. Since, in steady state, product variety is growing at the same rate as population or the labor force, it follows that the growth rate of knowledge, g_A, cannot increase in response to an increase in the number of researchers that keeps the number of researchers in fixed proportion to population.

Extending the knowledge production function to allow for the influence of inequality yields:

$$g_A = \lambda \left(\frac{X}{Q}\right)^{\sigma} \Phi^{\pi} A^{\phi-1}, \tag{4}$$

where Φ is income inequality and π is a constant. It follows from equation (4) that research intensity and inequality have only permanent growth effects if there are scale effects in ideas production, i.e., $\phi = 1$.

Equations (2) and (4) show that inequality can influence productivity growth through the four principal saving channels considered in this paper and the conditions under which inequality has temporary or permanent growth effects. Inequality-induced national saving, investment and education influence growth through the production function, equation (2), while inequality-induced R&D feeds through to growth through ideas production, equation (4). Temporary growth effects can be expected from the investment and schooling channels, given that they transmit to output through the production function under the assumption of diminishing returns to physical and human capital. Inequality will only have permanent growth effects if it affects ideas production and if there are constant returns to knowledge stock.

2.1 Imperfect capital markets, inequality and saving

Until relatively recently, inequality was thought to promote saving through higher expected returns on investment. However, this hypothesis has recently been challenged and the literature is increasingly focusing on the adverse saving and investment effects of inequality through

financial imperfections associated with credit rationing (Aghion and Bolton, 1997; Banerjee and Newman, 1993; Galor and Zeira, 1993; Piketty, 1997). Credit rationing implies that agents' initial wealth determines their ability to invest in education, fixed capital, and R&D. Furthermore, Banerjee and Newman (1993) show that inequality can also depress entrepreneurial activities in the presence of capital market imperfections and fixed costs associated with occupational choice; people opt to become workers rather than entrepreneurs. These effects are perpetuated by reduced savings options and saving facilities in financially underdeveloped economies, further inhibiting the poor from saving for future investment and gaining a record of financial prudence.

The less well-off are likely to be more affected by financial underdevelopment than the rich because they lack the means to finance education, fixed investment, and R&D; investments that are often indivisible and associated with large sunk costs (Galor and Zeira, 1993). Furthermore, they are less likely to have wealthy families from whom to borrow or rely upon for future inheritance as collateral (Piketty, 1997, 2014; Aghion *et al*., 1999). Higher initial inequality may also stimulate low-income entrepreneurial demand for credit and thereby increase interest rates. The resulting higher borrowing costs then become further obstacles to new investment, particularly inhibiting the poor from accumulating physical capital (Aghion and Bolton, 1997; Piketty, 1997). Consequently, redistribution of wealth from the rich to the poor can augment the long-term growth rate by increasing the relative proportion of agents that can undertake indivisible investment projects.

Inequality may, particularly, result in under-investment in schooling if the interest rate for borrowers is significantly higher than for lenders (Galor and Zeira, 1993). Lenders generally accept physical capital rather than human capital as collateral against loans. Therefore, in the presence of borrowing constraints, the adverse effect of income inequality will be more prominent on human capital formation than physical capital. Publicly provided education may partly alleviate these effects. However, as shown by Checchi and García-Peñalosa (2004), students face the risk of failing to complete their education, a risk against which there is no formal insurance. Parents' wealth provides insurance against this risk, explaining why socioeconomic disadvantaged groups tend to be underrepresented in tertiary education even in countries with free tertiary education and scholarships for all (e.g., Denmark and Australia).

In summary, the theoretical literature predicts that financial underdevelopment compounds the growth effects of inequality. Large impoverished populations may find it difficult to move out of poverty because they are prevented from reaching their educational and inventive potential and, consequently, the economy's growth potential remains unexploited. In perfectly

functioning financial markets, by contrast, all individuals invest their optimal amount of capital, and the poor, whose initial wealth prevents them from reaching the optimal amount of investment, are able to borrow from the rich. This means that the saving effects of inequality are dependent on financial development. Consequently, regressions that do not condition the saving effects of inequality on financial development may fail to capture the genuine growth effects of inequality. This may well be one reason for the conflicting findings on the growth effects of inequality. It is, therefore, crucial to allow for interactions between financial development and inequality in savings and growth regressions.

2.2 Model specifications

We investigate the effects of inequality on saving, conditional on financial development, by estimating the following models:

$$(5) \quad S_{it}/Y_{it}^{n} = \alpha_0 + \alpha_1\Phi_{it} + \alpha_2\Psi_{it} + \alpha_3(\Phi\Psi)_{it} + \alpha_4 Age_{it} + \alpha_5 r_{it} + \varepsilon_{1,it},$$

$$(6) \quad ln\left(\frac{I_{it}}{Y_{it}}\right) = \beta_0 + \beta_1\Phi_{it} + \beta_2\Psi_{it} + \beta_3(\Phi\Psi)_{it} + \beta_4 \ln q_{it} + \varepsilon_{2,it},$$

$$(7) \quad GER_{it} = \gamma_0 + \gamma_1\Phi_{it} + \gamma_2\Psi_{it} + \gamma_3(\Phi\Psi)_{it} + \gamma_4 e_{it}^{10} + \varepsilon_{3,it},$$

$$(8) \quad \ln Pat_{it} = \varphi_0 + \varphi_1\Phi_{it} + \varphi_2\Psi_{it} + \varphi_3(\Phi\Psi)_{it} + \varphi_4 ln\, Pat_{it}^{s} + \varphi_5 ln(R/Y)_{it} + \varepsilon_{4,it},$$

where S is gross private saving, Y^n is nominal GDP, Y is real GDP, Φ is income inequality, Ψ is financial development, *Age* is the age dependency ratio defined as the fraction of the population outside working age (higher than 65 and younger than 15), r is the real interest rate measured as the interest rate on long-term government bonds minus the contemporaneous inflation rate, I is real non-residential gross investment, q is Tobin's q, *GER* is the gross enrollment rate, the fraction of the school age population that is enrolled in primary, secondary and tertiary schooling, e^{10} is life expectancy at age 10, *Pat* is patent applications by domestic residents, Pat^s is the patent stock, *R/Y* is the domestic R&D intensity measured by the ratio of R&D expenditures to GDP, and ε is a random error term. Subscripts i and t refer to country i and year t. Time and country dummies are included in all regressions to account for unobserved country specific factors and shocks that affect all OECD nations, such as wars and the Great Depression. The saving rate in equation (5) is not in logs because saving rates are sometimes negative (for example during WWI in many countries and Greece before 1952).

Equation (5) is a standard life-cycle saving model in which saving is a negative function of age dependency and a positive function of the real interest rate. Equation (6) is a standard Tobin's *q* investment model where Tobin's *q* is a sufficient variable to explain the investment ratio. However, the benchmark level of *q* at which investment is undertaken exceeds one for credit and demand constrained firms and under increasing uncertainty (Dixit and Pindyck, 1994). Thus, inequality influences investment beyond Tobin's *q*, to the extent that it affects investment uncertainty and credit constraints.

GERs, equation (7), are assumed to be a positive function of life expectancy at schooling age. Schooling depends on life expectancy at the age at which the student enters secondary and tertiary education and not life expectancy at birth because the expected returns from schooling are positively related to life expectancy at the age at which the decision for secondary schooling is made. Crucially, *GER* is used as dependent variable as opposed to educational attainment of the working age population because it reflects schooling at the time when the schooling decisions are made.

