



Testing Piketty's Hypothesis on the Drivers of Income Inequality: Evidence from Panels VARs with Heterogeneous Dynamics

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IMF Working Paper

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Roadmap

1. Motivation

1.1 Relevance and contribution to the literature

1.2 Piketty's Model

2. Data and Stylized Facts

2.1 Data

2.2 Stylized Facts

3. Methodology and Results

3.1 Panel VAR Methodology

3.2 Empirical Models

3.3 Results

3.4 Robustness

4. Discussion and Conclusions

4.1 Implications of results and alternative explanations for inequality

4.2 Conclusions

Relevance and contribution to the literature

Why it matters?

- *Capital in the Twenty-First Century*, while rich in data, provides no formal empirical testing for its theoretical causal chain.
- The main contribution of this paper is to provide a rigorous empirical test of Piketty's very influential hypothesis.
- Knowing if Piketty is correct is very important, since without knowing the underlying causes of inequality trends, it is impossible to design policy actions to counter them.

Piketty's Model

What to test

Assumptions

- $Y_t = K_t^\alpha L_t^{1-\alpha}$; $K_{t+1} = (1 - \delta)K_t + sY_t$; $Y_{t+1} = (1 + g)Y_t$
- Since $\frac{\partial Y_t}{\partial K_t} = \alpha \frac{Y_t}{K_t}$, defining $r \equiv \frac{\partial Y_t}{\partial K_t}$ means $\alpha = \frac{rK_t}{Y_t}$ (1)

Sustainable growth path

- At the steady state $\frac{d}{dt} \left[\frac{K_t}{Y_t} \right] = 0$, which implies:

$$\frac{\dot{K}}{K} = \frac{\dot{Y}}{Y}, \quad \frac{sY - \delta K}{K} = \frac{gY}{Y}, \quad \frac{\bar{K}}{\bar{Y}} = \frac{\bar{s}}{\bar{g} + \bar{\delta}} \quad (2)$$
- Substituting (2) into (1) yields $\bar{\alpha} = \frac{\bar{r}\bar{s}}{\bar{g} + \bar{\delta}}$

Piketty's Model

Understanding $\bar{\alpha} = \frac{\bar{r}\bar{s}}{\bar{g}+\bar{\delta}}$ in a dynamic framework

Dynamic version of the second fundamental law

- Dynamically, adding random shocks to the steady state:
 $\alpha_t = \bar{\alpha} + \Phi(L)\xi_t$.
- Source of ξ_t ? Piketty takes the savings rate as somewhat constant and argues that the capital share (α) and income inequality (z) are rising functions of $r - g$.

Hypotheses

- Baseline: H_b : if $\Delta(r - g) > 0$, then $\Delta z > 0$, $\Delta\alpha > 0$
- Alternative: H_a : if $\Delta(r - g) > 0$, then $\Delta z \leq 0$, $\Delta\alpha \leq 0$

Data

How to Measure It?

- Sample of 19 advanced countries with maximum range from 1980 through 2012

The easy ones

- Inequality proxied by the Share of the Top 1% (z) from Piketty's World Top Incomes Database; capital share (α) from the Penn World Tables; real growth rates (g) from WEO.

Real rate of return

- **Baseline:** $r_{i,t} = [(1 - \tau_{i,t})i_{i,t} - d_{i,t}]$, with corporate tax rates (τ), LT sovereign bond yields (i) & percentage change in deflators (d).
- **Alternatives:** ST interest rates, implied from National Accounts

Stylized Facts

How Variables Evolved over Time

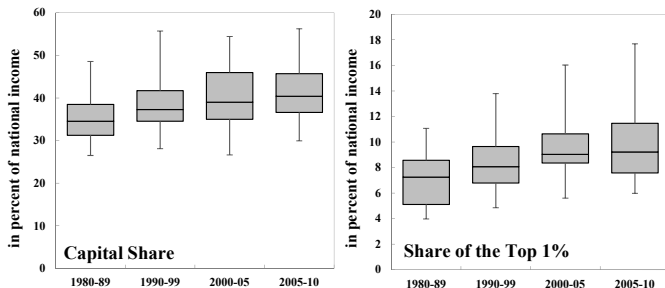


Figure: **Distribution of capital share and share of the top 1% over time.** Y-axis in percent, x-axis represents period averages. The sample refers to an unbalanced panel of 19 advanced economies ranging from 1981-2010. Boxplots show interquartile ranges and medians. Whiskers show minimum and maximums.

