Pricing Inequality

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Pricing and the Distribution of Demand

Core idea of this paper:

heterogeneity in household wealth and income $\rightarrow$ **heterogeneity in price sensitivity** $\rightarrow$ price setting

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Two examples motivating this idea...

1. Auer, Burstein, Lein, and Vogel (2022)
   - In the context of the 2015 Swiss appreciation, they find rich households are less price elastic.
2. Stroebel and Vavra (2019)
   - In the context of increases in local house prices, they find areas with more owners → larger increases in markups on goods.

Our Paper

1. Theory: $\underbrace{\text{incomplete markets}}_{\text{Bewley, Aiyagari, Hugget}} + \underbrace{\text{extensive margin demand}}_{\text{Multinomial logit + Oligopoly}}$ in general equilibrium.

We show how households' marginal utility of wealth shapes:

- variation price elasticities of demand,
- sorting into high- and low-price varieties,
- and affects pass-through.

2. Quantitative exercise (today): a lump sum transfer to households by the government.

Reduces demand elasticities of most elastic households, i.e. the poor. This leads to

$\Rightarrow$ higher markups, and especially so for the firms selling to poor,

$\Rightarrow$ lower TFP.

Goods and Firms

Differentiated goods:

Markets $m \in \mathcal{M}$, each contain J firms $j \in \{1, \ldots, J\}$, oligopolists with technology

$$y_{jmt} = z_{jm}\, n_{jmt} \quad , \quad \left(\psi_{jm}, z_{jm}\right) \sim \Gamma_{\psi,z}\left(\psi, z\right).$$

- z_{jm} is firm productivity.
- n_{jmt} are efficiency units of labor supplied by households.
- ψ_{jm} is quality (next slide), $\Gamma_{\psi,z}$ is the joint distribution of quality and productivity.

Homogeneous (outside) good:

Continuum of identical firms, competitive

$$y_{ct} = \overline{z}_c\, n_{ct}.$$

Households

Continuum of households with names $i \in [0,1]$. Household preferences:

$$\mathbb{E}_0\left[\sum_{t=0}^{\infty}\beta^t\sum_{m\in\mathcal{M}}\sum_{j=1}^{J}\widetilde{u}^i_{jmt}\right],\quad \widetilde{u}^i_{jmt}=\begin{cases}u\left(c^i_t, x^i_{jmt}\right)+\psi_{jm}+\zeta^i_{jmt} & \text{, if consume } jm\\ 0 & \text{, otherwise}\end{cases},\quad \underbrace{\zeta^i_t\sim\Gamma_\zeta\left(\zeta\right)}_{\text{iid each period}}.$$

Each period a household chooses

- a single good from a market m and producer j, and quantity x^i_{jmt},
- consumption of the homogeneous good,
- save a^i_t in government debt with interest rate r and facing borrowing constraint $\underline{a}$,
- while facing stochastic productivity e^i_t that evolve according to a Markov chain.

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Taste shocks are distributed GEV

$$\prod_{m \in \mathcal{M}} \exp \left\{ - \left(\sum_{j \in J} e^{-\eta \zeta^i_{jm}} \right)^{\theta/\eta} \right\}$$

- θ controls dispersion across markets $\mathcal{M}$,
- η controls dispersion across js within market m.
- Why are we doing this? With $\theta \neq \eta$ allows us to think about an Atkeson and Burstein (2008) like setting; with $\theta = \eta$ collapses to monopolistic competition.

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For now, we will keep u pretty general...

and summarize stuff in terms of elasticities and the hh's multiplier on its budget constraint.

What Households Do

Focus on a stationary setting. A hh's state are its asset holdings a and shock e.

1. Given prices p_{jm} and preferences ζ_{jm}, choose a market m and producer j

$$\overline{V}\Big(a, e\Big) := \mathbb{E}_{\zeta}\left[\ \max_{j,m}\left\{V\Big(a, e, p_{jm}\Big) + \frac{1}{\eta}\log\phi_{jm} + \zeta^{i}_{jm}\right\}\right]$$

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$$\widetilde{V}\left(a, e, \mathbf{p}_m\right) = \log \left[\sum_{j \in m} \phi_{jm} \exp\left\{ V\left(a, e, p_{jm}\right) \right\}^{\boldsymbol{\eta}} \right]^{1/\boldsymbol{\eta}}$$

