Top Income Inequality and the Business Cycle

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Preliminary version

2021 AEA/ASSA Annual Meeting: Business Cycles

Motivation

Since the mid-1980s, the characteristics of the business cycle in the U.S. have substantially changed.

Since the mid-1980s, the cross-section of income distribution has also dramatically changed.

This project studies how the rising top income inequality driven by pass-through business income contributed to the changes in the business cycle.

This project

- Studies the role of rising top income inequality driven by pass-through business income on the business cycle.
  - Dimension 1: Low top-income inequality vs. High top income inequality
  - Dimension 2: Business income vs. Factor income, given high top income inequality
- Analyzes how the same aggregate productivity fluctuations affect an economy differently depending on differences in the cross-section along Dimension 1 and Dimension 2.
- Applies the repeated transition method to characterize nonlinear dynamics of aggregate allocations in the general equilibrium.
  - Simple representation fails to approximate the aggregate dynamics due to high nonlinearity coming from the dynamics in the cross-section.

Key results

Business-income-driven top income inequality explains the following changes in the business cycle:

- Stronger negative correlation between labor hours and productivity
- Greater volatility of labor hours and productivity relative to the output volatility

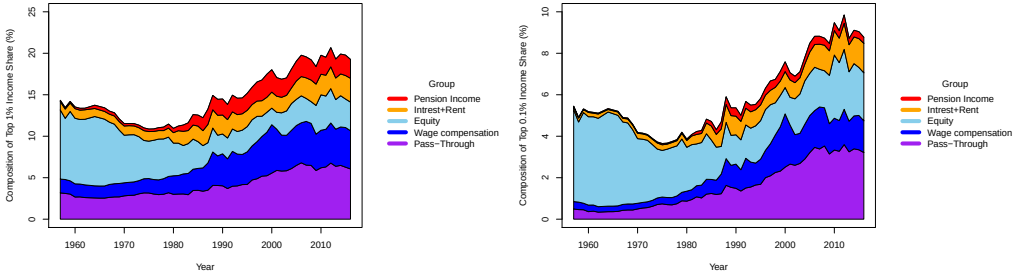
Roadmap

1. Summary of facts
2. Model
3. Core mechanism
4. Quantitative analysis
   - Calibration
   - Business cycle analysis
   - Failure of aggregation/representation

Summary of facts

Fact 1: Rising top income inequality driven by business income

- Pass-through business income is the main driver of rising top income inequality.
- In 2014, 84% of top 0.1% owned pass-through businesses. (Smith et al. 2019)



(a) Top 1%

(b) Top 0.1%

Figure: Rising top income share and income source decomposition (from PSZ data)

Fact 2: Changes in the business cycle

The literature has found the following changes in the business cycle since the mid-1980s:

- Output volatility has decreased.
- Correlation between hours and productivity has become negative.
- Volatilities of hours and productivity relative to output have increased.

	Pre-1984	Post-1985	RBC	Hetero. Labor supply	Reference
sd(Y)	2.59	1.23	1.60	1.28	Gali and Gambetti (2009)
Corr(Y/H,H)	0.18	-0.46	0.93	0.23	Gali and Gambetti (2009)
std(Y/H)/std(Y)	0.91	1.12	0.99	0.68	Gali and Gambetti (2009)
std(H)/std(Y)	0.79	1.20	0.44	0.76	Gali and Gambetti (2009)

Table: Changes in business cycle statistics

Model

Bird's-eye view of the model

Households

Measure one of heterogeneous households consume, work, and save.

Household is given with a: wealth, z: managerial ability, x: labor efficiency

Household can become an entrepreneur to earn a pass-through business profit.

Household is subject to a borrowing constraint (incomplete market).

Household pays income taxes and receive a lump-sum subsidy.

Production Technology

Pass-through businesses and C-corporations operate using labor and capital.

Pass-through businesses are subject to a financing constraint.

