

Market Power I

Market Power: Markups

- ▶ Secular trend: the emergence of “superstar firms”
- ▶ Has this lead to an increase in market power?
- ▶ If so, what are the consequences for inequality, welfare, policy... ?

Plan:

- Markups: Measurement and empirical facts
- Introduction to models with variable markups
- Applications
 - Government policies in open economies
 - Pass-through of exchange rate shocks into prices
 - Monetary policy

Motivation

WHITE HOUSE



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FACT SHEET: Executive Order on Promoting Competition in the American Economy



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The economy is booming under President Biden’s leadership. The economy has gained more than three million jobs since the President took office—the most jobs created in the first five months of any presidency in modern history. Today, the President is building on this economic momentum by signing an [Executive Order](#) ↗ to promote competition in the American economy, which will lower prices for families, increase wages for workers, and promote innovation and even faster economic growth.

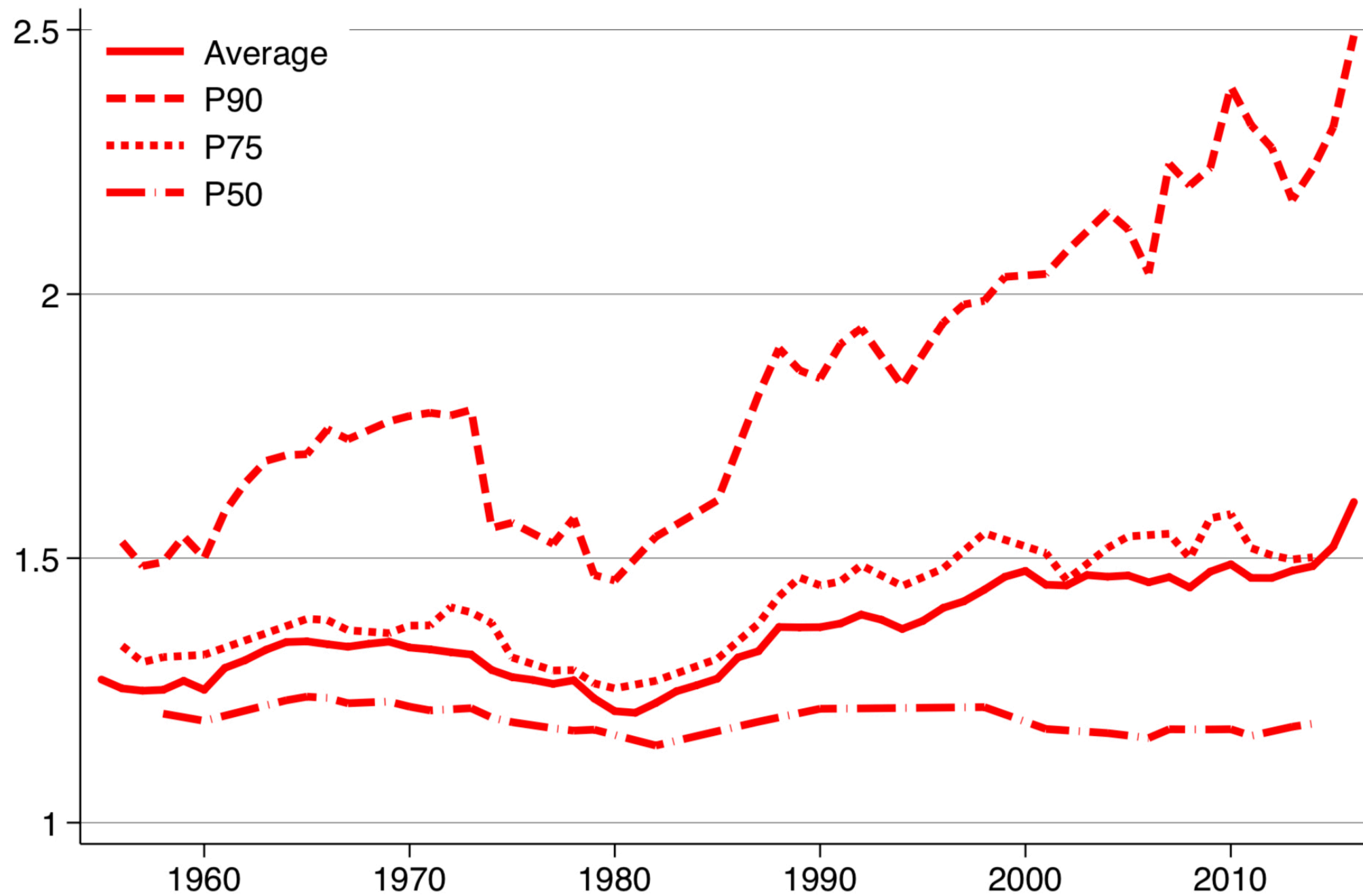
For decades, corporate consolidation has been accelerating. In [over 75%](#) ↗ of U.S. industries, a smaller number of large companies now control more of the business than they did twenty years ago. This is true across healthcare, financial services, agriculture and more.