3. Core identification strategy

It is necessary to instrument inequality because there are several channels through which the outcome variables (broadly savings) affect inequality.[2] We propose external communist influence as a new instrument for inequality. Our argument is that foreign communist influence resulted in income redistribution within the OECD. It was historically influential for workers' wage claims and led to wage, welfare, and redistribution concessions from governments and elites. Increasing wage claims tend to reduce income inequality because of the strong direct link between income inequality and labor's share and because the wage effect almost certainly exceeds the employment effect in standard union models (Bentolila and Saint-Paul, 2003; Blanchard and Giavazzi, 2003; Piketty, 2015).[3] Similarly, expansion of welfare provisions and

[2] For example, Acemoglu *et al*. (2001) argue that inequality is fundamentally caused by skilled biased technical change. This implies that ideas production will impact directly on inequality. Saving will also widen inequality, through Piketty's (2014) second law in which the income share of capital, S^K, is driven by the relationship $S^K = r\, s^n/g$, where r is the rate of return on capital, s^n the net saving rate and g the income growth rate. From this equation it follows that an increase in the saving rate increases income inequality as it increases net income from wealth, provided that r is not too responsive to an increase in the capital-output ratio.

[3] In right-to-manage and the efficient-bargain union bargaining models, unions set wages and firms choose employment conditional on wages (Bentolila and Saint-Paul, 2003). Increasing wages increases labor's share in the right-to-manage model if the elasticity of substitution between labor and capital is below one, because it is difficult to substitute capital for labor; thus labor's income share does not diminish in response to wage increases (Blanchard and Giavazzi, 2003; Bentolila and Saint-Paul, 2003). Labor's share unambiguously increases in

direct transfers, changes in working conditions, and increased worker representation all affected inequality.

Changes in social norms have strong impacts on labor markets and these changing norms often travel across economies (Atkinson, 1997; Gaston and Rajaguru, 2009). Gaston and Rajaguru (2009), for example, find that the increasing inequality in Australia since 1970 resulted from global de-unionization. Gassebner *et al*. (2011) argue that policy reforms are transmitted internationally through a domino-effect and find that economic reforms are transmitted internationally through geographic and linguistic proximity rather than through trade. Emulation is an important process in public policy (Gilardi, 2010). Thus, strategies that successfully diminish or neutralize communist influence, such as redistribution policies are likely to be emulated.

Revolutions often result from general discontent that is kept dormant until a significant event triggers an outburst (Weyland, 2010, 2014). For example, Weyland (2009) gives a fascinating taxonomy of how France's Louis Philippe's fall in 1848 was decisive for sparking the revolutionary wave across Europe and Latin America. The "event instilled consternation and fear in the established authorities, gave enormous encouragement to reformists and revolutionaries, and unleashed a groundswell of enthusiasm and hope" (Weyland, 2009, p. 395). Discontented sectors all over Europe and parts of Latin America took inspiration from the surprisingly easy overthrow of the French king. Similarly, the downfall of Tunisia's autocrat provided the impetus for the 'Arab Spring' uprising of early 2011. The issue here is not the ultimate success or otherwise of these revolutions but their spread across national borders. Moreover, this is not to deny that idiosyncratic factors or external military threat also play a major role.

Why does zeitgeist travel internationally to cultural neighbors? Several hypotheses have been advanced from a sociological and behavioral perspective. Two relevant sociological theories are normative promotion and cognitive heuristics (Dobbin *et al*., 2007; Weyland, 2009, 2010). Normative promotion theory suggests that waves of regime change result from new norms, ideologies, and ideas that spread from core countries to the periphery. Important actors in periphery nations seek to enhance their legitimacy and, consequently, keenly embrace the new international norms and modify their behavior accordingly. As modern values spread

response to increased workers' bargaining power in the efficient bargain model (see Bentolila and Saint-Paul, 2003) because the elasticity of substitution between labor and capital is most likely below one (Chirinko, 2008).

internationally, old elites may face new challenges to their rule, or they may absorb the novel norms and start regime transitions out of their own initiative.

According to cognitive heuristics theory, decision making is influenced disproportionately by drastic, striking, intense, and directly witnessed events, while equally relevant but less stunning information is neglected (Dobbin *et al*., 2007; Weyland, 2009, 2010). These heuristics focus attention to certain experiences and filter out irrelevant ones. It follows that striking and vivid events in neighboring countries often have a disproportionate stronger impact on peoples' emotions and attention than cautious rational learning justifies. Intense, drastic events can unleash waves of emotions, such as indignation, euphoria, or anger; and apparent success highlighted by events in other countries can stimulate hope and enthusiasm.

Experimental evidence shows that several of these emotions render people risk-acceptant, thus boosting their willingness to challenge unjust regimes (Druckman and McDermott, 2008). "The emotions unleashed by other countries' experiences thus reinforce people's tendency to deviate from rational demands of prudence and engage in dangerous protests, propelling regime contention farther than careful cost-benefit calculations advise" (Weyland, 2009, p. 401). Events in foreign countries hold special sway in situations of heightened uncertainty, such as during revolutions and regime transitions, when new opportunities are unleashed and players' actions and reactions are impossible to foresee.

Another factor is preference falsification. Kuran (1997) argues that revolutions in other comparable countries provide a mechanism by which to evaluate the level of hostility against the ruling regime. People may be reluctant to express revolutionary ideas because it is unclear how many others share similar ideas; this is particularly problematic under repressive regimes. However, a revolution elsewhere serves as both an example to emulate and provides information on resistance against prevailing regimes. This becomes more potent as cultural and economic similarity rises between countries.[4]

There are several examples of how news about revolutions abroad served as a rally call and as inspiration for local revolutionaries in cultural neighboring countries. For example, at the international level, workers started to organize from the middle of the 19th century. Events such as the First International (1864-1876), the Second International (1889-1916), and the Third International (1919-1943), underscore the increasing internationalization of the labor movement during the Second Industrial revolution. Furthermore, there have been four great

[4] Revolts can also be viewed as a network externality: the more people are involved with mass political action, the greater the interest in that action and benefits of joining it. A case in point is the wave of anti-colonial conflicts across numerous countries.

waves during which labor movements in today's OECD countries gained strength during the 20th century: the years surrounding 1910; 1916-1920; 1945-1950; and 1968-1978. The 1916-1920 and 1945-1950 waves were particularly inspired by transitions to communist regimes in several European and Asian countries. The last wave at which labor strength gained momentum was in the 1970s. This is often attributed to increasing pro-labor movements across the advanced countries and was signified by a new wave of strikes and labor unrest (Bruno and Sachs, 1985).

The Bolshevik-led Russian Revolution gave the impetus of the worldwide syndicalist successes in the wave of labor unrest following WWI and resulted in syndicalist-lead strikes across Europe and Latin America (Collier, 1999). The 'heightened working-class pressure in Germany, Belgium, Sweden and Finland was surely activated as much by the Russian Revolution as by World War I. From the side of the working class, what perhaps changed most was not the greater force of its pro democratic agitation, but the revolutionary rather than the democratic example of the Russian Revolution' (Collier, 1999, p. 78).

Similarly, several countries adopted communism immediately after WWII. While most of these transitions were imposed by the Soviet Union, some countries adopted the Soviet Union model more voluntarily such as Yugoslavia (Collier, 1999). At the same time, communist inspired forces began fighting the French colonial government in Indochina and other anti-colonial struggles emerged in Africa. Moreover, communist governments gave ideological support to movements elsewhere and at times also financial support (and in some cases military support, though not for the OECD nations in the sample).

The worldwide spread of communism was a tangible and credible threat and ruling elites and employers' concessions to improve workers' relative and absolute standard of living, and mitigate their various grievances, were one practical, effective and potentially lower cost option to stem the spread of communism; repression was in some cases an alternate and often complementary policy option (e.g., banning communist parties). Furthermore, policy reforms that led to substantial reductions in annual working hours, introduction or improvements in unemployment insurance, increasing minimum wages, and increasing pensions were undertaken (Acemoglu and Robinson, 2000). Elsewhere, land and other reforms were initiated as a pre-emptive move against communist threat, e.g., in Taiwan and South Korea, the primary motivation for land redistribution was to reduce communist threat. All these factors substantially improved worker's relative and absolute welfare. At the same time, labor movements and socialist parties and organizations also lobbied for policy changes, such as

greater welfare provisions, and issues of justice, anti-discrimination and inequality took center stage in political discourse and action.