Aggregate TFP follows AR(1) process.

Competitive market

Two sectors over the same input factors: Pass-through business vs. C-Corp. sector

Pass-through business income

- An entrepreneur with wealth a_t and managerial ability z_t earns business income π defined as follows:

$$\pi(a_t, z_t) := \max_{k_t, l_{t,d}} z_t A_t \left(k_t^{\alpha} l_{t,d}^{1-\alpha} \right)^{\gamma} - w_t l_{t,d} - (r_t + \delta) k_t$$
$$\text{s.t} \quad k_t \leq a_t / \lambda$$

- $\gamma < 1$ is the span of control parameter: profit size is determined.
- Financing constraint λ: For capital stock k_t, only $1 - \lambda$ fraction of wealth a_t could be borrowed.
- Financing constraint motivates entrepreneur's saving besides the precautionary motivation.

Full characterization: Recursive formulation

Households are given with a : wealth, z : managerial ability, x : labor efficiency, and an occupation $j \in \{E(entrepreneur), W(worker), N(non\text{-}worker)\}$.
They receive the idiosyncratic shocks and then choose the occupation.

$$v_j(a,z,x;A,\Phi) = \max_{c,a'} \quad log(c) - \eta\bar{h}\{j \in \{E,W\}\}$$
$$+ \beta\mathbb{E}\left[\int_0^{\bar{\xi}} \max\{\max\{v_W(a',z'.x'), v_E(a',z'.x')\} - \xi, v_N(a',z',x')\} dG(\xi_w)\right]$$

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s.t.

$$c + a' = T + a + \left(\pi(a,z;A,\Phi)\mathbb{I}\{j=E\} + w(A,\Phi)x\bar{h}\mathbb{I}\{j=W\} + ar(A,\Phi)\right)(1-\tau)$$
$$a' \geq 0, \quad j \in \{E,W,N\}, \quad \Phi' = G_\Phi(K,\Phi,A),$$
$$log(A') = \rho_A log(A) + \sigma_A\epsilon, \quad log(z') = \rho_z log(z) + \sigma_z\epsilon, \quad x'|x \sim \Gamma(x'|x)$$

where A is aggregate TFP and Φ is the distribution of households.

Supply and demand in the input market

- Competitive C-Corp. production sector is considered.

$$\max_{K,L} \quad AK^{\alpha}L^{1-\alpha} - w(A,\Phi)L - (r(A,\Phi)+\delta)K$$

- Prices $(r(A,\Phi), w(A,\Phi))$ clear capital and labor market
- Capital market clears:

$$\underbrace{\int k(a,z,x;A,\Phi)\mathbb{I}\{j=E\}d\Phi(a,z,x;A)}_{\text{K demand from pass-through}} + \underbrace{K(A,\Phi)}_{\text{K demand from C-Corp.}} = \underbrace{\int a d\Phi(a,z,x;A)}_{\text{K supply}}$$

- Labor market clears:

$$\underbrace{\int l_d(a,z,x;A,\Phi)\mathbb{I}\{j=E\}d\Phi(a,z,x;A)}_{\text{L demand from pass-through}} + \underbrace{L(A,\Phi)}_{\text{L demand from C-Corp.}} = \underbrace{\int x\mathbb{I}\{j=W\}d\Phi(a,z,x;A)}_{\text{L supply}}$$

Core mechanism

Core mechanism

- Financially constrained pass-through businesses: the labor adjustment and output change is less volatile than in C-corporations (in intensive margin).
- This generates an intercept effect in the aggregate output.

$$\text{Productivity} = \frac{Y^A}{H} = \frac{\int y_i d\Phi + Y}{\int l_{d,i} d\Phi + L} = \frac{y + Y}{l_d + L} = \frac{y + \frac{w(A,\Phi)}{(1-\alpha)} L}{l_d + L} = \frac{y + \frac{w(A,\Phi)}{(1-\alpha)} (H - l_d)}{H}$$

$$= \frac{\overbrace{\left(y - \frac{w(A,\Phi)}{(1-\alpha)} l_d \right)}^{\text{Intercept effect}} + \overbrace{\frac{w(A,\Phi)}{(1-\alpha)}}^{\text{Conventional productivity}} H}{H}$$

Core mechanism - output intercept

- An increase in hours(H) is associated with a drop in productivity(Y/H) on average due to the presence of the intercept effect in output(Y^A).

