Unequal Growth

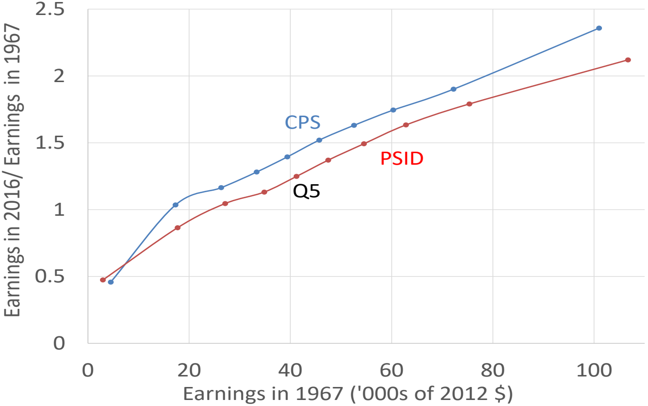
Francesco Lippi and Fabrizio Perri
EIEF, Luiss *FRB of Minneapolis*

June 2019

Introduction

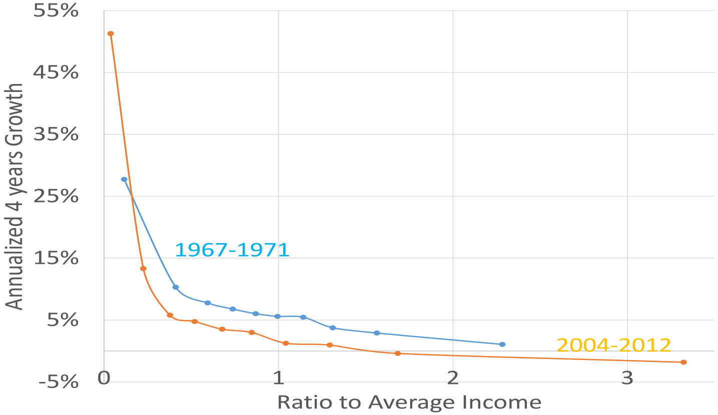
- Over past 50 years U.S. has experienced a large increase in household income inequality
- Many studies on the causes of this, much less work on its growth impact
- Changes that drive increase in income inequality are changes in income dynamics, which naturally can have a growth impact
- Building block: Changes in income dynamics that are unequal across income levels (Unequal growth), affect, at the same time, aggregate growth, income inequality and welfare
- Objective: Use micro data and minimal theory to connect growth and inequality, estimate these changes and assess their impact

Unequal growth 1967-2016: a cross sectional view



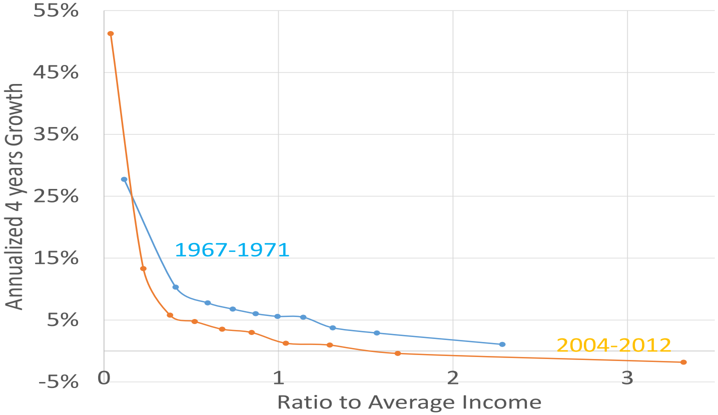
- Each point: level & growth of deciles of 1967 income distribution
- Top grew fast, bottom stagnated: not same households across time!

Unequal growth 1967-2016: a panel view (PSID)



- Poor grow faster than rich (mean reversion), early and late in sample
- Same households across time!

Unequal growth 1967-2016: a panel view (PSID)



- Poor grow faster than rich (mean reversion), early and late in sample
- Same households across time!
- How is this fig(β convergence) consistent with previous (σ divergence)?
- How are these changes connected with aggregate growth?

Outline

- A micro decomposition of aggregate growth
- Empirical analysis on decomposition
- Simple model to measure the changes driving the data, and assess impact

Some Related literature

- Empirical: “Earnings, Inequality and Mobility in the United States”, Kopczuk, Saez and Song 2010, “The Nature of Countercyclical Income Risk” Guvenen, Ozkan, and Song. 2014
- Models of Income Inequality: “Uninsured Idiosyncratic Risk and Aggregate Saving", Ayiagari 1994, “Dynamics of inequality”, Gabaix, Lasry, Lions and Moll 2016, “Top income inequality dynamics”, Kim and Jones 2017
- From micro to macro: “Misallocation and growth”, Jovanovic 2014, “The Granular Origins of Aggregate Fluctuations”, Gabaix 2011

A micro decomposition of aggregate growth

- Let y_{it} real income of household i at time t
- Aggregate growth in period t over horizon T, $\Gamma_{t,T}$ can be written as

$$\Gamma_{t,T} = \frac{E_i(y_{i,t+T})}{E_i(y_{i,t})} = E_i\left(\frac{y_{i,t+T}}{y_{i,t}}\frac{y_{i,t}}{E(y_{i,t})}\right)$$

- Define $g_{i,T} = \frac{y_{i,t+T}}{y_{i,t}}$, $s_{i,t} = \frac{y_{i,t}}{E(y_{i,t})}$ so that $\Gamma_{t,T} = E_i(g_{i,T} \cdot s_{i,t})$