None of the countries in our sample were communist, though some did have communist parties with significant electoral support, e.g., France, Italy and Greece. The communist influence IV considers only communist influence external to the country.

3.1 Weighting scheme

Foreign communist influence, Lab^{Com}, facilitated by linguistic distance, as a proxy for cultural distance, from country *j* to country *i* (OECD countries) is constructed as follows:

$$(9) \qquad Lab_{it}^{Com} = \frac{\sum_{j=1}^{111}\left(Pop_{ijt}D_{jt}^{Com}/Dis_{ij}^{Lin}\right)}{\sum_{j=1}^{111}\left(Pop_{ijt}/Dis_{ij}^{Lin}\right)},$$

where

$$(10) \qquad Dis_{ij}^{Lin} = 1 - \left\{\frac{\omega_{ij}}{[0.5(\omega_j+\omega_i)]}\right\}^{\lambda};$$

Dis^{Lin} is linguistic distance, D^{Com} is a communist dummy variable taking the value of 1 if the government is communist and zero otherwise, *Pop* is the size of the population, ω_{ij} is the number of common nodes between country *i*'s and *j*'s languages, ω_j (ω_i) is the number of nodes in the main language spoken in country *j* (*i*), and λ is a scaling parameter which we set to 0.5 following Fearon (2003).

The intuition behind equation (10) is that the labor movement in country *i* is influenced by communist regimes in other countries; the 111 countries for which data are available (approximately 95% of the world population). Communist influence is an increasing function of: 1) the number of countries that are formally ruled by communist government; 2) the more populous the communist country is; and 3) the linguistically closer country *i* is to a country *j* under communist rule. Communist influence is weighted by linguistic distance where linguistic distance is used as a proxy for cultural distance. Cultural/linguistic distance gives a more plausible account of the spread of political ideas than geographic proximity as discussed at length above. For example, Australia and New Zealand, at least until recently, have been politically, culturally and linguistically closer to Europe than to the geographically closer countries of South East and East Asia. Canada and the USA are culturally closer to many

European countries than to Latin America, and so forth. Social movements in one country often flow to culturally similar neighboring countries because they share common values.

3.2 Backdating the communist influence index from 1917

A challenge in the construction of the communist influence instrument is that no country in the world was under communist governance prior to 1917 and yet the labor movement was gaining strength in the West already from the mid-19th century, partly drawing inspiration from Marx and Engels's 1848 *Manifesto of the Communist Party*. The increasing strength of the labor movement was signified by increasing strike activity, unionization, formation of labor, socialist and communist parties, and increasing parliamentary vote share of left-wing political parties, and communist revolts such as the Paris commune in 1871, the rebellion against Tsarist Russia in 1898 (Andican Uprising), and the 1905 Russian Revolution against Tsar Nicholas II. Consequently, we backdated communist influence over the period 1870-1917 using foreign union influence in which unionization (union members divided by economy-wide employment) is used instead of D^{Com} in equation (9) and the data are spliced with Lab^{Com} in 1917. According to union bargaining models, unionization has be found to be the most significant determinant of union strength derived (see McDonald and Suen, 1992).

Several studies have established that unions can have a profound impact on income distribution and inequality (Blanchard and Giavazzi, 2003; Checchi and García-Peñalosa, 2010). There are several mechanisms through which this might occur. First, unions can compress incomes by increasing the pay of the unskilled relative to the skilled. Second, beyond increasing members' wages, unions have often also been instrumental in increasing the minimum wage, which can also have a redistributive impact (Checchi and García-Peñalosa, 2010). Third, unions usually support left-wing and social democratic governments, which tend to implement policies that reduce inequality. Fourth, unions seek to extract some of the firm's rents or share rents with firms (Blanchard and Giavazzi, 2003).

3.3 Exclusion restriction

The exclusion restriction for our identification strategy is satisfied if: communist influence affects saving only through inequality and if communist influence is *not* driven by external forces that are common for all countries. In our view these conditions hold. First, communist influence is unlikely to influence savings through channels other than inequality because

communist influence, to the best of our knowledge, has not been considered as an explanatory variable in models of saving and investment in physical capital, R&D and education, and, at least not thus far, been considered as important for our outcome variables. Importantly, however, in the event that communist influence impinges on expected returns, which is a common determinant of the saving variables, the results will be biased in the direction opposite to our findings. To see this, assume that the expected returns to savings are reduced by increasing wages induced by increasing communist influence. This simultaneously leads to lower saving/investment and lower inequality; thus establishing a positive relationship between saving and inequality, which is opposite to the finding in this paper. Consequently, the results in this paper, if anything, will be conservative. Furthermore, if communist threat reduces savings through heightened uncertainty, it will likely be because savers/investors fear that their expected returns will be reduced through higher real wage claims.

It is also unlikely that communist influence is driven by external forces that are common across countries. A possibility is that gradually accumulating problems caused by industrialization suddenly reach a critical breaking point. However, this argument runs the risk of retrodiction and communist regime changes occurred across countries at different levels of development. As discussed by Weyland (2010), revolutions that lead to regime changes are rarely due to common causes alone. Furthermore, the choice of cultural weights in the weighting scheme will minimize the influence of non-communist external forces that are common across countries. If, alternatively, geographic distance was used as weights, it cannot be excluded that economic development in one country spills over to affect its geographic neighboring countries through channels other than inequality; e.g., a neighboring country's inequality can influence domestic income via unobserved spatial spillover effects and other confounding factors that are likely to be correlated with the error terms in the structural regressions.

4. Data

The income inequality data used in this paper are the post-tax, post-transfer Gini coefficient (Gini) and pre-tax top 10 percent income shares (Top10) for 21 high income OECD countries over the period 1870-2011. The 21 OECD countries are: Australia, Austria, Belgium, Canada, Denmark, Finland, France, Germany, Greece, Ireland, Italy, Japan, Netherlands, New Zealand, Norway, Portugal, Spain, Sweden, Switzerland, the United Kingdom, and the United States. The data are backdated and interpolated using functional income shares in which the income

of self-employed own labor has been computed as wage income, to obtain a balanced panel spanning the years 1870-2011, as detailed in Islam and Madsen (2015). De La Escosura (2008) shows that capital's share and inequality were histrorically strongly positively related because labor received very little capital income and workers were income-wise more homogenous before WWII than they are today.

Gini and Top10 are used as complementary measures of inequality since their coverage differs across time and space; some of the Gini data goes back to 1870 while most of the Top10 data commences in the early 19th hundreds and Top10 is available back in history for some countries for which the Gini is not. Furthermore, while Gini has the advantage of covering the entire spectrum of the income distribution, the Gini data based on surveys often miss out the extremely high incomes (Atkinson *et al.*, 2011). This is not the case for our historical Gini data, most of which is derived from population censuses and, therefore, are not biased because of the exclusion of the extremely rich; this is particularly a problem in survey-based Gini estimates for non-OECD countries. A potential downside associated with the Top10 income shares is that they miss out the low-income brackets. However, since income distributions tend to follow the Pareto distribution (Piketty, 2015), changes in the income distribution of the Top10 should automatically change the distribution of income across the entire distributional spectrum.

The log of Tobin's q is measured as the deviation of the log of real share prices from a linear time trend, where stock prices are deflated by the GDP deflator. The trend is removed from stock prices to filter out the influence on stock prices of accumulated retained earnings per share. It can be shown that real stock prices increase over time only because of retained earnings that are reinvested in the company. If companies do not retain earnings, real stock prices would collapse to Tobin's q (see, for exposition, Madsen and Davis, 2006). Under the assumption that the retention ratio and stock returns are both relatively constant, the log of real stock prices will fluctuate around a linear trend and the deviation of the log of stock prices around this trend will reflect the log of Tobin's q. Empirically, Barro (1990) finds that the deviation of real stock prices from their trend is a good approximation of Tobin's q.