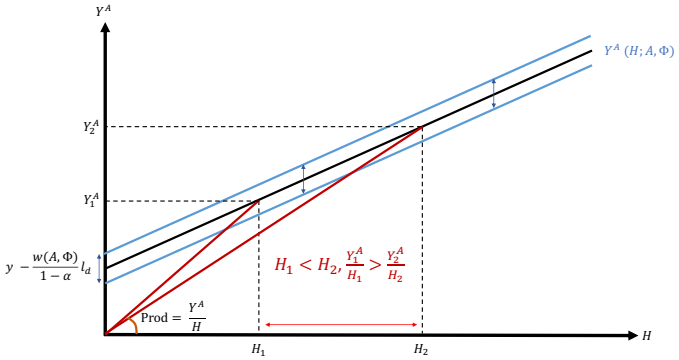


Figure: Intercept effect from path-through business

Core mechanism - empirical evidence

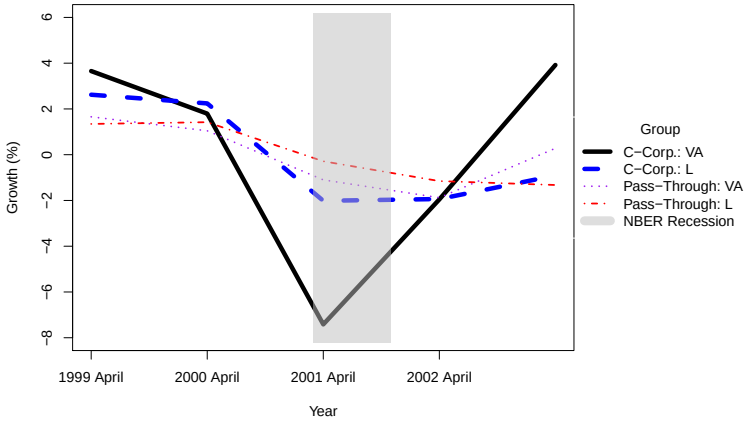


Figure: Value-add and labor cost around the dot-com bubble

(Source: SOI Tax Stats - Integrated Business Data)

Core mechanism - empirical evidence II

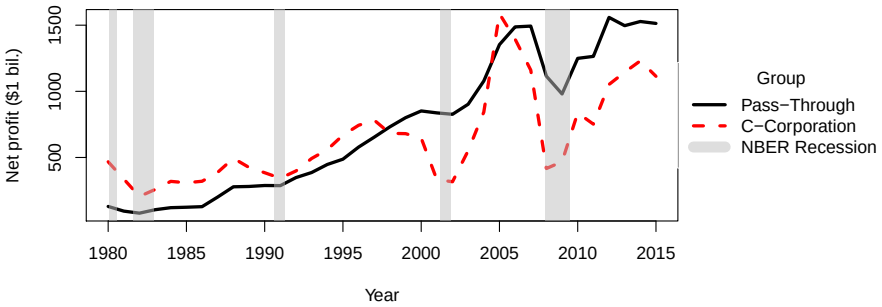


Figure: Net profit for pass-through businesses and C-corporations
(Source: SOI Tax Stats - Integrated Business Data)