A micro decomposition of aggregate growth

- Let y_{it} real income of household i at time t
- Aggregate growth in period t over horizon T, $\Gamma_{t,T}$ can be written as

$$\Gamma_{t,T} = \frac{E_i(y_{i,t+T})}{E_i(y_{i,t})} = E_i\left(\frac{y_{i,t+T}}{y_{i,t}}\frac{y_{i,t}}{E(y_{i,t})}\right)$$

- Define $g_{i,T} = \frac{y_{i,t+T}}{y_{i,t}}$, $s_{i,t} = \frac{y_{i,t}}{E(y_{i,t})}$ so that $\Gamma_{t,T} = E_i(g_{i,T} \cdot s_{i,t})$

$$\begin{aligned}\Gamma_T &= cov(g_{i,T}, s_i) + E(g_{i,T}) \\ &= corr(g_{i,T}, s_i)\sigma(g_{i,T})\sigma(s_i) + E(g_{i,T})\end{aligned}$$

A micro decomposition of aggregate growth

- Let y_{it} real income of household i at time t
- Aggregate growth in period t over horizon T, $\Gamma_{t,T}$ can be written as

$$\Gamma_{t,T} = \frac{E_i(y_{i,t+T})}{E_i(y_{i,t})} = E_i\left(\frac{y_{i,t+T}}{y_{i,t}}\frac{y_{i,t}}{E(y_{i,t})}\right)$$

- Define $g_{i,T} = \frac{y_{i,t+T}}{y_{i,t}}$, $s_{i,t} = \frac{y_{i,t}}{E(y_{i,t})}$ so that $\Gamma_{t,T} = E_i(g_{i,T} \cdot s_{i,t})$

$$\begin{aligned} \Gamma_T &= cov(g_{i,T}, s_i) + E(g_{i,T}) \\ &= corr(g_{i,T}, s_i)\sigma(g_{i,T})\sigma(s_i) + E(g_{i,T}) \end{aligned}$$

- Who grows matters for aggregate growth, and how growth takes place matter for inequality
- Similar decomposition widely used in IO (Olley and Pakes, 1996)

Insights from decomposition

$$\Gamma_T = cov(g_{i,T}, s_i) + E(g_{i,T})$$
$$= corr(g_{i,T}, s_i)\sigma(g_{i,T})\sigma(s_i) + E(g_{i,T})$$

- Simple way to sum micro moments to evaluate a given Γ_T:
- Growth can be:
  - Equal ($\sigma(g_i) = 0$, $E(g_i = \bar{g}$)
  - Unequal ($\sigma(g_i) > 0$). In this case inequality $\sigma(s_i)$ and mobility $cov(g_i, s_i)$) matter for Γ_T
- Whether growth is equal or unequal has welfare consequences

Warning: $Cov(g_i, s_i), E(g_i)$ .. not independent primitives: structural changes in income dynamics change (at same time) all terms: need a theory!

Plan

- (1) measure $corr(g_i, s_i)$, $\sigma(g_{it})$, $\sigma(s_{it})$ and $E(g_i)$ over 1967-2016
- (2) simple mechanism to understand driving force of changes

Panel Study of Income Dynamics (PSID)

- Long panel of about 5,000 HH, representative of U.S. population
- Panel essential to identify change of individual dynamics (vs composition)

- 1967-2016 (Annual until 1996, bi-annual after)

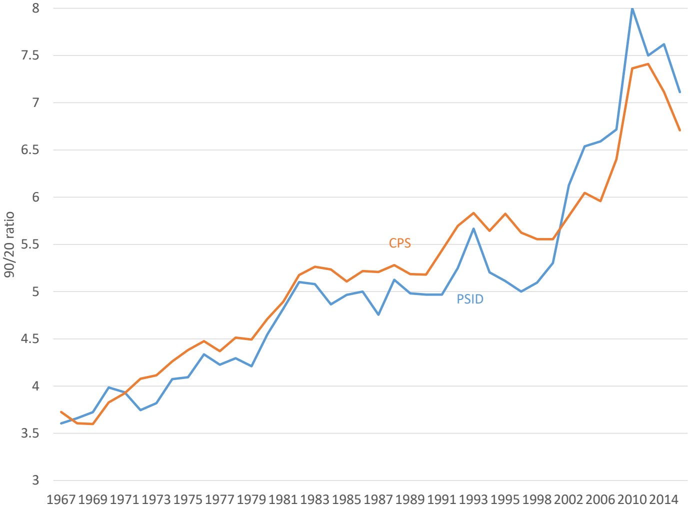
- Publicly available

- Panel data must aggregate up to macro outcomes

PSID v/s NIPA: 4y growth of real labor income pc

- Aggregate PSID matches well macro NIPA Dynamics (including recent growth slowdown)

PSID v/s CPS: Cross sectional inequality



- PSID matches well cross sectional inequality in labor income from much larger sample (CPS)

Mapping decomposition to panel data

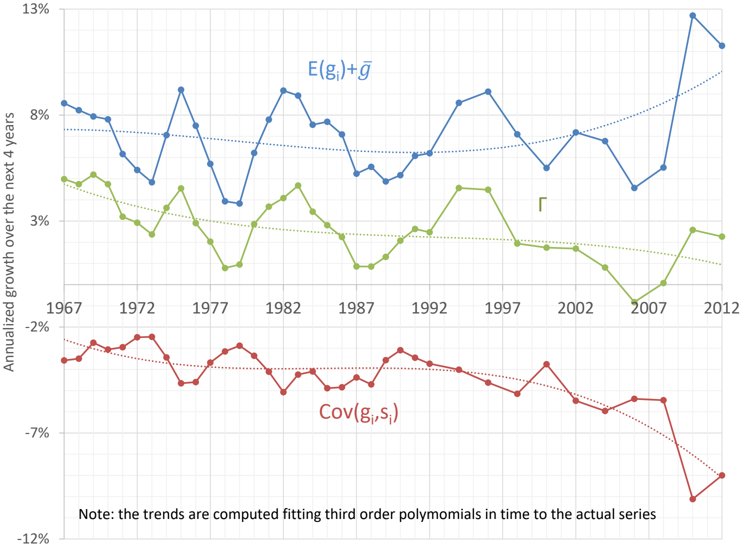
Let $T = 4$ years, $y_{j,i,t}$ be real (PCE deflated) income of HH j, in decile i in year t and P_t total population in sample in year t