Stylized Facts

How $(r - g)$ Correlates with Capital Share and Inequality

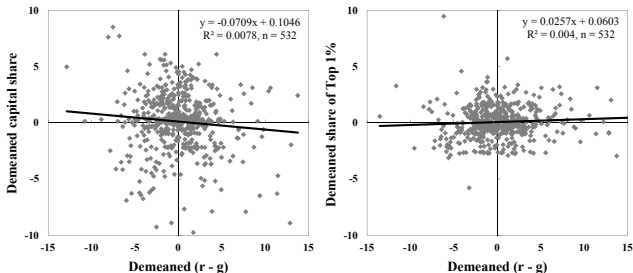


Figure: **Contemporaneous correlations between $r - g$ spread and capital share or share of the top 1%, respectively.** The sample refers to an unbalanced panel of 19 advanced economies ranging from 1981-2012. Variables are demeaned to account for time-invariant country-specific characteristics.

Panel VAR Methodology

Pedroni's Panel VAR with Heterogeneous Dynamics

Several advantages to this methodology

- Full heterogeneity in statics (different intercepts), dynamics (different slopes) and lag lengths.
- Goes beyond averages: information about several moments of the distributions of IRFs for each response horizon
 - much more robust inference
- Uses time effects to decompose impulse responses between responses to *idiosyncratic shocks* and country-specific responses to *common shocks*.

Panel VAR Methodology

Pedroni's Panel VAR with Heterogeneous Dynamics

The model

$$B_i y_{i,t}^* = A_i(L) y_{i,t-1}^* + e_{i,t}$$

- $y_{i,t}^*$ is n -dimensional vector of demeaned stacked endogenous variables
- $A_i(L) \equiv (\sum_{j=0}^{J_i} A_j^i L^j)$ is a polynomial of lagged coefficients with country-specific lag-lengths J_i
- A_j^i is a matrix of coefficients
- $e_{i,t}$ is a vector of stacked residuals
- B_i is a matrix of contemporaneous coefficients

Heterogeneous dynamics

Beyond averages: what does it mean?

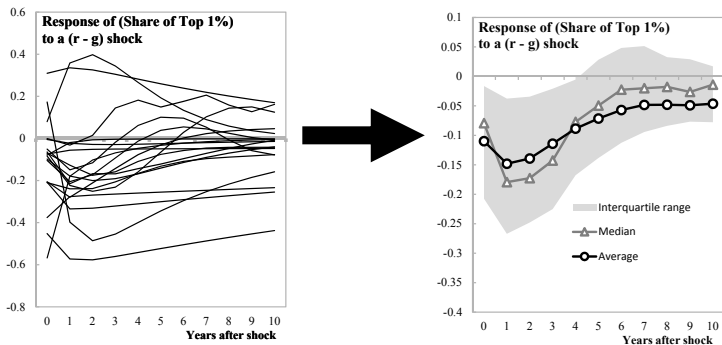


Figure: Distribution of IRFs for all countries presented as interquartile range, median and average.

Empirical Models

Set of structural Panel VARs

I build three structural Panel VARs

- In **Model 1**, $y_{i,t} \equiv [p_{i,t}, z_{i,t}]'$, where $z_{i,t}$ is the share of the top 1% and $p_{i,t} \equiv (r_{i,t} - g_{i,t})$.
- In **Model 2**, $y_{i,t} \equiv [p_{i,t}, k_{i,t}]'$, where $k_{i,t}$ is the share of capital.
- In **Model 3**, $y_{i,t} \equiv [p_{i,t}, s_{i,t}, k_{i,t}]'$, incorporating the savings rate ($s_{i,t}$).

The identification strategies are recursive, short-term, lower triangular restrictions on the B_i matrices and follow Piketty's theoretical model: i.e., take $r - g$ as the (most) exogenous variable. In the robustness section, I present results with the inverted restrictions.

Model 1

Effects of $(r - g)$ on Inequality

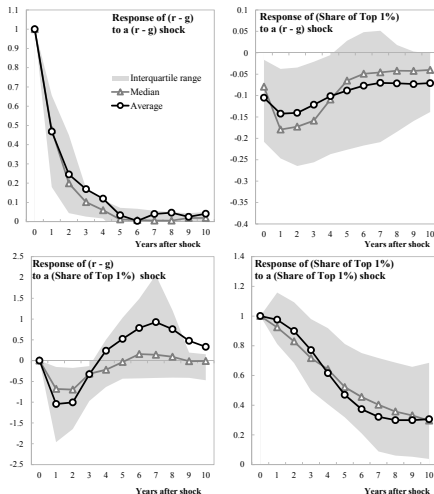


Figure. Model 1: Heterogeneous composite impulse responses across sample. The median, averages, and interquartile ranges were calculated from the distribution of IRFs of the 19 cross-sections.