Quantitative Analysis

Calibration - cross-sectional moments

Target Moments	D(10s)	M(10s)	D(80s)	M(80s)	M(CF)	Parameters
Baseline						
Emp-to-population ratio (%)	59.4	60.9	60.1	61.5	61.3	η: Labor supply disutility
Pass-through output fraction (%)	64.0	62.2	33.2	29.1	27.2	γ: Span of control
Top 0.1% income share (%)	9.2	8.2	4.8	4.1	8.2	ρ: Managerial ability
Top 1% income share (%)	19.7	19.1	12.5	12.1	19.2	σ: Managerial ability
Top 0.1% business income share (%)	3.3	3.7	1.5	1.1	0.8	x_2: Labor efficiency
Top 1% business income share (%)	6.2	6.8	2.6	2.3	1.9	x_3: Labor efficiency
Top 0.1% wealth share (%)	19.3	15.4	8.6	6.5	18.5	m_1: Labor transition rate
Top 1% wealth share (%)	37.5	38.1	23.6	21.1	39.1	m_2: Labor transition rate

Table: Target moments (Decreasing: blue, Increasing: red)

- The financing constraint λ is fixed at 0.75: imperfect calibration yet.
- Gini coefficient for wealth and income distribution is (0.88, 0.49) in the 2010s, and (0.88, 0.40) in the 1980s. (Kuhn and Rios-Rull, 2016: (0.85, 0.58) in 2013, and Gini coefficient for income was 0.55 in 1989)

Business cycle analysis: Cyclicality

- The economy with business-income-driven top income inequality features the strongest negative correlation between labor hours and productivity.

	2010s		1980s		Counterfactual	RBC
	Data	Baseline	Data	Model	Model	Model
Corr(C,Y)	0.84	0.82	0.81	0.81	0.84	0.96
Corr(I,Y)	0.90	0.92	0.93	0.95	0.94	0.98
Corr(H,Y)	0.83	0.79	0.81	0.80	0.81	0.95
Corr(H,Y/H)	-0.53	-0.46	-0.22	-0.01	-0.11	0.93

Table: Time-series correlations

Business cycle analysis: Volatility

- The economy with business-income-driven top income inequality features the highest volatility of labor hours and productivity relative to the output volatility.
- The levels of the volatilities are not perfectly consistent: missing volatility that might be explained by non-technological shocks.

	2010s		1980s		Counterfactual	RBC
	Data	Baseline	Data	Model	Model	Model
std(Y)	0.84	0.82	0.81	0.83	0.84	1.60
std(C)/std(Y)	0.64	0.55	0.47	0.56	0.57	0.45
std(H)/std(Y)	1.17	0.81	0.93	0.61	0.65	0.45
std(Y/H)/std(Y)	0.65	0.89	0.61	0.71	0.73	0.66

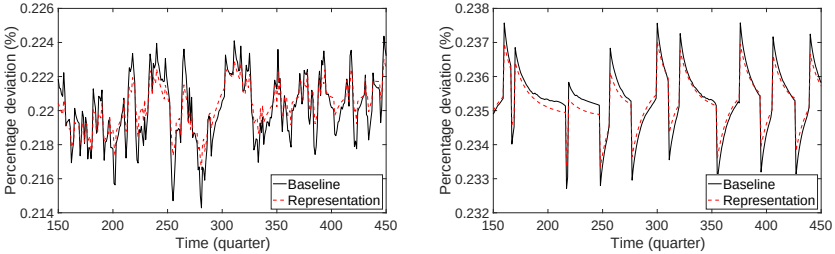
Table: Time-series volatilities

Why does baseline model work while the others not?

- If an economy's TFP-driven dynamics can be perfectly represented by an aggregate dynamics of a single agent, it is simply a different calibration of the standard RBC model.

- The baseline model is not perfectly represented by the aggregate dynamics of a model with a representative agent.
  - It is due to endogenous changes in the fraction of financially-constrained firms: nonlinearity in the labor demand.