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2. Conditional on choosing firm jm, and given W, r, Π, p_{jm}, their problem is

$$V\Big(a, e, p_{jm}\Big) = \max_{a', c, x} \; u\big(c, x\big) + \beta \int \overline{V}\Big(a', e'\Big) \, d\Gamma_e\big(e'|e\big),$$

subject to: $\quad p_c c + p_{jm} x_{jm} + a' = \Big(1 - \tau\Big) we + (1 + r)a + \Pi \quad \text{and} \quad a' \geq \underline{a},$

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subject to: $\quad p_c c + p_{jm}x_{jm} + a' = \Big(1-\tau\Big)we + (1+r)a + \Pi \quad$ and $\quad a' \geq \underline{a},$

an important object: $\quad \lambda(a, e, p_{jm})$ = multiplier on the budget constraint / shadow value of wealth

What Firms Do

Given competitors' Prices $\mathbf{p}_m$ and aggregates $\mathbf{S}$, choose price p_{jm} to maximize profits

$$p^*_{jm} = \arg\max_{p_{jm}} \underbrace{x\Big(p_{jm}, \mathbf{p}_m, \mathbf{S}\Big)}_{\text{Demand}} \underbrace{\left(p_{jm} - \frac{w}{z_{jm}}\right)}_{\text{Per unit profit}}$$

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The equilibrium quantity sold is

$$x\Big(p_{jm}, \mathbf{p}_m, \mathbf{S}\Big) = \int_{A\times E} \rho\Big(a, e, p_{jm}, \mathbf{p}_m, \mathbf{S}\Big) x\Big(a, e, p_{jm}, \mathbf{p}_m, \mathbf{S}\Big)\, \mathrm{d}\,\Gamma(a, e)$$

$$\rho\Big(a, e, p_{jm}, \mathbf{p}_m, \mathbf{S}\Big) = \phi_{jm} \left(\frac{\exp\left\{V\big(a, e, p_{jm}\big)\right\}}{\exp\left\{\widetilde{V}\big(a, e, p_{jm}, \mathbf{p}_m\big)\right\}}\right)^{\boldsymbol{\eta}} \left(\frac{\exp\left\{\widetilde{V}\big(a, e, p_{jm}, \mathbf{p}_m\big)\right\}}{\exp\left\{\overline{V}\big(a, e\big)\right\}}\right)^{\boldsymbol{\theta}}$$

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The equilibrium quantity sold is (and simplifying notation a bit)

$$x_{jm} = \int \rho^i_{jm} x^i_{jm}\, di$$

$$\rho^i_{jm} = \underbrace{\phi_{jm} \left(\frac{\exp\left\{V^i(p_{jm})\right\}}{\exp\left\{\widetilde{V}^i(\mathbf{p}_m)\right\}} \right)^{\boldsymbol{\eta}}}_{x^i_{j|m}} \underbrace{\left(\frac{\exp\left\{\widetilde{V}^i(\mathbf{p}_m)\right\}}{\exp\left\{\overline{V}^i\right\}} \right)^{\boldsymbol{\theta}}}_{x^i_m}$$

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Optimality — standard markup condition under Bertrand

$$p^*_{jm} = \underbrace{\frac{\varepsilon_{jm}}{\varepsilon_{jm} - 1}}_{\text{Markup}} \quad \underbrace{\frac{w}{z_{jm}}}_{\text{Marginal cost}}$$

$$\varepsilon_{jm} = -\frac{\partial \log x_{jm}}{\partial \log p_{jm}}\bigg|_{\mathbf{p}^*_{-jm}}$$

Elasticities of Demand

The firms elasticity of demand is

$$\varepsilon_{jm} = -\frac{\partial \log x_{jm}}{\partial \log p_{jm}} = \int \underbrace{\left(\frac{\rho_{jm}^{i} x_{jm}^{i}}{x_{jm}}\right)}_{\text{weights}} \underbrace{\left(\varepsilon_{jm}^{\rho,i} + \varepsilon_{jm}^{x,i}\right)}_{\text{individual elasticities}} \; di,$$

a weighted average of **individuals** elasticities of demand. . . on the extensive and intensive margin.

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a weighted average of **individuals** elasticities of demand... on the extensive and intensive margin.

$$\varepsilon^{\rho,i}_{jm} = \underbrace{\left[\boldsymbol{\eta}\left(1-\rho^{i}_{j|m}\right) + \boldsymbol{\theta}\rho^{i}_{j|m}\right]}_{\text{oligopoly}} \times \underbrace{\left[\lambda^{i}_{jm} \; p_{jm} \; x^{i}_{jm}\right]}_{\text{wealth}}$$

Extensive margin demand depend on two factors:

1. How important firm jm is in the market of type i consumers — where the oligopoly part matters.
2. How rich or poor those consumers as summarized by λ^{i}_{jm} — where the Bewley part matters.