$$\text{then} \quad g_{i,t+T} = \frac{\sum_j y_{j,i,t+T}}{\sum_j y_{j,i,t}} \frac{P_t}{P_{t+T}} \quad \text{and} \quad s_{i,t} = \frac{\sum_j y_{j,i,t}}{\sum_i \sum_j y_{j,i,t}}$$

Aggregating by income deciles (quintiles) useful with measurement error

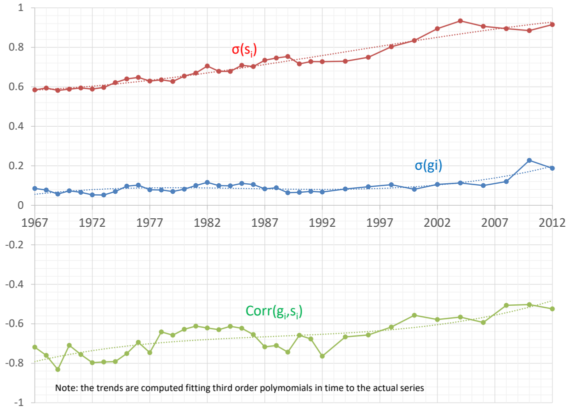
- Income measure: Labor Earnings of all household members
- Sample restrictions: Households with head 25-60, with income above 20% of the pvty line, no imputed labor income, which are in sample in year t and $t + 4$ (avg. sample per year $\simeq$ 3500)
- Similar patterns for hholds with 25-40 head (age composition)

Aggregate growth decomposition (PSID)



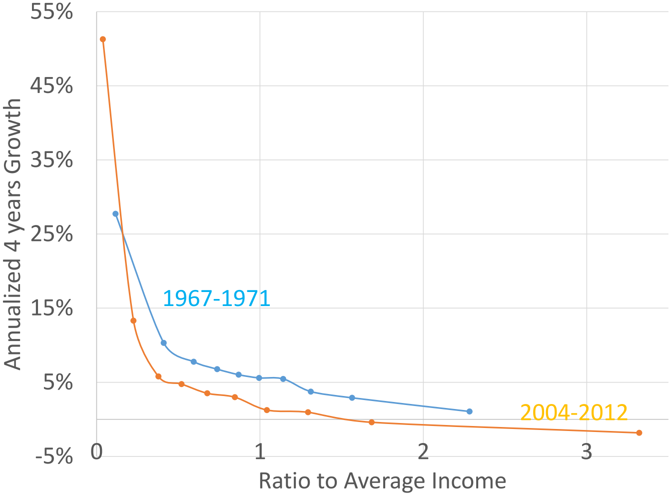
- Γ declines, $E(g_i)$ does not, Implies: $cov_t \downarrow$

Covariance decomposition (PSID)



- Increasing $\sigma(s_i)$ measure of increasing income inequality
- $Corr(g_i, s_i)$ increasing (toward 0) signals less rank mobility

Why is correlation increasing?

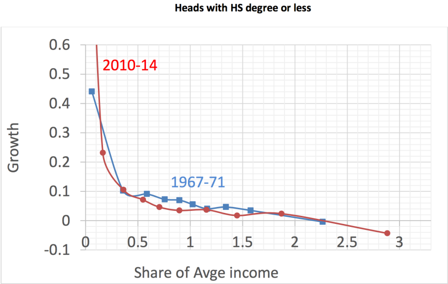


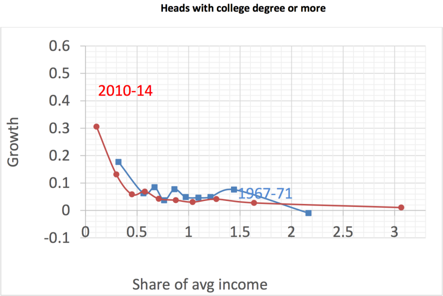
- Relation between g_i and s_i, becoming less linear (spike for low s, flatter for high s)

Robustness of growth decomposition

Cut sample by HH head education:

at most High-school | College or more

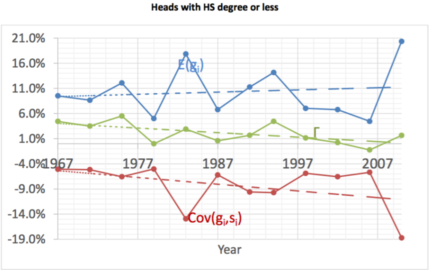


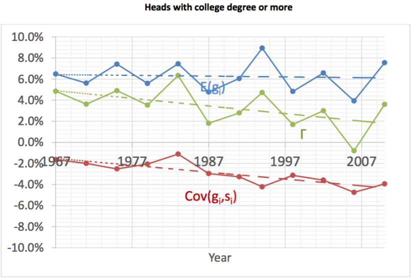


Robustness of growth decomposition (1)