Model 1

Effects of $(r - g)$ on Inequality

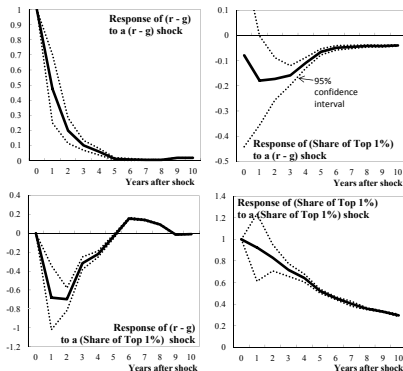


Figure. Model 1: Median composite responses and confidence intervals. Median response across a heterogeneous distribution of IRFs across 19 countries. Confidence intervals calculated from a resampling simulation with 500 repetitions.

Model 1

Effects of $(r - g)$ on Inequality

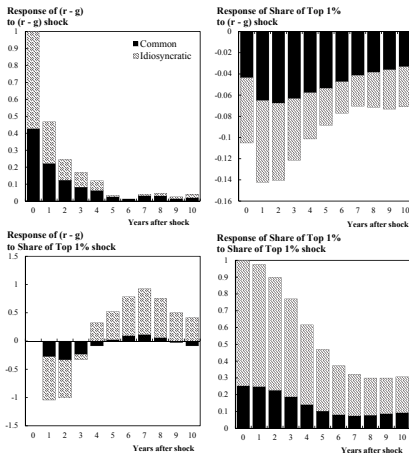


Figure. Model 1: Decomposition of median composite responses. Median responses can be decomposed into country-specific responses to common shocks and responses to idiosyncratic shocks through the use of loading factors that denote the relative importance of common shocks for each country

Model 2

Effects of $(r - g)$ on Capital Share

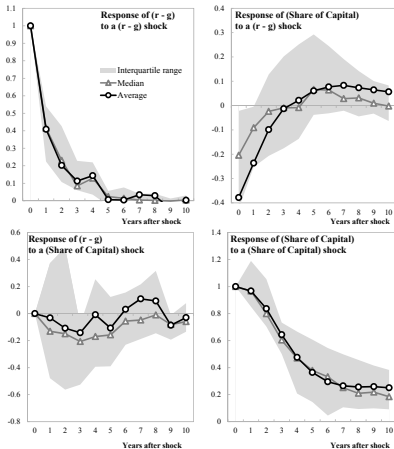


Figure. Model 2: Heterogeneous composite impulse responses across sample. The median, averages, and interquartile ranges were calculated from the distribution of IRFs of the 18 cross-sections.

Model 2

Why do We See This Reponse?

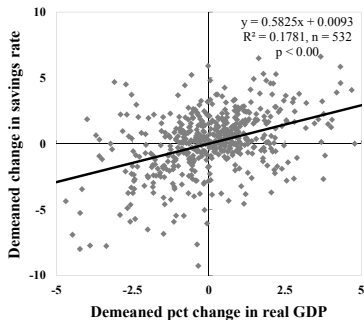


Figure: Contemporaneous correlations between GDP growth and changes in the savings rate. The sample refers to an unbalanced panel of 18 advanced economies ranging from 1981-2012. Variables are demeaned to account for time-invariant, country-specific characteristics.

Model 3

Effects of $(r - g)$ on Capital Share and Savings

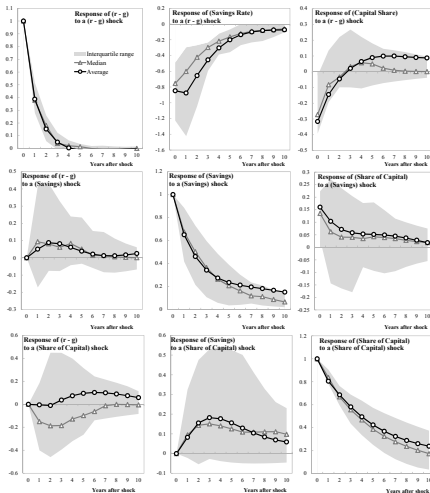


Figure. Model 3: Heterogeneous composite impulse responses across sample. The median, averages, and interquartile ranges were calculated from the distribution of IRFs of the 18 cross-sections.