GER is measured as the weighted sum of primary, secondary and tertiary GERs, where the weights are the number of years at each educational level. The GER at each level is measured as the number of students enrolled divided by the population in the age groups of each level. Private saving is measured as the sum of total fixed investment and the current account on the balance of payments minus public savings, where public saving is the surplus on the government's primary balance net of interest payments on government debt. Domestic stock

of knowledge, Pat^s, is computed using the perpetual inventory method for patent applications with a depreciation rate of 15%. Financial development, Ψ, is measured as bank credit to the non-bank private sector divided by nominal GDP. The credit-GDP ratio is used in the benchmark estimates because it ultimately measures the most important function of the financial system, namely lending (Madsen and Ang, 2016). Credit encompasses lending by commercial banks, savings banks, postal banks, credit unions, mortgage banks, insurance companies and building societies, to households and the non-financial corporate sector at the end of the year. Details of the data sources and their definitions are listed in the Online Appendix.

The unweighted averages for all 21 OECD countries of the Gini coefficient and communist influence are displayed in Figure 1. Figure 1 illustrates an overall inverse relationship between income inequality and external communist influence, indicating that communist influence may be sufficiently strongly correlated with the Gini to act as a powerful instrument; this is confirmed formally below by *F*-tests for the excluded instrument. The increasing inequality in the post-1980 period is associated with the downfall of the Eastern European block and the collapse of the Soviet Union.

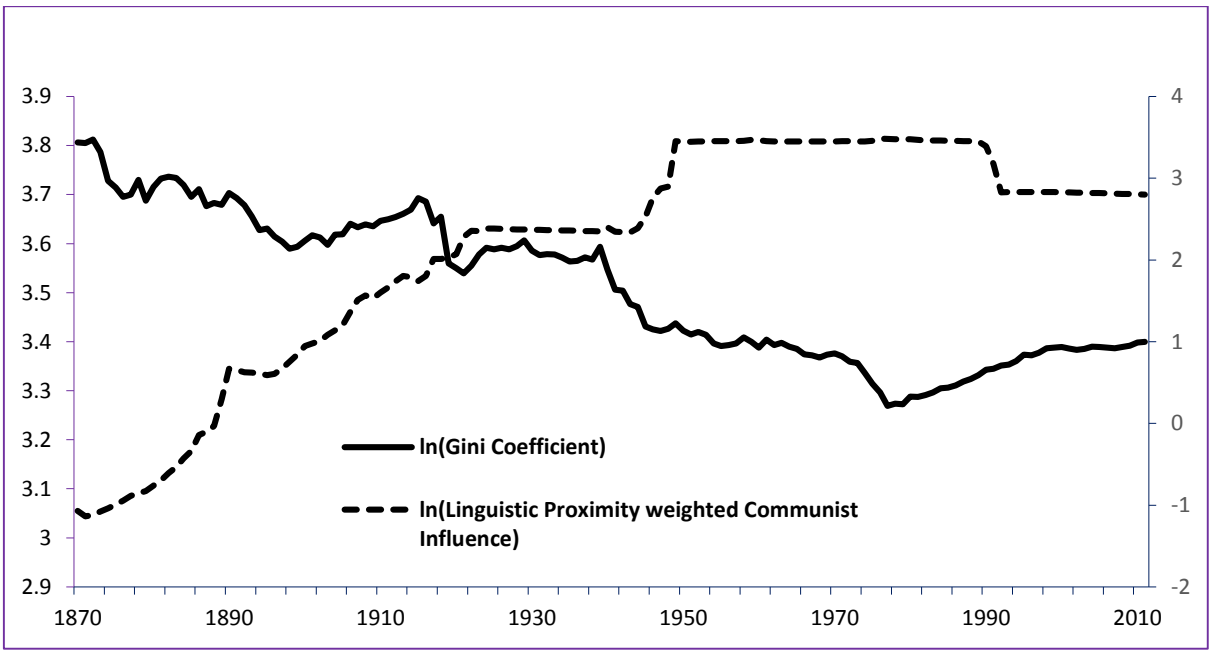

FIGURE 1. TRENDS IN GINI COEFFICIENT VERSUS LINGUISTIC PROXIMITY WEIGHTED COMMUNIST INFLUENCE IN OECD COUNTRIES, 1870-2011

Note: The figures are unweighted averages of 21 OECD countries.

5. Results

5.1 Unconditional estimates

OLS bivariate regressions are presented in the top panel of Table 1. Inequality has mixed effects on the outcome variables. While the coefficient of inequality on ideas production is significantly negative, the significance and sign of inequality on the other outcome variables is sensitive to the measurement of inequality (Gini or Top 10%). The divergent results suggest measurement errors, potential endogeneity problems, or model misspecification due to omitted variable bias, e.g., not allowing for the interaction between inequality and financial development.

Reverse causality is likely, as saving, investment, and patenting widen inequality. For example, Krusell *et al*. (2000) argue that investment in machinery and equipment are a strong indicator of skill-biased technological progress and consequently growth in these investments increases inequality. Patenting is also likely to lead to increasing inequality because it is complementary to fixed capital stock. Therefore, the coefficients of inequality will be biased upwards in OLS regressions due to the marked increase in saving and investment rates and the associated proliferation in investment in machinery and equipment in OECD countries since 1870.

TABLE 1 - UNCONDITIONAL ESTIMATES OF THE EFFECTS OF INEQUALITY ON TRANSMISSION CHANNELS, 21 OECD COUNTRIES OVER THE PERIOD 1870-2011

	Inequality = Gini coefficient				Inequality = Top 10% income shares			
	S/Y	ln(I/Y)	GER	lnPat	S/Y	ln(I/Y)	GER	lnPat
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
				OLS				
Inequality	-0.011	0.015***	0.040	-0.028***	0.098***	0.007***	-0.235***	-0.020***
	(0.022)	(0.001)	(0.037)	(0.003)	(0.029)	(0.002)	(0.035)	(0.004)
				IV-2SLS - Second Stage Regressions				
Inequality	-1.875***	-0.079***	-4.028***	-0.444***	-3.024***	-0.127**	-6.496***	-0.717***
	(0.428)	(0.025)	(0.777)	(0.090)	(1.150)	(0.059)	(2.187)	(0.267)
				IV-2SLS - First Stage Regressions				
$Communist_{it}$	-0.192***	-0.192***	-0.192***	-0.192***	-0.119***	-0.119***	-0.119***	-0.119***
	(0.039)	(0.039)	(0.039)	(0.039)	(0.043)	(0.043)	(0.043)	(0.043)
F-statistic	24.700	24.700	24.700	24.700	7.830	7.830	7.830	7.830
Endog(*p-val*)	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Observations	2982	2982	2982	2982	2982	2982	2982	2982

Notes: The numbers in parentheses are robust standard errors. Inequality is instrumented by linguistic proximity weighted communist influence index (Communist). Constants, country and time dummies are included in all regressions but their coefficients are not reported for brevity. *F*-statistic is an *F*-test for excluded instruments. *Endog* is a Hausman-Wu test for endogeneity of inequality in the regressions. The following transmission channels of inequality are considered as the dependent variable: (i) the ratio of private savings to GDP (S/Y), (ii) the ratio of non-residential investment to GDP (in logs) (ln(I/Y)), (iii) the combined primary, secondary and tertiary school gross enrolment rate (GER), and (iv) the number of patent applications by domestic residents (in logs) (lnPat). ***Significant at the 1 percent level. **Significant at the 5 percent level. *Significant at the 10 percent level.

Unconditional IV regressions are presented in the last two panels in Table 1. Communist influence has the expected negative sign in the first-stage regressions. The *F*-test for excluded instruments in the first-stage regressions is 25 in regressions with inequality measured by the Gini, suggesting that the maximum bias in the IV estimators in these regressions is well below 5%. The *F*-test is 8 in the regressions with inequality measured by Top 10%, suggesting that the maximum bias in the IV estimators is close to 7%. As shown in the next sub-sections, the *F*-test increases substantially when financial development and its interaction with income inequality is included in the regressions.