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a weighted average of **individuals** elasticities of demand. . . on the extensive and intensive margin.

$$\varepsilon^{\rho,i}_{jm} = \underbrace{\eta}_{\text{taste shocks}} \times \underbrace{\left[u'(x^i_{jm})\; x^i_{jm}\right]}_{\text{wealth}}$$

Special case: $\eta = \theta$ (no market power); only differentiated goods. . .

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$$\varepsilon^{\rho,i}_{jm} = \underbrace{\eta}_{\text{taste shocks}} \times \underbrace{\left[x^i_{jm}\right]^{1-\sigma}}_{\text{wealth}}$$

Special case: $\eta = \theta$, only differentiated goods...

With CRRA $\Rightarrow$ and $\sigma > 1$, than the poor are more elastic on extensive margin.

With log, then we have an Anderson et al. (1987) like result and heterogeneity plays no role.

Elasticities of Demand

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$$\varepsilon^{x,i}_{jm} = -\frac{\partial \log x^i_{jm}}{\partial \log p_{jm}}$$

Intensive margin is harder to characterize, but it depends on. . .

- substitutability / complimentarily between c and x,
- intertemporal motives,
- on the computer we know it's small relative to the extensive margin.

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What about the weights? This depends upon how rich and poor households sort across the product space . . . next slide.

Sorting

Here is the question:

Fix prices, how do choices probabilities $\rho^i_{j|m}$ change with wealth?

$$\frac{\partial}{\partial p_{jm}} \frac{\partial \log \rho^i_{j|m}}{\partial a^i} \approx (1+r)\, \boldsymbol{\eta} \left(\frac{\lambda^i_{\overline{jm}} - \lambda^i_{\underline{jm}}}{p_{\overline{jm}} - p_{\underline{jm}}} \right) > 0$$

where $\overline{jm}$ is a high price good relative to $\underline{jm}$.

This term has to be positive since higher prices tighten the budget constraint.

Like previous slide, this is all about the marginal utility of wealth — that's the core issue dictating who consumes what.

Pass-Through

How do prices change given a change in marginal costs, aka pass-through:

$$\frac{\partial \log p_{jm}}{\partial \log mc_{jm}} = \frac{[\varepsilon_{jm} - 1]}{[\varepsilon_{jm} - 1] + \left\{ \frac{\partial \log \varepsilon_{jm}}{\partial \log p_{jm}} \right\}_{(+)}} \in (0, 1),$$

where $\frac{\partial \log \varepsilon_{jm}}{\partial \log p_{jm}} := \mathcal{E}_{jm}$ is the "super-elasticity" which takes this form...

The Super-Elasticity

The super-elasticity...

$$\mathcal{E}_{jm} = \int \overbrace{\underbrace{\left(\frac{\rho^i_{jm} x^i_{jm} \varepsilon^i_{jm}}{\int \rho^i_{jm} x^i_{jm} \varepsilon^i_{jm}}\right)}_{\text{weights}} \left(\frac{\partial \log \left[\rho^i_{jm} x^i_{jm} / x_{jm}\right]}{\partial \log p_{jm}}\right)}^{\text{composition}} di \quad + \quad \int \left(\frac{\rho^i_{jm} x^i_{jm} \varepsilon^i_{jm}}{\int \rho^i_{jm} x^i_{jm} \varepsilon^i_{jm}}\right) \underbrace{\mathcal{E}^i_{jm}}_{\text{i's super elasticity}} di.$$

The aggregate super-elasticity is a weighted average of

- how do expenditure weights change,
- how individual elasticities change.

The Individual Super-Elasticity

Individual super elasticity is weighted average of extensive and intensive margin super elasticities. . . abstract from the intensive margin and we have:

$$\mathcal{E}^i_{jm} \approx \underbrace{\left[\frac{\eta(\eta-\theta)\rho^i_{j|m}(1-\rho^i_{j|m})}{\eta-(\eta-\theta)\rho^i_{j|m}}\right] \times \left[\lambda^i_{jm} p_{jm} x^i_{jm}\right]}_{\text{market power effect}} + \underbrace{\frac{\partial \log \lambda^i_{jm}}{\partial \log p_{jm}} + \varepsilon^{i,x}_{jm} + 1}_{\text{wealth effect}}.$$

As with the elasticities, very similar ideas here:

- market power,
- how the marginal utility of wealth changes.