Model 3

Effects of $(r - g)$ on Capital Share and Savings

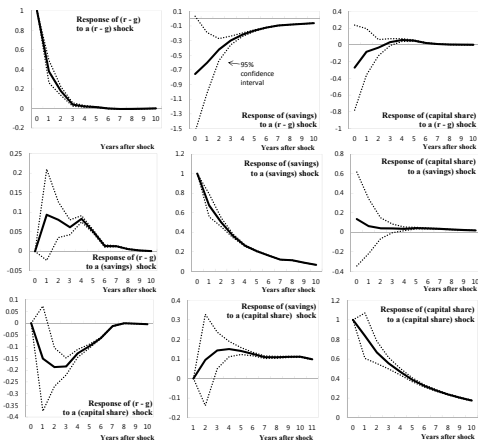


Figure. Model 3: Median composite responses and confidence intervals. Median response across a heterogeneous distribution of IRFs across 18 countries. Confidence intervals calculated from a resampling simulation with 500 repetitions.

What does heterogeneity imply?

Which variables correlate with the cross-sectional dimension of IRFs

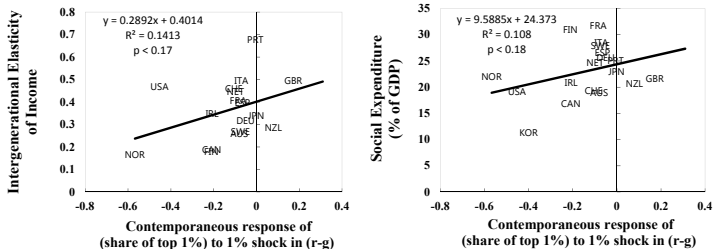


Figure: Correlation between heterogeneous responses and intergenerational elasticity of income and social expenditure, respectively. Y-axis in percent, x-axis represents period averages. Data on intergenerational elasticity of income from Corak (2016) and Causa and Johansson (2013). Data on social spending from the OECD's social expenditure database.

Robustness

Different specifications for r and inverted cholesky ordering

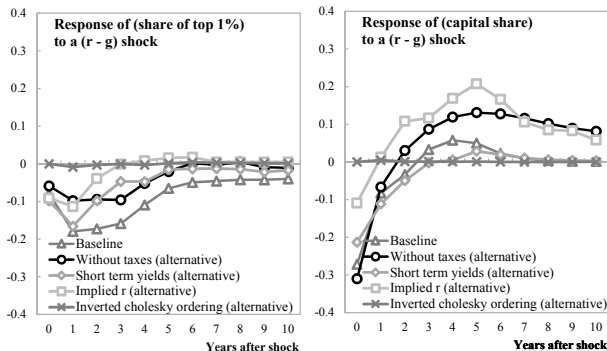


Figure: Robustness checks - re-estimation of Models 1 and 3: Median composite responses. This figure compares median responses across a distribution of IRFs of 19 (Model 1) / 18 (Model 3) countries using different specifications.

Implications of results

What the results mean and how do they relate to previous tests?

- Piketty: as $r - g$ move up, α moves up, and inequality moves up.
- This paper suggests there are endogenous forces preventing that: non-negligible diminishing returns on capital and pro-cyclical changes in the savings rate.
- This paper confirms the single-equation results of Acemoglu & Robinson (2015).
- This paper provides support for the theoretical model proposed by Krusell & Smith (2015), who argue that Piketty's predictions are grounded on a flawed theory of savings.

Alternative explanations for inequality

The literature is quite rich

- Most of the increase inequality is due to labor income inequality not factor income inequality (Francese and Mulas-Granados, 2015)
- Potential explanations:
 - Changes in labor market institutions, e.g. deunionization: Dabla-Norris et al. (2015), Jaumotte and Buitron (2015).
 - Innovation and technological change (Shumpeterian effect): Aghion et al. (2015).
 - Social exclusion in marriages: Mare (2016), Greenwood et al. (2012).
 - Exclusive institutions exacerbate inequality: Chong and Gradstein (2007), Acemoglu and Robinson (2015).

Conclusions

What is the takeaway?

- Using the best available data, I find no evidence to corroborate the idea that the $r - g$ gap drives the capital share or inequality;
- There are endogenous forces (diminishing marginal returns to capital and pro-cyclical changes in the savings rate) which explains this;
- Observed inequality have other causes and policy solutions to counter it should not focus on $r - g$, but elsewhere.