Inequality is highly statistically significant in the second stage regressions, suggesting that inequality is detrimental for growth through all channels considered here. Economically, however, the coefficients are implausible. For saving, the estimated coefficient of Gini is -1.88, implying that the 15 percentage point decline in the average Gini in the OECD over the period 1870-1976 resulted in a 28.8 percentage point increase in the saving rate. The corresponding responses to the decline in inequality are increases of 13.3 (elasticity × 15 × average investment rate) percentage points for fixed investment, 60.4 percentage points for GERs, and a 6.66% increase in the number of patents (patents is a special case as argued below). Thus, declining inequality can explain most of the increase in saving, investment and the GER over the period 1870-1976, which we find implausible. However, estimates become more plausible when the interaction between financial development and inequality, and other control variables are introduced in the regressions.

The moderating role of financial development

Financial development and its interaction with inequality are included in the regressions in Table 2. The *F*-tests of the excluded instrument exceed 39 in the first-stage regressions in all cases, reinforcing the finding above that communist influence is potentially a very strong instrument for income inequality. The coefficients of inequality are highly statistically significantly negative in all cases regardless of measurement of inequality. Furthermore, the coefficients of the interaction terms are all significantly positive.

These results suggest that the outcome variables are negatively affected by inequality at low levels of financial development and positively affected by inequality at high levels of financial development, as predicted by theory. Saving, for example, is reduced by inequality for credit-income levels below 92% and enhanced by increasing inequality beyond this level. The exact relationship between inequality and the outcome variables at different levels of financial

development is simulated and discussed in Section V below. For now, however, it is important to point out that the coefficients of inequality in the regressions in Table 2 are approximately of the same magnitude as their counterparts in Table 1. Since the coefficients of interaction terms are all positive and quantitatively quite high, the effects of changes in inequality on the outcome variables are reduced substantially, as shown in the next sub-section.

Finally, the coefficients of the credit-income ratio are also significantly negative, which in conjunction with the positive coefficient of the interaction term suggest that financial development has an adverse effect on growth at low levels of inequality. However, the positive interaction effect implies that financial development has larger positive effects on the outcome variables the more unequal a society is. For a high Gini, for example, the economy has a lot to gain from financial development because the pool of low income people has more to gain, in terms of the outcome variables, from gaining access to financial services.

TABLE 2 - UNCONDITIONAL ESTIMATES OF THE EFFECT OF INEQUALITY AND FINANCIAL DEVELOPMENT ON TRANSMISSION CHANNELS

	Inequality = Gini coefficient				Inequality = Top 10% income shares			
	S/Y	ln(I/Y)	GER	lnPat	S/Y	ln(I/Y)	GER	lnPat
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
IV-2SLS Second Stage Regressions								
$Inequality_{it}$	-1.830***	-0.068***	-4.095***	-0.429***	-1.964***	-0.072***	-4.384***	-0.460***
	(0.348)	(0.019)	(0.596)	(0.071)	(0.383)	(0.020)	(0.658)	(0.077)
$Credit_{it}$	-0.564***	-0.019***	-1.378***	-0.124***	-0.516***	-0.017***	-1.160***	-0.128***
	(0.113)	(0.006)	(0.191)	(0.022)	(0.108)	(0.005)	(0.175)	(0.020)
$Inequality_{it}$	0.017***	0.001***	0.040***	0.004***	0.016***	0.001***	0.036***	0.004***
$\times Credit_{it}$	(0.003)	(0.000)	(0.006)	(0.001)	(0.003)	(0.000)	(0.005)	(0.001)
IV-2SLS First Stage Regressions								
$Communist_{it}$	-0.193***	-0.193***	-0.193***	-0.193***	-0.180***	-0.180***	-0.180***	-0.180***
	(0.030)	(0.030)	(0.030)	(0.030)	(0.029)	(0.029)	(0.029)	(0.029)
F-statistic	40.230	40.230	40.230	40.230	39.270	39.270	39.270	39.270
Endog(*p-val*)	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Observation	2982	2982	2982	2982	2982	2982	2982	2982

Notes. See notes to Table 1. Financial development is measured by the ratio of domestic credit provided by banking sector to GDP (Credit).

5.2 Conditional estimates

The regressions in Table 3 extend the regressions in Table 2 with the inclusion of other determinants of the outcome variables, as specified in equations (5) to (8). The *F*-tests for excluded instruments in the first-stage regressions remain highly significant, confirming that inequality is sufficiently correlated with communist influence for this variable to act as a good instrument for inequality. Financial development and its interaction with inequality is included

in the regressions in columns (5) to (8) but excluded from the regressions in columns (1) to (4). Inequality is measured by the Gini in the regressions presented in the reminder of the paper to preserve space. The results remain intact when inequality is measured by top 10% income shares; these results are presented in Table A1 in the Online Appendix.

The coefficient of age dependency is significantly negative in the saving functions in columns (1) and (5), consistent with the predictions of the life-cycle hypothesis in which individuals dis-save outside their working-age. The coefficients of the real interest rates are significantly positive, indicating that the substitution effect exceeds the income effect in saving. The coefficients of Tobin's *q* are significantly positive in the investment regressions in columns (2) and (6) and their magnitude indicates large investment adjustment costs. In the GER regressions, columns (3) and (7), the coefficients of life expectancy are, unexpectedly, negative; perhaps this arises because life expectancy is heavily influenced by mortality rates beyond working age which should not influence the schooling decision.

TABLE 3 - CONDITIONAL ESTIMATES OF THE EFFECT OF INEQUALITY AND FINANCIAL DEVELOPMENT ON TRANSMISSION CHANNELS

	IV-2SLS (Conditional)				IV-2SLS (Conditional & Financial Development)			
	S/Y	ln(I/Y)	GER	lnPat	S/Y	ln(I/Y)	GER	lnPat
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Second Stage Regressions								
$Gini_{it}$	-1.601***	-0.079***	-4.679***	-0.029***	-1.303***	-0.069***	-4.667***	-0.030***
	(0.419)	(0.025)	(1.002)	(0.008)	(0.266)	(0.019)	(0.746)	(0.007)
Age_{it}	-0.326***				-0.444***			
	(0.053)				(0.039)			
r_{it}	1.863***				1.356***			
	(0.238)				(0.138)			
lnq_{it}		0.124**				0.090**		
		(0.053)				(0.042)		
e^{10}_{it}			-0.735***				-0.681***	
			(0.264)				(0.189)	
$lnPat^{s}_{it}$				0.953***				0.956***
				(0.008)				(0.007)
$ln(R/Y)_{it}$				0.094***				0.048**
				(0.031)				(0.020)
$Credit_{it}$					-0.339***	-0.019***	-1.540***	-0.009***
					(0.084)	(0.006)	(0.235)	(0.002)
$Gini_{it} \times Credit_{it}$					0.011***	0.001***	0.046***	0.0003***
					(0.002)	(0.000)	(0.007)	(0.000)
First Stage Regressions								
$Communist_{it}$	-0.171***	-0.192***	-0.191***	-0.215***	-0.196***	-0.193***	-0.193***	-0.204***
	(0.039)	(0.039)	(0.042)	(0.036)	(0.030)	(0.030)	(0.032)	(0.029)
F-statistic	19.390	24.650	20.570	34.850	41.280	40.380	35.140	50.020
Endog(*p-val*)	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Observation	2982	2982	2982	2982	2982	2982	2982	2982

Notes: Income Inequality is measured by the Gini coefficient (Gini). Control variables include (i) age dependency ratio (Age), (ii) Tobin's *q* (in logs) (lnq), (iii) life expectancy at age 10 (e^{10}), (iv) domestic patent stock (ln Pat^{s}), and (v) domestic research intensity (ln(*R&D*/*Y*)). Financial development is measured by the ratio of domestic credit provided by banking sector to GDP (Credit). See also notes to Table 1.