That lack of competition drives up prices for consumers. As fewer large players have controlled more of the market, mark-ups (charges over cost) [have tripled](#) ↗. Families are paying higher prices for necessities—things like prescription drugs, hearing aids, and internet service.

Barriers to competition are also driving down wages for workers. When there are only a few employers in town, workers have less opportunity to bargain for a higher wage and to demand dignity and respect in the workplace. In fact, research shows that industry consolidation is decreasing advertised wages by [as much as 17%](#) ↗. [Tens of millions](#) ↗ of Americans—including those working in construction and retail—are required to sign non-compete agreements as a condition of getting a job, which makes it harder for them to switch to better-paying options.

In total, higher prices and lower wages caused by lack of competition are now estimated to cost the median American household [\\$5,000 per year](#) ↗.

Motivation: Markup estimates for the US



Why does this matter?

- ▶ Market power is a source of misallocation
 - If mark-up is endogenous, how do population, trade, productivity shocks affect allocative efficiency of the economy?
 - We care about both the level and dispersion
- ▶ Many other secular trends where connection to markup changes is yet to be fully understood
 - Falling labor share
 - Declining business dynamism
 - Wage stagnation
 - Regional changes in concentration
- ▶ Lots of interesting work to be done!
- ▶

Estimating Market Power

- ▶ Classic focus is on **markups**

$$p_i = \mu_i mc_i = \frac{\sigma_i}{\sigma_i - 1} mc_i$$

1. Demand-based methods, estimate the **residual demand curve**
 2. Production-based methods, estimate **production function**
- ▶ We will spend more time on 2. as it has been much more commonly applied in recent work in trade/macro/trade/labor
 - ▶ They involve quite different sets of assumptions so it would be nice to compare the two approaches in one setting
 - See de Loecker and Scott (2016) for an exercise like that for the US beer industry

Method 1: Demand-based methods

- ▶ By far the most common approach in the field of IO
 - See e.g., Akerberg et al (2007, Handbook chapter)
- ▶ Basic idea is to imagine that within some industry grouping with J products we can estimate the demand system:

$$Q_i = d_i(\mathbf{P}), \quad \forall i$$

- ▶ Then assume some sort of “conduct”, or market structure
 - = the game that producers are playing in the model

Method 1: Demand-based

- ▶ Challenges to implementing this:
 1. Demand estimation is hard
 - High-dimensional function
 - Hard to find instruments
 2. Which conduct to assume?
 - With wide range of supply-and demand-side instruments, conduct is identified in parametric and non-parametric models
- ▶ Why little application outside of IO?
 - Demand estimation is much harder

Method 1

- ▶ Firm's FOC can be written as:

$$P_i = \mu_i MC_i \quad \mu_i \equiv \frac{\sigma_i}{\sigma_i - 1}$$

- ▶ σ_i : The firms perceived elasticity of demand (residual elasticity) given by:

$$\sigma_i = - \frac{dQ_i}{dP_i} = - \left(\frac{\partial Q_i}{\partial P_i} + \sum_{j \neq i} \frac{\partial Q_i}{\partial P_j} \frac{dP_j}{dP_i} \right)$$

- ▶ Special cases (e.g., perfect/monopolistic competition, Bertrand, Cournot, Collusion,...) restrict $\frac{dP_i}{dP_j}$

Method 2: Production-based

- ▶ Basic idea: Use firm production data (output and inputs) to effectively measure something like MC (and then just take $\mu = P/MC$)
- ▶ The historical development of the current approach
 - Hall (JPE 1988)
 - Olley Pakes (1999), ...
 - De Loecker Warczynski (AER 2012)

de Loecker Warzynski

- ▶ Idea: Start from cost-minimization problem of the firm
 - Markups related to input cost shares and output elasticities
 - Hard part is to estimate the output elasticity
- ▶ Assumptions
 - Firm has production function $Q_{it} = F(X_{it}^1, \dots, X_{it}^V, K_{it}, \theta_{it})$ where X is a variable input
 - Variable input prices P_{it}^X are taken as given
 - Firms minimize cost
 - No restrictions on demand curve or conduct (!)