The Individual Super-Elasticity

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As with the elasticities, very similar ideas here:

- market power,
- how the marginal utility of wealth changes.

So what? The key issue is how markups and super-elasticities are (i) not "parameterized" and (ii) depend upon market power forces and the distribution of wealth.

Quantitative Analysis

This is what I'll do today...

0. Special case: monopolistic competition, no homogenous good, no quality.

1. Jiggle parameters around aiming for Auer et al. (2022) like facts.

2. Highlight some cross-sectional implications of the model.

3. Main exercise: How does the economy respond to a fiscal transfer?

Parameters

Household Parameters:

- CRRA for u with relative risk aversion σ — varied to fit elasticities in Auer et al. (2022).
- Dispersion parameter on taste shocks, η — aiming for average mark-up of 20%.
- Earnings process as in Krueger, Mitman, and Perri (2016).
- No Borrowing, $\bar{a} = 0$.
- Discount factor β to target an interest rate of 2.0%.

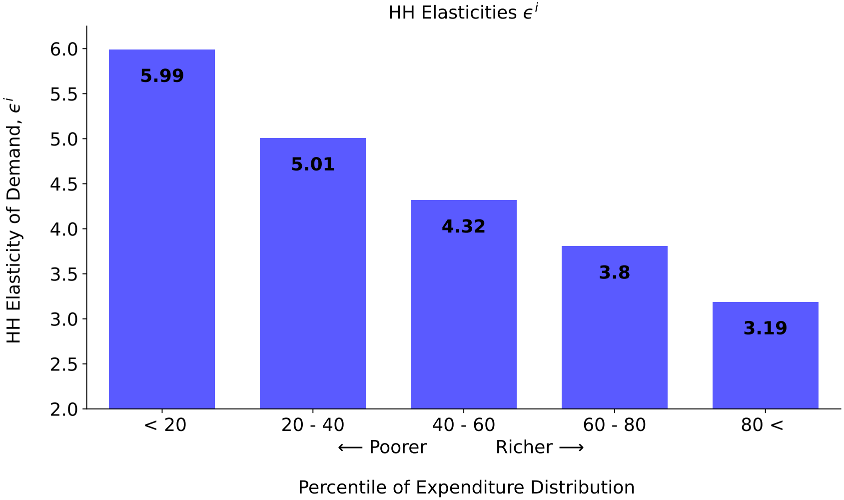
Firm Parameters:

- Firm productivity Pareto distributed with shape parameter of 3.

Government:

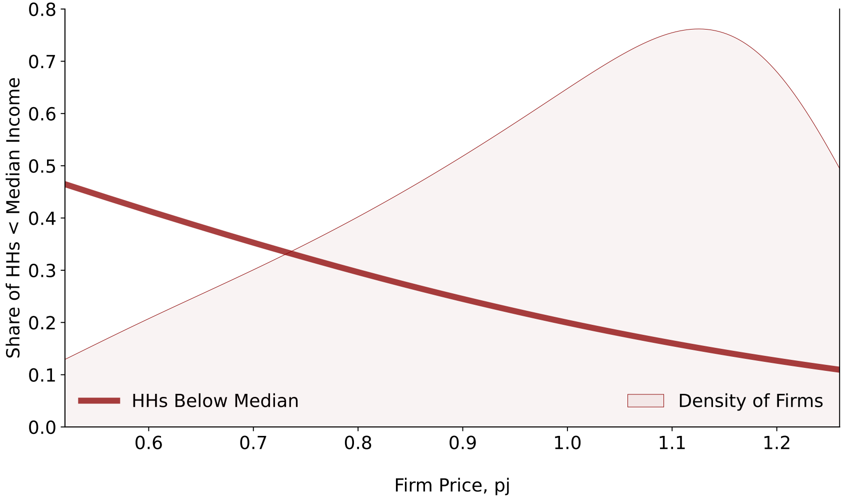
- Labor income tax rate of 20%; government debt (liquid wealth) of 56% of GDP.