Turning to the estimates of the ideas production functions in columns (4) and (8), the coefficients of research intensity, $R\&D/Y$, and patent knowledge stock, Pat^S, are statistically highly significant and have the expected signs. The positive coefficient on research intensity suggests that R&D increases the number of product lines and only enhances growth to the extent that it increases the fraction of GDP that is allocated to R&D, as predicted by Schumpeterian growth theory. The coefficient on knowledge stock is highly significant and are close to one, indicating the presence of scale effects in ideas production.

These results have two important implications. First, R&D intensity has permanent, or at least highly persistent, growth effects. Thus, productivity grows at a constant rate in steady state due to R&D, as long as R&D is kept to a constant fraction of GDP. Second, inequality has either permanent or close to permanent productivity growth effects – a result that is crucial because it implies that the findings of permanent growth effects of inequality found in some of the literature on inequality and growth are initiated from ideas production. That is, inequality has permanent growth effects because it influences ideas production directly and because of the presence of scale effects in ideas production. This result is important as it offers a solution to the paradox that inequality is often assumed to transmit to growth through the savings-investment channel in the literature despite investment being highly unlikely to have permanent growth effects due to diminishing returns to capital.

Regarding the main variables of interest, the coefficients of inequality and the interaction between inequality and financial development remain statistically highly significant and with the expected signs in all cases. Economically, the coefficient on inequality is also approximately the same magnitude as the regressions in Tables 1 and 2; the exception is the ideas production function regressions in which the absolute value of the coefficient on inequality is substantially lower. This result, however, is not surprising because the long-run effects of inequality on patenting are compounded over time by the knowledge stock. An increase in patenting induced by inequality increases the stock of knowledge, which in turn perpetuates the initial increase in patenting. Assuming that there is a scale effect in ideas production (i.e., the coefficient of knowledge stock is one), a 10 percentage points decrease in the Gini increases the number of patents by 0.30% every year, which compounds to very large effects in the long run.

Finally, the economic significance of inequality on the outcome variables is much more plausible when controls and, particularly the interaction between financial development and inequality, are included in the regressions. Setting the credit-income ratio equal to the average

of 38.6% over the period 1870-1976 and using the estimated coefficients in columns (5)-(8), the 15 percentage point decline in inequality over the period 1870-1976 resulted in a 13.1 percentage point increase in saving, a 5.10 percentage point increase in the investment ratio, and a 43.6 percentage point increase in GERs; numbers that are in a much more plausible range than the results from the simple bivariate IV-regressions.

6. Time-Variation of Elasticities

In this section we assess the economic significance of inequality on the four outcome variables by computing the outcome semi-elasticities of inequality. Average credit-income ratios are used to trace how the semi-elasticities have evolved since 1870. The semi-elasticities are computed as follows:

$$(11) \quad \eta_t^s = \frac{\partial s}{\partial \Phi} = \hat{\alpha}_1 + \hat{\alpha}_3 \Psi_t = -1.303 + 0.011\Psi_t$$

$$(12) \quad \eta_t^{I/Y} = \frac{\partial (I/Y)}{\partial \Phi} = \left(\hat{\beta}_1 + \hat{\beta}_3 \Psi_t\right) \overline{\left(\frac{I}{Y}\right)} = -0.760 + 0.0111\Psi_t$$

$$(13) \quad \eta_t^{GER} = \frac{\partial GER}{\partial \Phi} = \hat{\gamma}_1 + \hat{\gamma}_3 \Psi_t = -4.667 + 0.046\Psi_t$$

$$(14) \quad \eta_t^{Pat} = \frac{\partial ln(Pat)}{\partial \Phi} = \hat{\varphi}_1 + \hat{\varphi}_3 \Psi_t = -0.030 + 0.003\Psi_t,$$

where $s = S/Y^n$, and η_t^s, $\eta_t^{I/Y}$, η_t^{GER}, and η_t^{Pat} are the percentage point change in the saving rate, investment rate, GER, and patents, in response to a percentage point change in the Gini, respectively. The semi-elasticities are computed over time with the credit-income ratio estimated as the unweighted average of the credit-income ratio for the sample of the 21 OECD countries used in this study.

The semi-elasticities are illustrated in Figure 2, where the elasticities for GER have been divided by 5 and those of patents are multiplied by 30. The elasticities increase with financial development up to WWI, decline during and immediately after the two World Wars, and return to their 1913 level in the late 1960s. Figure 3 illustrates the relatively constant trend in the credit-income ratio during the approximate period 1913-1970. This was an outcome of increasing regulation of the financial markets (particularly during the Great Depression, where banks' reserve requirements increased dramatically), contraction of world trade that reduced the need for credit facilities, and uncertainty that constrained lending (Madsen and Ang, 2016). This lack of financial development during the period 1913-1970 constrained productivity

growth though inequality. However, the decline in inequality during the same period, reduced the proportion of the population that was credit constrained and, consequently, contributed to growth through the outcome variables considered here.

The marked post-1970 increase in the credit-income ratio has reduced the growth-abating effects of inequality as low-income groups have gained increasing access to credit facilities; this has in turn increased their opportunities to save, invest, innovate and further their education. The strong increase in the credit-income ratio has lately rendered the semi-elasticities positive and have changed the growth-inequality nexus from negative to positive. The investment elasticity switches from negative to positive in 1981/1982, while the other outcome variables switch later in the following years: GER in 1998/1999, patents in 2001/2002, and saving in 2004/2005.

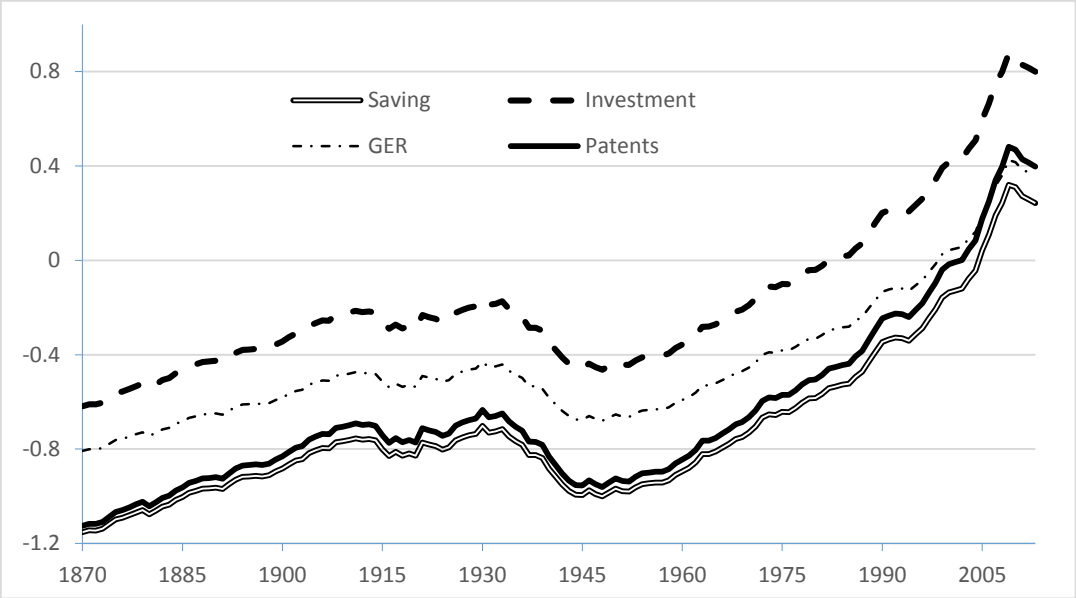

FIGURE 2. SEMI-ELASTICITIES OF OUTCOME VARIABLES WITH RESPECT TO INEQUALITY

Notes: The semi-elasticities for GER and Patents are divided by 5 and multiplied by 30, respectively.