de Loecker Warzynski: Sketch

- ▶ The Lagrangian for cost-minimization is given by

$$\mathcal{L} (X_{it}^1, \dots, X_{it}^V, K_{it}, \lambda_{it}) = \sum_{v=1}^V P_{it}^v X_{it}^v + r_{it} K_{it} + \lambda_{it} (Q_{it} - Q(\cdot))$$

- ▶ First-order condition:

$$P_{it}^v = \lambda_{it} \frac{\partial Q_{it}(\cdot)}{\partial X_{it}^v}$$

- λ_{it} = Lagrangean Multiplier = Marginal cost of production at Q_{it}

de Loecker Warzynski: Sketch

$$P_{it}^v = \lambda_{it} \frac{\partial Q_{it}(\cdot)}{\partial X_{it}^v}$$

- ▶ Multiply by X_{it}^v / Q_{it}

$$\frac{P_{it}^v X_{it}^v}{Q_{it}} \frac{1}{\lambda_{it}} = \frac{X_{it}^v}{Q_{it}^v} \frac{\partial Q_{it}(\cdot)}{\partial X_{it}^v}$$

- ▶ Use the fact that $MC_{it} = \lambda_{it} = P_{it} / \mu_{it}$

$$\frac{P_{it}^v X_{it}^v}{P_{it} Q_{it}} \mu_{it} = \frac{X_{it}^v}{Q_{it}^v} \frac{\partial Q_{it}(\cdot)}{\partial X_{it}^v}$$

The markup formula

- ▶ This leads to the simple expression

$$\mu_{it} = \theta_{it}^v (\alpha_{it}^v)^{-1}$$

- θ_{it}^v : The output elasticity with respect to input v
 - α_{it}^v : The expenditure cost share of input v
- ▶ This is essentially Hall's insight: Whenever a variable input's output elasticity is greater than the input's revenue share, the difference is the markup ($\mu_{it} > 1$) - but here no need to impose CRTS!
 - ▶ Implementation:
 - Input shares are easily observed
 - Hard job is knowing that input's output elasticity

Production function estimation: A brief primer

- ▶ How to estimate an input's output elasticity?
- ▶ State-of-the-art methods based on Olley-Pakes
- ▶ Consider a Cobb-Douglas technology (everything in logs)

$$q_{it} = \theta^l l_{it} + \theta^k k_{it} + \omega_{it} + \epsilon_{it}$$

- Hicks-neutral productivity $\exp(\omega_{it})$
- ϵ_{it} : idiosyncratic productivity shock/measurement error
- ▶ ω_{it} observed by firm, not by econometrician
 - input choices respond to unobserved ω_{it}
 - OLS, therefore, suffers from endogeneity

Olley and Pakes (1996)

- ▶ Key idea: address the simultaneity problem by imposing additional structure on firms factor input decisions
- ▶ Consider a firm that maximizes the present discounted value of current and future profits
- ▶ Assume the observed productivity term ω_{it} evolves exogenously according to

$$p(\omega_{it+1} | I_{it}) = p(\omega_{it+1} | \omega_{it})$$

- ▶ I_{it} : Information set at time t
- ▶ Implies that we can write: $\omega_{it} = \mathbb{E}(\omega_{it} | \omega_{it-1}) + \xi_{it}$
- ▶ Labor is assumed to be a static input chosen optimally each period with zero adjustment costs

Capital

- ▶ Capital is a dynamic input subject to an investment process

$$k_{it} = \kappa(k_{it-1}, i_{it-1})$$

- ▶ Key assumption: Since k_{it} is decided upon at $t - 1$, the productivity process implies

$$\text{cov}(k_{it}, \omega_{it} - \mathbb{E}(\omega_{it} | I_{it-1})) = \mathbb{E}(k_{it} \xi_{it}) = 0$$

- ▶ This will be one key moment condition
- ▶ But we need measures of productivity ω_{it} , right? This is where the control function approach comes in

Labor

- ▶ Labor is chosen each period, so potentially correlated with ω_{it}
- ▶ (Potential solution): Assume that a firm's optimal investment is a strictly increasing function of their current productivity ω_{it}

$$i_{it} = f_t(\omega_{it}, k_{it})$$

- ▶ f_t captures input prices etc.
- ▶ Since this function is monotonic, we can invert it:

$$\omega_{it} = f_t^{-1}(i_{it}, k_{it})$$

- ▶ Key idea: use this inverse function to control non-parametrically for the unobserved value in the production function