Cut sample by HH head education:

at most High-school | College or more





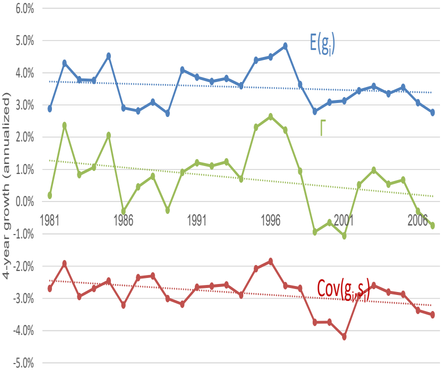
Patterns robust to several more demographics (e.g. age, race)

Robustness of growth decomposition (2)

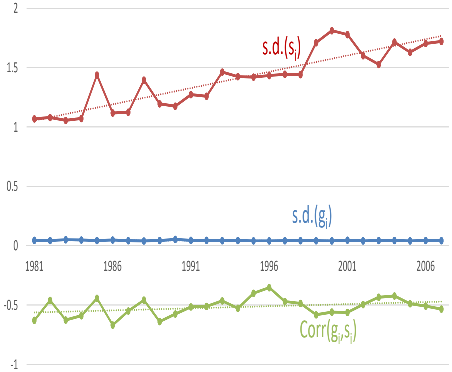
Administrative data from SIPP users

Larger sample (20x), higher quality data, indiv v/s hholds, 1980-2012

Growth decomposition



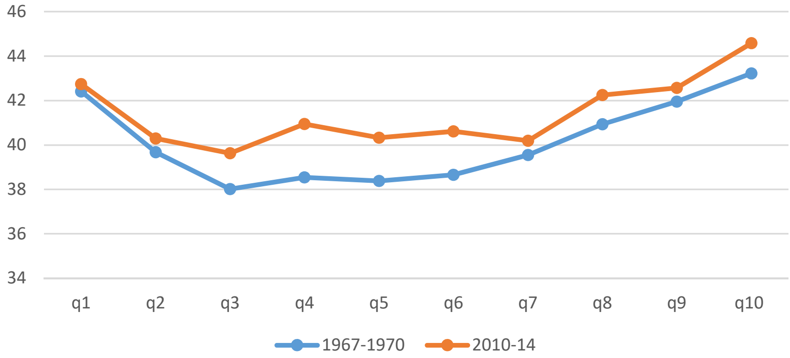
covariance decomposition



Who is in the different deciles?

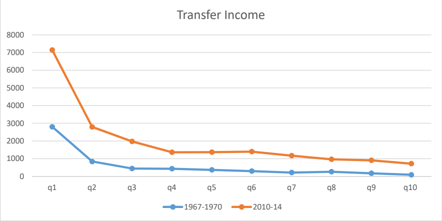
- Before writing a model for (g_i, s_i), show some characteristics of different deciles of income distribution.

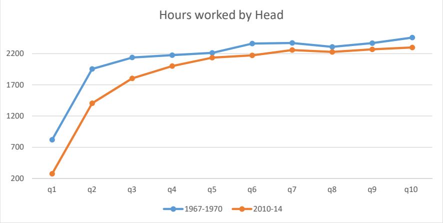
Age of different quantiles



- The poor fast growers are not all young
- Mean reversion not all explained by demographic (Some household become poor-fast growers because of shocks)

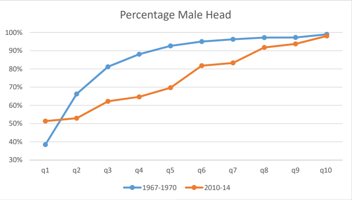
Hours and transfers

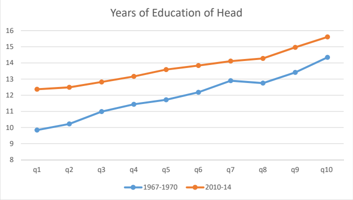


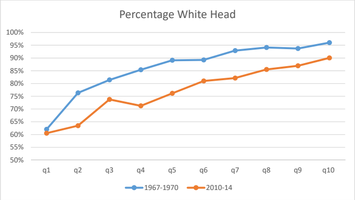


- Poor fast-growers work much less hours and receive more transfers, suggesting they are experiencing (temporary) shock to their ability/willingness to work (Low hours mostly explained by extensive margin)

White, Male and College Educated







- All lines increasing, suggesting the importance of permanent differences (fixed effects) across deciles.

The theory

- Is there a simple can change in income dynamics that can account for the changes documented in the decomposition?
- And can this change explain changes in aggregate growth?

A Bewley-Ayiagari Model

- Continuum of infinitely lived households
- Log of household i earning potential is

$$
\begin{aligned}
y_{it} &= e_{it} + \alpha_i + g_{it} \\
e_{it} &= \rho e_{it-1} + \varepsilon_{it}, \varepsilon_{it} \sim N(\mu(s_{it}), \sigma^2_{\varepsilon t} g(s_{it})) \\
\alpha_i &\sim N(0, \sigma_\alpha) \\
g_{it} &= h(s_{it}) + g_{it-1} \qquad h(s_{it}) = \gamma + \beta \frac{1 - s_{it}}{1 + s_{it}}
\end{aligned}
$$

- e_{it} standard autoregressive part. Variance of shocks $g(s_{it})$ declining in income s_{it} (Meghir and Pistaferri, 2004)
- α_i is household fixed effect
- g_{it} is growth factor, γ is equal growth, β captures unequal growth