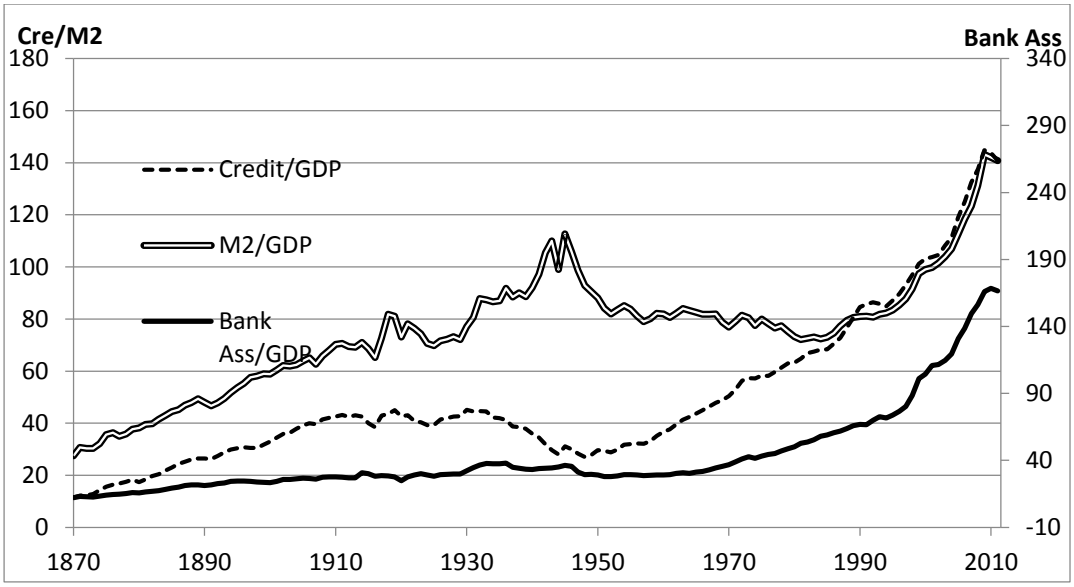

FIGURE 3. INDICATORS OF FINANCIAL DEVELOPMENT

Considering the individual outcome variables, education and ideas production are the most important channels through which inequality interacts with financial development to influence productivity growth. Although the semi-elasticity is small for patents, it is large in the long run because it has permanent growth effects, in contrast to the other outcome variables that only have productivity level effects. Thus, it is just a matter of time before ideas production overtake the output effects.

An important question is whether the finding that the absolute value of the inequality elasticities of GERs are approximately four times as large as those for saving translates to output effects. The model of Mankiw *et al*. (1992) given by equation (2) predicts that the productivity elasticity of the investment ratio, *I*/*Y*, equals $\alpha/(1-\alpha-\beta)$, and that of GER equals $\beta/(1-\alpha-\beta)$, where α is capital's factor share and β is the share of income accruing to human capital. Mankiw *et al*. (1992) argue that α is about a third, while β is between a third and a half. Thus, from this perspective, the productivity effect of inequality through education is likely to be a multiple of saving and fixed investment. Education has an even stronger effect on productivity if the social returns to education exceed private returns, which appears to be the case (see, for example, Madsen, 2014).

7. Conclusions

Inequality is a persistent issue. The consequences of inequality on growth remain unclear and the empirical evidence remains mixed and inconclusive. The possible transmission

channels through which inequality affects growth have yet to be comprehensively examined. In this paper we have sought to gain some clarity by empirically examining the extent to which income inequality transmits to growth through savings, investment, education, and knowledge production. We have compiled a new panel data set for 21 OECD countries over the period 1870-2011. External communist influence is used as a new time-varying instrument for inequality to address reverse causation. Furthermore, inequality is interacted with financial development following the predictions of most of the theoretical literature that inequality is most harmful for growth in financially underdeveloped economies.

The unconditional IV-regressions show that income inequality hampers growth through all four outcome variables: saving, investment, education, and ideas production. Consistent with theoretical predictions, we find that inequality has significant negative effects on the outcome variables in financially underdeveloped economies, predominantly because low-income households have limited access to credit facilities in financially repressed economies. However, in economies with highly developed and sophisticated credit facilities, inequality affects positively the four outcome variables. Our simulations show that the 21 advanced OECD economies included in our sample have recently surpassed the threshold at which credit constrains discourage low-income groups from education, investing, saving, and innovating; they have done so to such a degree that the net effect of inequality on growth is positive. However, the majority of countries around the globe have yet to reach the critical benchmark level of financial development at which inequality fosters growth. We conclude that only in the financially most advanced countries does inequality augment growth.

Modelling interactions between inequality and financial development is important not only because it is consistent with theory, but also because the inequality elasticities of the outcome variables are implausibly high when the interaction between inequality and financial development is excluded from the regressions. If this interaction is excluded, it leads to the false inference that the entire increase in saving, investment and education over the period 1870-1976 can be explained by a decreasing inequality. However, the absolute values of semi-elasticities of inequality are substantially more plausible when interaction between financial development and inequality is allowed in the regressions.

Our finding that inequality impacts all four outcome variables considered here highlights the critical role that inequality and its interaction with financial development play for economic development and growth. Inequality's impact is far reaching and widespread, working through numerous dimensions, including financial development, that mask the genuine inequality effects. One implication of our findings is that the growth effects of inequality may have been

underestimated in most time-series studies because: (1) positive feed-back effects from the outcome variables to inequality have not been addressed by adequate identification strategies; and (2) the negative effects of inequality on gross enrollment rates and ideas production take several years to impinge on growth and these effects may not be sufficiently well captured by reduced form growth equations. However, we also show that the negative growth effects of inequality found in some studies may have been over-stated because the sample has been dominated by countries with low financial development for which we find inequality to be particularly negative for growth. The results in this paper show that the nexus between inequality and growth is much more complex than reduced form growth regressions are likely to reveal.

Acknowledgements
We thank participants at the Australasian Public Choice Conference, 2014, the Australasian Development Workshop, 2015, and seminar participants at University of Southern Denmark, and Axel Dreher for comments and suggestions. Stoja Andric, Thandi Ndhlela, and Cong Wang provided excellent research assistance. Jakob Madsen gratefully acknowledges financial support from the Australian Research Council (DP110101871 and DP120103492).

References

Acemoglu, D. and Robinson, J.A. 2000. "Why Did the West Extend the Franchise? Democracy, Inequality, and Growth in Historical Perspective." *The Quarterly Journal of Economics* 115 (4): 1167-99.

Acemoglu, D., Aghion, P. and Violante, G.L. 2001. "Deunionization, technical change and inequality." *Carnegie-Rochester Conference Series on Public Policy* 55 (1): 229-64.

Aghion, P. and Bolton, P. 1997. "A Theory of Trickle-Down Growth and Development." *Review of Economic Studies* 64 (2): 151-172.

Aghion, P., Caroli, E. and García-Peñalosa, C. 1999. "Inequality and Economic Growth: The Perspective of the New Growth Theories." *Journal of Economic Literature* 37 (4): 1615-1660.

Aghion, P. and Howitt, P. 2006. "Joseph Schumpeter Lecture Appropriate Growth Policy: A Unifying Framework." *Journal of the European Economic Association* 4(2-3): 269-314.

Aidt, T.S. and Jensen, P.S. 2014. "Workers of the World, Unite! Franchise Extensions and the Threat of Revolution in Europe, 1820–1938." *European Economic Review*, 72: 52-75.

Alesina, A., Michalopoulos, S. and Papaioannou, E. 2016. "Ethnic Inequality." *Journal of Political Economy, Forthcoming.*

Atkinson, A.B. 1997. "Bringing Income Distribution in From the Cold." *The Economic Journal*, 107 (441): 297-321.