Model: HH-Level Elasticities



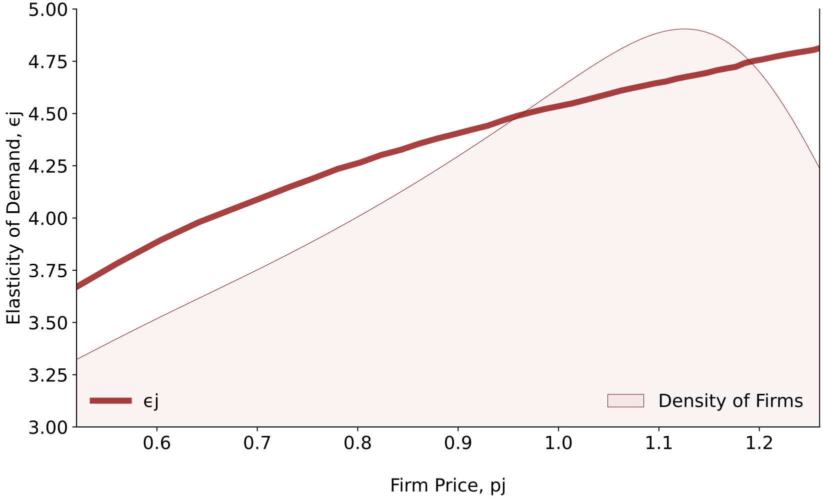
- Poor more elastic than the rich, consistent with findings in Auer et al. (2022).

Model: Sorting of HHs and Firms



- Low price (and larger firms) sell to relatively more poor households.

Model: Firms and Elasticities



- Low price (and larger firms) have lower elasticities and larger markups.

How Does the Economy Respond to a Fiscal Transfer?

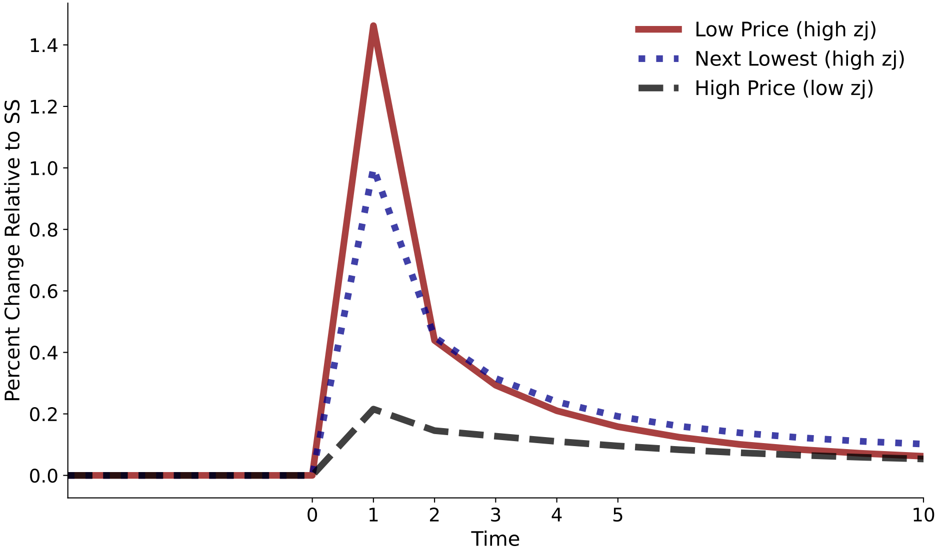
The government lump sum transfers resources to all households. . .

- One time, unanticipated shock. We solve for the complete transition path.
- R is fixed and government spending is fixed, debt policy passively adjusts.

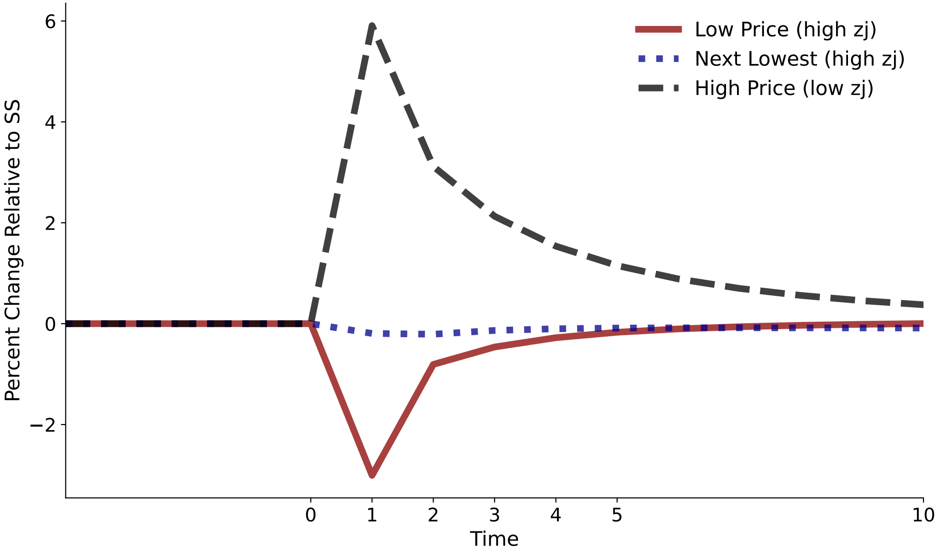
Focus on. . .