Extensive margin

- Household works iff

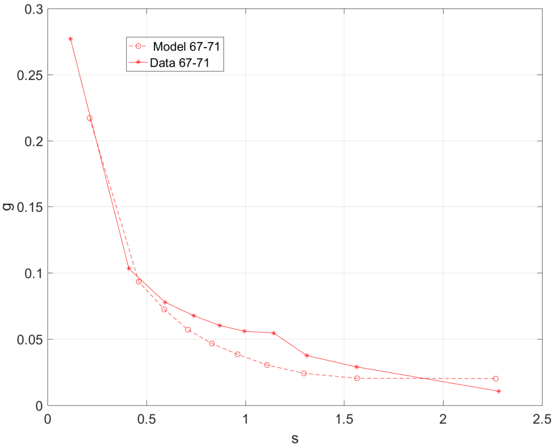
$$\begin{aligned} y_{it} &> \phi_t \\ \phi_t &= \phi_{t-1} + \gamma \end{aligned}$$

- When household work: earnings = earning potential
- Earning potential evolves when household does not work
- ϕ_t chosen to match increase of non participant household in data (in our PSID sample from 3% to 6%)

Exercise

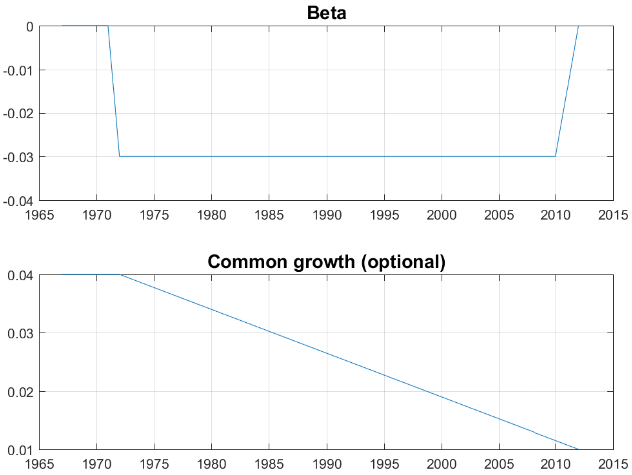
- Set β=0, calibrate all parameters to initial steady state (1967-1972)
- Calibrate a temporary decline in β (rich growing faster than poor), to match increase in income inequality (std s_{it})
- Assess empirical performance, growth and welfare impact of this change.

Initial steady state



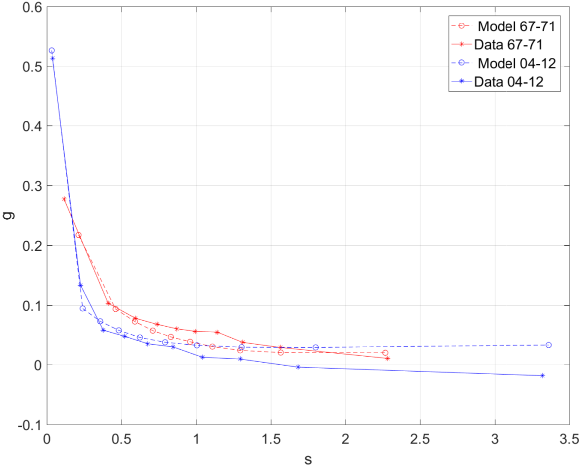
- Given $\rho \simeq 0.6$, from many micro studies, fixed effects needed to match flat right part
- Extensive margin plus increasing shock variance for low s_i needed to match spike on left part

Impulse

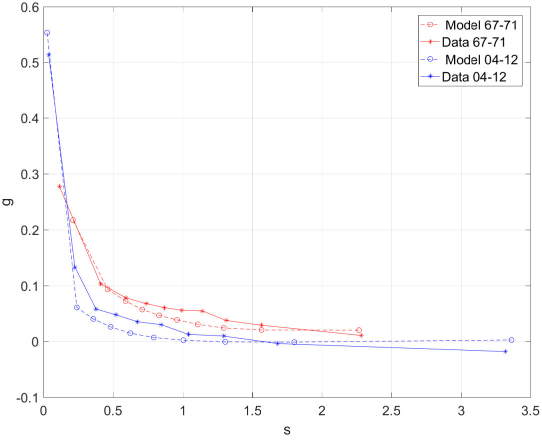


Change in β implies that hhold with $s_i = 2$ grows 1% per year faster than hhold at $s_i = 1$ (mean income)

Growth by decile of the income distribution Model vs Data (no common growth decline)

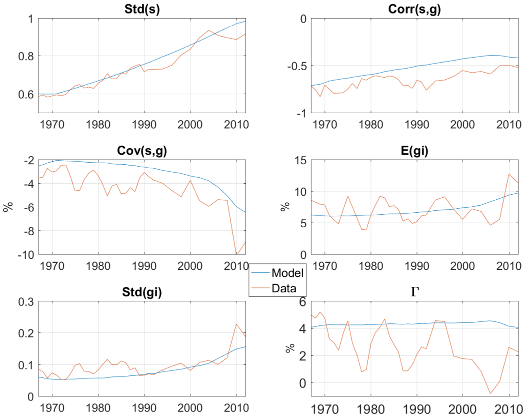


Growth by decile of the income distribution Model vs Data (with common growth decline)



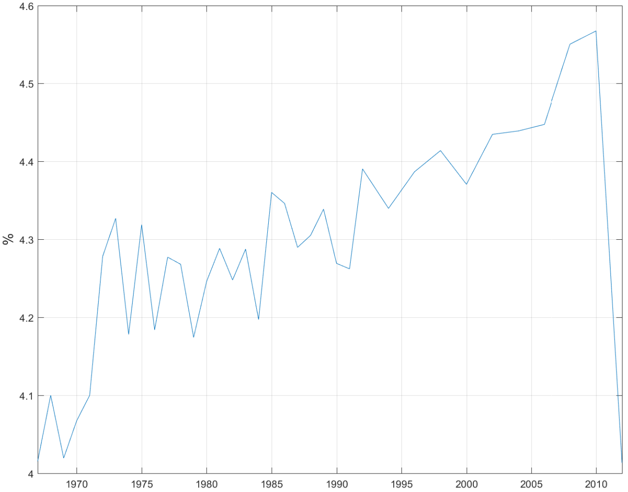
- Common growth decline of 3% needed to account for the full change