Nonlinear dynamics of aggregate employment



(a) Baseline model of 2010s: $R^2 = 0.41$ (b) Counterfactual model: $R^2 = 0.82$

Figure: Comparison of dynamics aggregate employment

- Due to hetergeneous labor demand sensitivities to TFP shocks between pass-through businesses and C-corporations, each sectors' dynamics does not follow a log-linear rule in the baseline model: R^2 is around 0.41.
- Repeated transition method properly solves the equilibrium nonlinear dynamics without an internal loop for the non-trivial market clearing condition.

Conclusion

Conclusion

- Top income households as pass-through business owners play an important role in the productivity-driven aggregate fluctuations.
  - Decreases correlations between labor hours and productivity.
  - Increases volatility of labor hours and productivity relative to output volatility on the TFP-driven aggregate fluctuations.

Thank you!

Core mechanism - proof

$$\text{Productivity} = \frac{\int y_i d\Phi + Y}{\int l_{d,i} d\Phi + L} = \frac{\left(\frac{(1-\alpha)\gamma}{w(A,\Phi)}\right)^{\frac{(1-\alpha)\gamma}{1-(1-\alpha)\gamma}} \int \left(z_i A k_i^{\alpha\gamma}\right)^{\frac{(1-\alpha)\gamma}{1-(1-\alpha)\gamma}} d\Phi + \left(\frac{1-\alpha}{w(A,\Phi)}\right)^{\frac{1-\alpha}{\alpha}} AK}{\left(\frac{(1-\alpha)\gamma}{w(A,\Phi)}\right)^{\frac{1}{1-(1-\alpha)\gamma}} \int \left(z_i A k_i^{\alpha\gamma}\right)^{\frac{(1-\alpha)\gamma}{1-(1-\alpha)\gamma}} d\Phi + \left(\frac{1-\alpha}{w(A,\Phi)}\right)^{\frac{1}{\alpha}} AK}$$

$$= \quad \ldots$$

$$= \frac{\left(\frac{(1-\alpha)\gamma}{w(A,\Phi)}\right)^{\frac{(1-\alpha)\gamma}{1-(1-\alpha)\gamma}} M(\Phi) + \left(\frac{1-\alpha}{w(A,\Phi)}\right)^{\frac{1-\alpha}{\alpha}} Q(A,\Phi)}{\left(\frac{(1-\alpha)\gamma}{w(A,\Phi)}\right)^{\frac{1}{1-(1-\alpha)\gamma}} M(\Phi) + \left(\frac{1-\alpha}{w(A,\Phi)}\right)^{\frac{1}{\alpha}} Q(A,\Phi)}$$

Core mechanism - proof (Cont'd) Back

- If all pass-through businesses are financially constrained and no entry and exit is allowed, in the partial equilibrium,

$$\frac{\partial \text{Productivity}}{\partial Q(A,\Phi)} = \frac{M(\Phi)\left(\left(\frac{1-\alpha}{w}\right)^{\frac{1-\alpha}{\alpha}}\left(\frac{(1-\alpha)\gamma}{w}\right)^{\frac{1}{1-(1-\alpha)\gamma}} - \left(\frac{(1-\alpha)\gamma}{w}\right)^{\frac{(1-\alpha)\gamma}{1-(1-\alpha)\gamma}}\left(\frac{1-\alpha}{w}\right)^{\frac{1}{\alpha}}\right)}{\left(\left(\frac{(1-\alpha)\gamma}{w}\right)^{\frac{1}{1-(1-\alpha)\gamma}} M(\Phi) + \left(\frac{1-\alpha}{w}\right)^{\frac{1}{\alpha}} Q(A,\Phi)\right)^2} < 0$$

$$\frac{\partial \text{Labor hour}}{\partial Q(A,\Phi)} = A^{\frac{(1-\alpha)\gamma}{1-(1-\alpha)\gamma}}\left(\frac{1-\alpha}{w}\right)^{\frac{1}{\alpha}} > 0$$

- Thus, productivity and hours become negatively correlated.