- how prices (and markups) respond,
- firm size,
- and aggregate productivity.

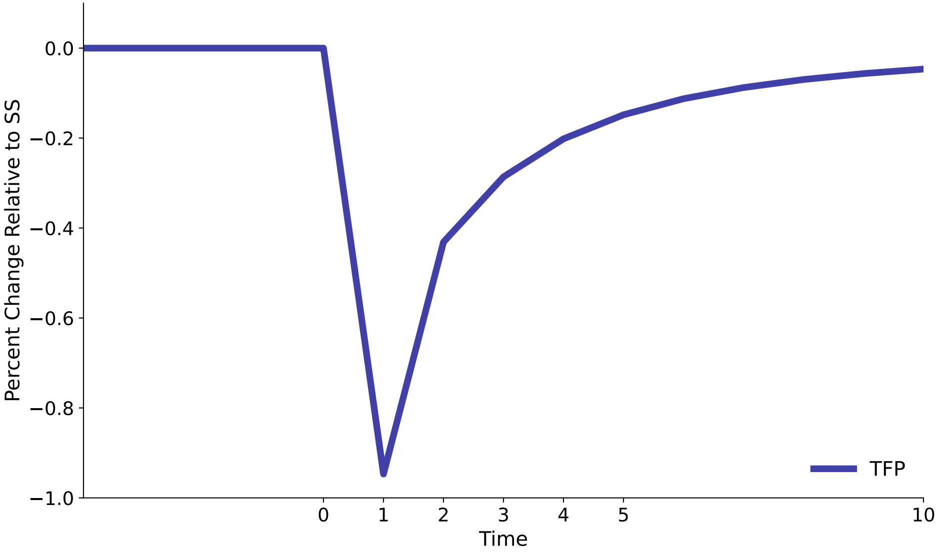
Lump Sum Transfer $\Rightarrow$ Prices and Markups $\nearrow$



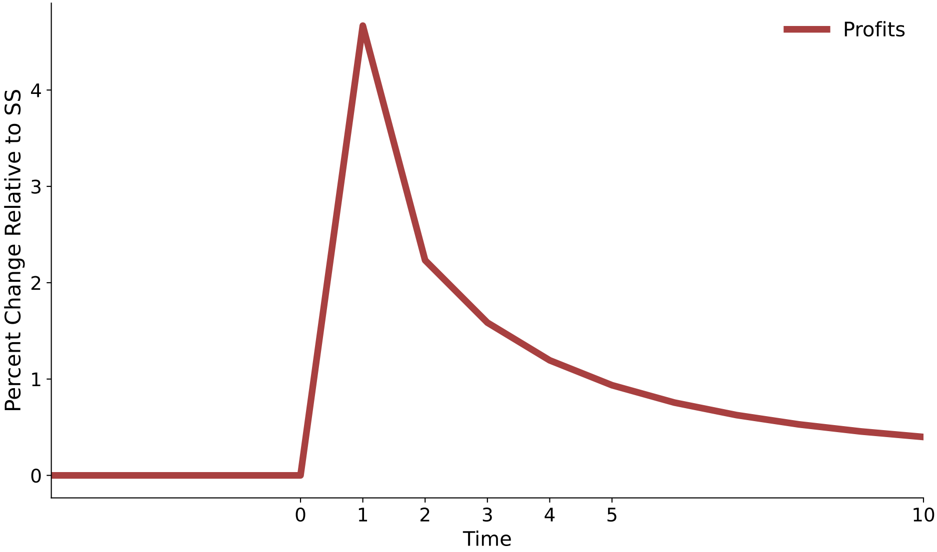
Lump Sum Transfer ⇒ Reallocation Across Firms



Lump Sum Transfer $\Rightarrow$ TFP $\searrow$



Lump Sum Transfer ⇒ Aggregate Profits ↗



Still baking. . .

Things to lookout for in the future. . .

- Complete quantitative analysis with oligopoly.
- The role of quality vs. productivity in determining firm outcomes and sorting of hh's to firms.
- The role of market incompleteness in shaping pricing outcomes. Connects with our other work on complete markets in discrete choice economies.

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