Time series patterns: Model v/s data



- Model qualitatively accounts for time series patterns of $cov(s_i, g_i)$ and $corr(s_i, g_i)$

Aggregate growth impact
Growth with $\bar{g} = 0$



Average growth contribution over 40 years is less than 0.5% per year

Welfare impact of the increase in unequal growth (β) (prelim)

	Ex ante welfare
Complete Mkts (Or strong public redistribution)	+
Incomplete Mkts + curvature	- -

Reason for the negative effect in IM

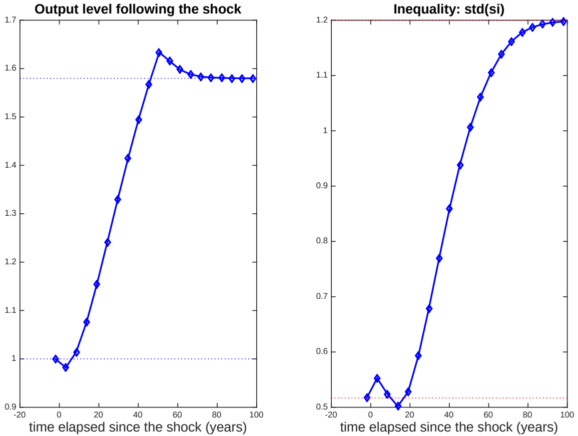
- Unequal growth leads to increase in permanent income inequality (Bowlus Robin, 2004, Abbott and Gallipoli, 2019, Straub, 2019)
- Increase in risk at the bottom of the distribution, where is more costly.

A Pareto model

- Show that unequal growth (i.e. more growth concentrated in the top of the distribution) can account for the facts in a model of the income process where distribution is Pareto (v/s log normal)
- In that model the growth impact of unequal growth is larger (1%)

Implication for Transition

Effects triggered by changes in inequality (shape of distribution)



About a 0.9% output growth per year over the first 40 years

Closing remarks and open issues

- Explore a statistical connection between inequality and growth
- $\Gamma_T = cov(g_{i,T}, s_i) + E(g_{i,T})$
  Use it to inform simple income process: Increase in unequal growth can account for patterns of inequality and has a non trivial effect on growth (+) and welfare (-)
- Takeaway: not inequality drives growth; but, micro changes that drive up inequality, also impact aggregate growth

Closing remarks and open issues

- Explore a statistical connection between inequality and growth
- $\Gamma_T = cov(g_{i,T}, s_i) + E(g_{i,T})$
  Use it to inform simple income process: Increase in unequal growth can account for patterns of inequality and has a non trivial effect on growth (+) and welfare (-)
- Takeaway: not inequality drives growth; but, micro changes that drive up inequality, also impact aggregate growth

Open issues

- What has driven the increase in unequal growth (SBTC certainly part of it, maybe other factors, like reduced access to opportunities (Fogli and Guerrieri, 2019), playing a role
- What has driven the large (and early) decline in equal growth?

Additional slides

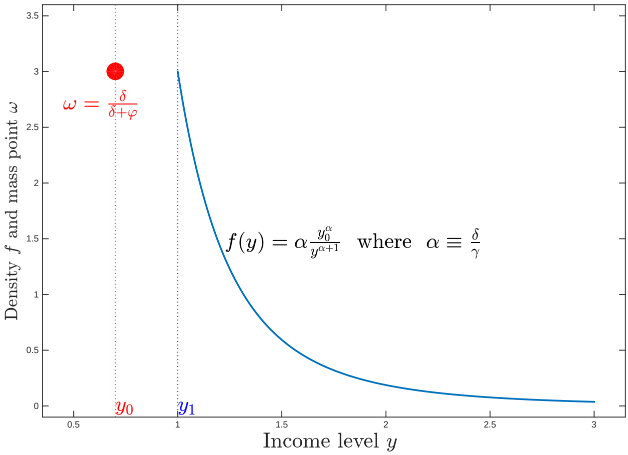
Simple model of “type depend. growth”, Gabaix et al.

Minimal assumptions for unequal growth:

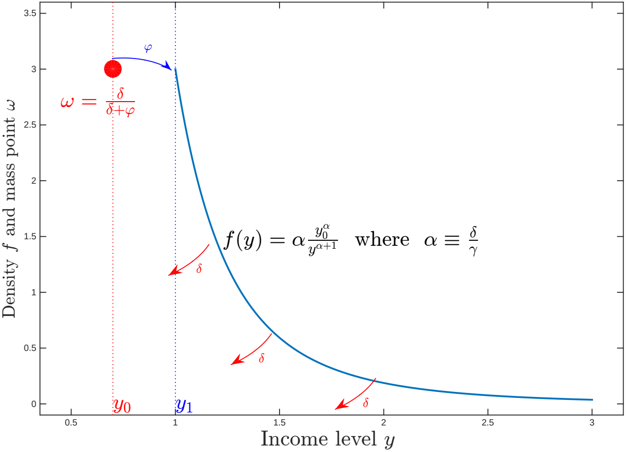
Environment: Income produced by successful projects/jobs

- New projects created at rate φ; die at rate δ
- Income from first successful project is y_1 grows at rate γ
- Fraction $\omega \equiv \frac{\delta}{\delta+\varphi}$ of agents w/o project w. constant income y_0