Atkinson, A.B., Piketty, T. and Saez, E. 2011. "Top Income in the Long Run of History." *Journal of Economic literature* 49: 3-71.

Banerjee, A.V. and Duflo, E. 2003. "Inequality and Growth: What Can the Data Say?" *Journal of Economic Growth* 8 (3): 267-299.

Banerjee, A.V. and Newman, A.F. 1993. "Occupational Choice and the Process of Development." *Journal of Political Economy* 101 (2): 274-298.
Barro, R.J. 1990. "The Stock Market and Investment." *Review of Financial Studies* 3 (1): 115-131.
Barro, R.J. 2000. "Inequality and Growth in a Panel of Countries." *Journal of Economic Growth* 5 (1): 5-32.
Bentolia, S. and Saint-Paul, G. 2003. "Explaining Movements in the Labor Share." *Contributions to Macroeconomics* 3 (1), Article 9.
Berg, A., Ostry, J.D. and Zettelmeyer, J. 2012. "What Makes Growth Sustained?" *Journal of Development Economics* 98 (2): 149-166.
Blanchard, O. and Giavazzi, F. 2003. "Macroeconomic Effects of Regulation and Deregulation in Goods and Labor Markets." *Quarterly Journal of Economics* 118 (3): 879-907.
Bordo, M.D. and Meissner, C.M. 2015. "Growing Up to Stability? Financial Globalization, Financial Development and Financial Crises." NBER Working Papers 21287, National Bureau of Economic Research, Cambridge, MA.
Bruno, M. and Sachs, J. 1985. *Economics of Worldwide Stagflation*. Cambridge, MA: Harvard University Press.
Checchi, D. and García-Peñalosa, C. 2004. "Risk and the distribution of human capital." *Economics Letters* 82 (1): 53-61.
Checchi, D. and García-Peñalosa, C. 2010. "Labour Market Institutions and the Personal Distribution of Income in the OECD." *Economica* 77 (307): 413-450.
Chirinko, R.S. 2008. "σ: The long and short of it." *Journal of Macroeconomics* 30: 671-686.
Collier, R. 1999. *Paths Toward Democracy*. Cambridge, UK: Cambridge University Press.
Davidson, R. and MacKinnon, J.G. 2006. "The Power of Bootstrap and Asymptotic Tests." *Journal of Econometrics* 133 (2): 421-441.
De La Escosura, L.P. 2008. "Inequality, Poverty and the Kuznets Curve in Spain, 1850–2000." *European Review of Economic History* 12 (03): 287-324.
Dixit, A.K. and Pindyck, R.S. 1994. *Investment under Uncertainty*. Princeton, NJ: Princeton University Press.
Dobbin, F., Simmons, B. and Garrett, G. 2007. "The Global Diffusion of Public Policies: Social Construction, Coercion, Competition, or Learning?" *Annual Review of Sociology* (Vol. 33, pp. 449-472). Palo Alto: Annual Reviews.
Druckman, J. and McDermott, R. 2008. "Emotion and the Framing of Risky Choice." *Political Behavior* 30 (3): 297-321.
Easterly, W. 2007. "Inequality Does Cause Underdevelopment: Insights from a New Instrument." *Journal of Development Economics* 84 (2): 755-776.
Fearon, J. 2003. "Ethnic and Cultural Diversity by Country." *Journal of Economic Growth* 8 (2): 195-222.
Forbes, K.J. 2000. "A Reassessment of the Relationship between Inequality and Growth." *American Economic Review* 90 (4): 869-887.
Galor, O. and Zeira, J. 1993. "Income Distribution and Macroeconomics." *The Review of Economic Studies* 60 (1): 35-52.
Gassebner, M., Gaston, N. and Lamla, M.J. 2011. "The Inverse Domino Effect: Are Economic Reforms Contagious?" *International Economic Review* 52 (1): 183-200.
Gaston, N. and Rajaguru, G. 2009. "The Long-run Determinants of Australian Income Inequality." *The Economic Record* 85 (270): 260-275.
Gilardi, F. 2010. "Who learns from what in policy diffusion processes?" *American Journal of Political Science* 54 (3): 650–666.
Halter, D., Oechslin, M. and Zweimüller, J. 2014. "Inequality and Growth: the Neglected Time Dimension." *Journal of Economic Growth* 19 (1): 81-104.

Islam, M.R. and Madsen, J.B. 2015. "Is Income Inequality Persistent? Evidence Using Panel Stationarity Tests, 1870–2011." *Economics Letters* 127: 17-19.
Johnson, S., Larson, W., Papageorgiou, C. and Subramanian, A. 2013. "Is newer better? Penn World Table Revisions and their impact on growth estimates." *Journal of Monetary Economics* 60 (2): 255-274.
Krusell, P., Ohanian, L.E., Ríos-Rull, J.-V. and Violante, G.L. 2000. "Capital-skill Complementarity and Inequality: A Macroeconomic Analysis." *Econometrica* 68 (5): 1029-1053.
Kuran, T. 1997. *Private truths, public lies: The social consequences of preference falsification.* Cambridge, Massachusetts: Harvard University Press.
Levine, R., Loayza, N. and Beck, T. 2000. "Financial intermediation and growth: Causality and causes." *Journal of Monetary Economics* 46 (1): 31-77.
Madsen, J.B. 2014. "Human Capital and the World Technology Frontier." *The Review of Economics and Statistics* 96 (4): 676-692.
Madsen, J.B. and Ang, J.B. 2016. "Finance-led Growth in the OECD since the 19th Century: How Does Financial Development Transmit to Growth?" *The Review of Economics & Statistics, Forthcoming*.
Madsen, J.B. and Davis, E.P. 2006. "Equity Prices, Productivity Growth and 'The New Economy'." *The Economic Journal* 116 (513): 791-811.
Mankiw, N.G., Romer, D. and Weil, D.N. 1992. "A Contribution to the Empirics of Economic Growth." *The Quarterly Journal of Economics* 107 (2): 407-437.
McDonald, I.M. and Suen, A. 1992. "On the Measurement and Determination of Trade Union Power." *Oxford Bulletin of Economics and Statistics* 54 (2): 209-224.
Panizza, U. 2002. "Income Inequality and Economic Growth: Evidence from American Data." *Journal of Economic Growth* 7 (1): 25-41.
Peretto, P. 1998. "Technological Change and Population Growth." *Journal of Economic Growth* 3 (4): 283-311.
Peretto, P.F. and Valente, S. 2011. "Resources, Innovation and Growth in the Global Economy." *Journal of Monetary Economics* 58(4): 387-99.
Piketty, T. 1997. "The Dynamics of the Wealth Distribution and the Interest Rate with Credit Rationing." *The Review of Economic Studies* 64 (2): 173-189.
Piketty, T. 2014. *Capital in the Twenty-First Century*. Cambridge: Belknap Press of Harvard University Press.
Piketty, T. 2015. "About Capital in the Twenty-First Century." *American Economic Review: Papers & Proceedings* 105 (5): 48–53.
Ulku, H. 2007. "R&D, Innovation and Growth: Evidence from four manufacturing sectors in OECD countries." *Oxford Economic Papers* 59 (3), 513-535.
Venturini, F. 2012a. "Product Variety, Product Quality, and Evidence of Endogenous Growth." *Economics Letters* 117 (1): 74-77.
Venturini, F. 2012b. "Looking into the Black Box of Schumpeterian Growth Theories: An Empirical Assessment of R&D Races." *European Economic Review* 56 (8): 1530-1545.
Weyland, K. 2009. "The Diffusion of Revolution: '1848' in Europe and Latin America." *International Organization* 63 (3): 391-423.
Weyland, K. 2010. "The Diffusion of Regime Contention in European Democratization, 1830-1940." *Comparative Political Studies* 43(8-9): 1148-1176.
Weyland, K. 2014. *Making Waves: Democratic Contention in Europe and Latin America since the Revolutions of 1848*. New York: Cambridge University Press.