Model in a nutshell (steady state)

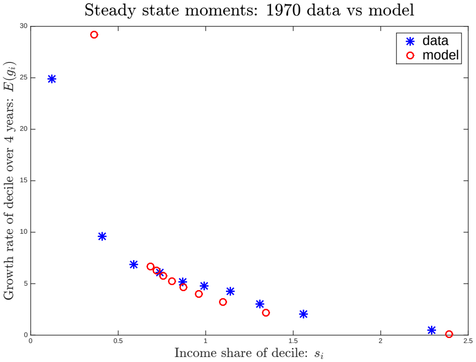


Model in a nutshell (steady state)



Model calibrated to early 1970's

Assumes steady state , so that $\Gamma_t = \bar{g}_t$, hence $E(g_i) = -cov(s_i, g_i)$



- $\{\delta, \varphi, \gamma, y_0\}$ chosen to match $std(s_i), std(g_i), cov(s_i, g_i), mobility$
- Captures tail of rich agents and growth spikes at the bottom

Transition after permanent shock

- Suppose parameters once and for all change at $t = 0$
- Old active projects keep old params (growth γ, die at rate δ)
- Agents w/o projects immediately face $\tilde{\delta}$, $\tilde{\varphi}$, $\tilde{\gamma}$
- Compute *transition* CDF, $F(y, t)$ and implied $\{cov(t), \sigma_{s_i}(t), \sigma_{g_i}(t)\}$
  – observable moments t periods after the shock occurred
- Calibration:
  – choose δ , φ , γ to match steady state moments in 1970
  – choose $\tilde{\delta}$, $\tilde{\varphi}$, $\tilde{\gamma}$ to match moments after $t = 40$ years

Tool: characterise dynamics of cross sectional distribution $f(y,t)$

- $t \in (0,\infty)$ time elapsed since shock

– fraction of agents who **low growth**: $\tilde{\omega}(t)$

$$\tilde{\omega}(t) = \tilde{\omega} + (\omega - \tilde{\omega} + \chi)\, e^{-(\tilde{\delta}+\tilde{\varphi})t} - \chi e^{-\delta t} \quad \text{where} \quad \chi \equiv \frac{(\tilde{\delta}-\delta)(1-\omega)}{\tilde{\varphi}+\tilde{\delta}-\delta}$$

– fraction of agents with **high growth**:

$$\eta(t) = 1 - \tilde{\omega}(t) - (1-\omega)e^{-\delta t}$$

– density of agents with **new project**: $\tilde{f}(y,t)$ solves KFE

$$\frac{\partial}{\partial t}\tilde{f}(y,t) = -\frac{\partial}{\partial y}\left(\tilde{f}(y,t)\tilde{\gamma}y\right) - \delta\tilde{f}(y,t) \quad \text{s.t.} \quad \int_{y_1}^{y_1 e^{\tilde{\gamma}t}} \tilde{f}(y,t) = \eta(t)$$

Characterising transition (in closed form)

Solving the PDE (using eigenvalue-eigenfunction decomposition) gives

$$\tilde{f}(y,t) = (1-\tilde{\omega})\frac{\tilde{\alpha} y_1^{\tilde{\alpha}}}{y^{1+\tilde{\alpha}}} - e^{-\delta t}(1-\omega-\chi)\frac{\frac{(\tilde{\delta}-\delta)}{\tilde{\gamma}} y_1^{\frac{(\tilde{\delta}-\delta)}{\tilde{\gamma}}}}{y^{1+\frac{(\tilde{\delta}-\delta)}{\tilde{\gamma}}}} + e^{-(\tilde{\delta}+\tilde{\varphi})t}(\omega-\tilde{\omega}+\chi)\frac{\frac{\tilde{\varphi}}{\tilde{\gamma}} y_1^{-\frac{\tilde{\varphi}}{\tilde{\gamma}}}}{y^{1-\frac{\tilde{\varphi}}{\tilde{\gamma}}}}$$

where exponents are “eigenvalues” (as in Gabaix et al. 2016)

Characterising transition (in closed form)

Solving the PDE (using eigenvalue-eigenfunction decomposition) gives

$$\tilde{f}(y,t) = (1-\tilde{\omega})\frac{\tilde{\alpha} y_1^{\tilde{\alpha}}}{y^{1+\tilde{\alpha}}} - e^{-\delta t}(1-\omega-\chi)\frac{\frac{(\tilde{\delta}-\delta)}{\tilde{\gamma}} y_1^{\frac{(\tilde{\delta}-\delta)}{\tilde{\gamma}}}}{y^{1+\frac{(\tilde{\delta}-\delta)}{\tilde{\gamma}}}} + e^{-(\tilde{\delta}+\tilde{\varphi})t}(\omega-\tilde{\omega}+\chi)\frac{\frac{\tilde{\varphi}}{\tilde{\gamma}} y_1^{-\frac{\tilde{\varphi}}{\tilde{\gamma}}}}{y^{1-\frac{\tilde{\varphi}}{\tilde{\gamma}}}}$$

where exponents are "eigenvalues" (as in Gabaix et al. 2016)

– distribution of incomes y at time t

$$\tilde{f}(y,t) \quad + \quad (1-\omega)\, h(y) \qquad \text{for} \quad y \in (y_1, \infty)$$

use it to compute moments $\{cov(t), \sigma_{s_i}(t), \sigma_{g_i}(t)\}, \quad \forall t$

Model calibration: fit and parameters

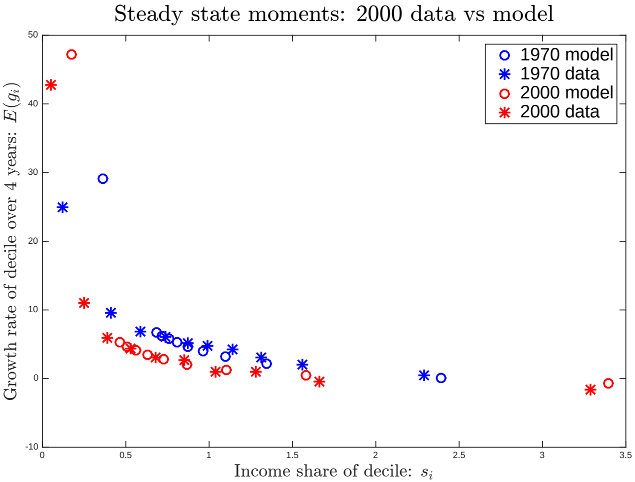
Target moments: data vs model

	$cov(g_i, s_i)$	$std(s_i)$	$std(g_i)$	Persistence at d10
1967-71	-0.033	0.62	0.07	0.60
model fit	-0.024	0.53	0.08	0.60
2004-2012	-0.066	0.94	0.13	0.68
model fit	-0.052	0.88	0.15	0.68
Calibr. Targets	NO	YES	YES	YES

Calibration Parameters chosen to match moments (st-st and transition)

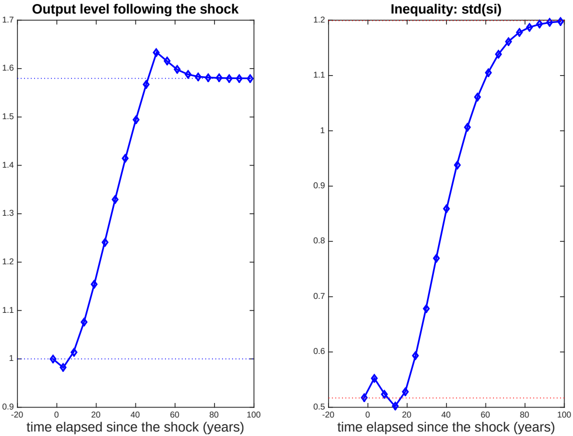
	δ	γ	φ	y_0
pre-shock	0.13	0.049	2.0	0.25
post -shock	0.10	0.068	1.1	0.25

Cross-sectional model fit



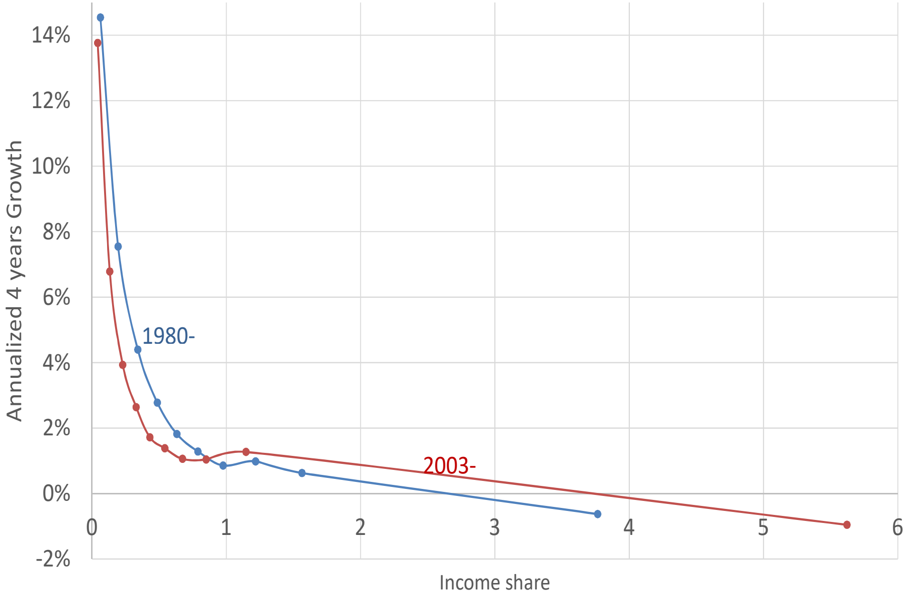
Implication for Transition

Effects triggered by changes in inequality (shape of distribution)

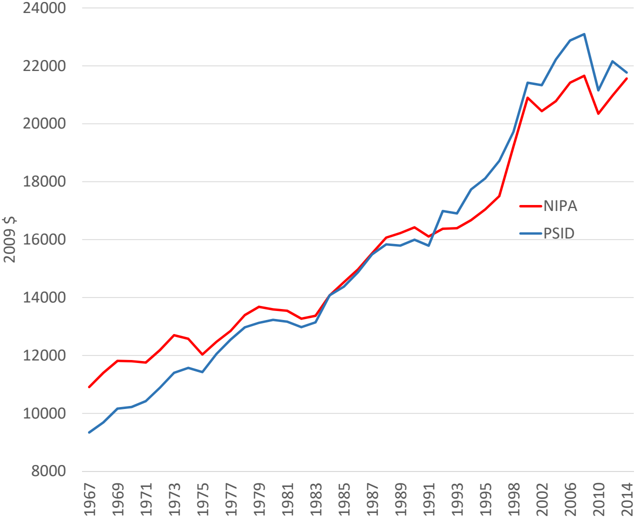


About a 0.9% output growth per year over the first 40 years

Income Growth and Income level in SIPP data



PSID v/s NIPA
Wages and Salaries per capita (Constant 2009 $)



- For labor income PSID matches NIPA Dynamics *and* Levels