OP first-stage

- ▶ Substitute inverse function into the production technology

$$q_{it} = \theta^l l_{it} + \theta^k k_{it} + f_t^{-1}(i_{it}, k_{it}) + \epsilon_{it}$$

- ▶ Model the inverse function non-parametrically, which yields:

$$q_{it} = \theta^L l_{it} + \Phi_t(i_{it}, k_{it}) + \epsilon_{it}$$

- ▶ The coefficient on capital is not identified in the first-stage
 - colinear with the non-parametric function in i_{it} and k_{it}
- ▶ But can obtain estimates for Φ_t and θ^L in the first-stage

OP Second Stage

- ▶ Productivity process: $\omega_{it} = E(\omega_{it} | \omega_{it-1}) + \xi_{it}$
- ▶ ξ_{it} satisfies $E(\xi_{it} | I_{it-1}) = 0$
- ▶ Since $k_{it} \in I_{it-1}$, this implies: $E(\xi_{it} | k_{it}) = 0$
- ▶ Independence implies $E(k_{it}\xi_{it}) = 0$
- ▶ This supplies a moment condition to estimate θ^K
- ▶ GMM procedure:
 1. Start with a guess for θ^K
 2. Compute $\omega_{it}(\theta^K) = \hat{\Phi}_t - \theta^K k_{it}$
 3. Compute ξ_{it} from regressing ω_{it} on ω_{it-1}
 4. Compute the sample analog to the moment condition above

OP summary

- ▶ To identify the labor elasticity, use information in firms investment decisions to control for productivity shocks that is correlated with labor inputs
- ▶ Assume capital is determined before unobserved productivity realizes to estimate capital elasticity
- ▶ This approach can be implemented with more general technologies than Cobb-Douglas

Where it went from OP

- ▶ Investment is messy and there is many zeros in the data
- ▶ Levinson and Petrin (2003): propose to use intermediate inputs m_{it}
 - Model it as an additional input under the same assumptions that it is strictly increasing in productivity
 - Then the first stage becomes: $q_{it} = \theta^L l_{it} + \Phi(m_{it}, k_{it}) + \epsilon_{it}$
- ▶ Akerberg et al: Noted that if both labor and materials are chosen with zero adjustment costs, they are both functions of ω_{it} and k_{it} .
- ▶ But this implies that l_{it} is itself a non-parametric function of the same variables: $l_{it} = g_t(\omega_{it}, k_{it}) = g_t(f_t^{-1}(m_{it}, k_{it}), k_{it}) = h_t(m_{it}, k_{it})$
- ▶ Hence θ^L is not identified in the first stage

ACF approach

- ▶ Abandon the attempt to estimate the labor coefficient in the first stage
- ▶ Timing assumption: Labor is chosen after capital is chosen in the previous period, but before materials were chosen at time t
- ▶ Under these timing assumptions: $m_{it} = f_t(\omega_{it}, k_{it}, l_{it})$
- ▶ Under monotonicity, this can be estimated and used to substitute for ω_{it} in the production function

ACF procedure (implemented in De Loecker and Warzyinski)

- ▶ We can write:

$$q_{it} = \Phi_t(m_{it}, k_{it}, l_{it}) + \epsilon_{it}$$

$$\Phi_t(m_{it}, k_{it}, l_{it}) = \theta^k k_{it} + \theta^l l_{it} + f_t^{-1}(m_t, k_{it}, l_{it})$$

- ▶ From the first stage estimate Φ_t
- ▶ The moment condition to identify θ^k is the same
- ▶ We get an additional moment condition to identify labor
 - Note that $\xi_{it} = \omega_{it} - \omega_{it-1}$ is orthogonal to lagged labor inputs, since this is in the information set at $t - 1$. Essentially, lagged labor is an instrument for current labor.
 - So given a guess for both θ^k and θ^l , can compute $\omega_{it}(\theta^k, \theta^l) = \hat{\Phi}_{it} - \theta^k k_{it} - \theta^l l_{it}$
 - Then compute ξ_{it} as before, and compute the moment analogues to $\mathbb{E}(k_{it}\xi_{it}) = \mathbb{E}(l_{it-1}\xi_{it}) = 0$

Putting it together

- ▶ Individual mark-up

$$\mu_{it} = \theta_{it}^v (\alpha_{it}^v)^{-1}$$

- ▶ Average mark-up (weighted by cost-share, sales, employment,...)

$$\mu_t = \sum_i m_{it} \mu_{it}$$

- ▶ Note: this methodology can also be applied to measure mark-down on wages so long as one factor v is competitively sourced:

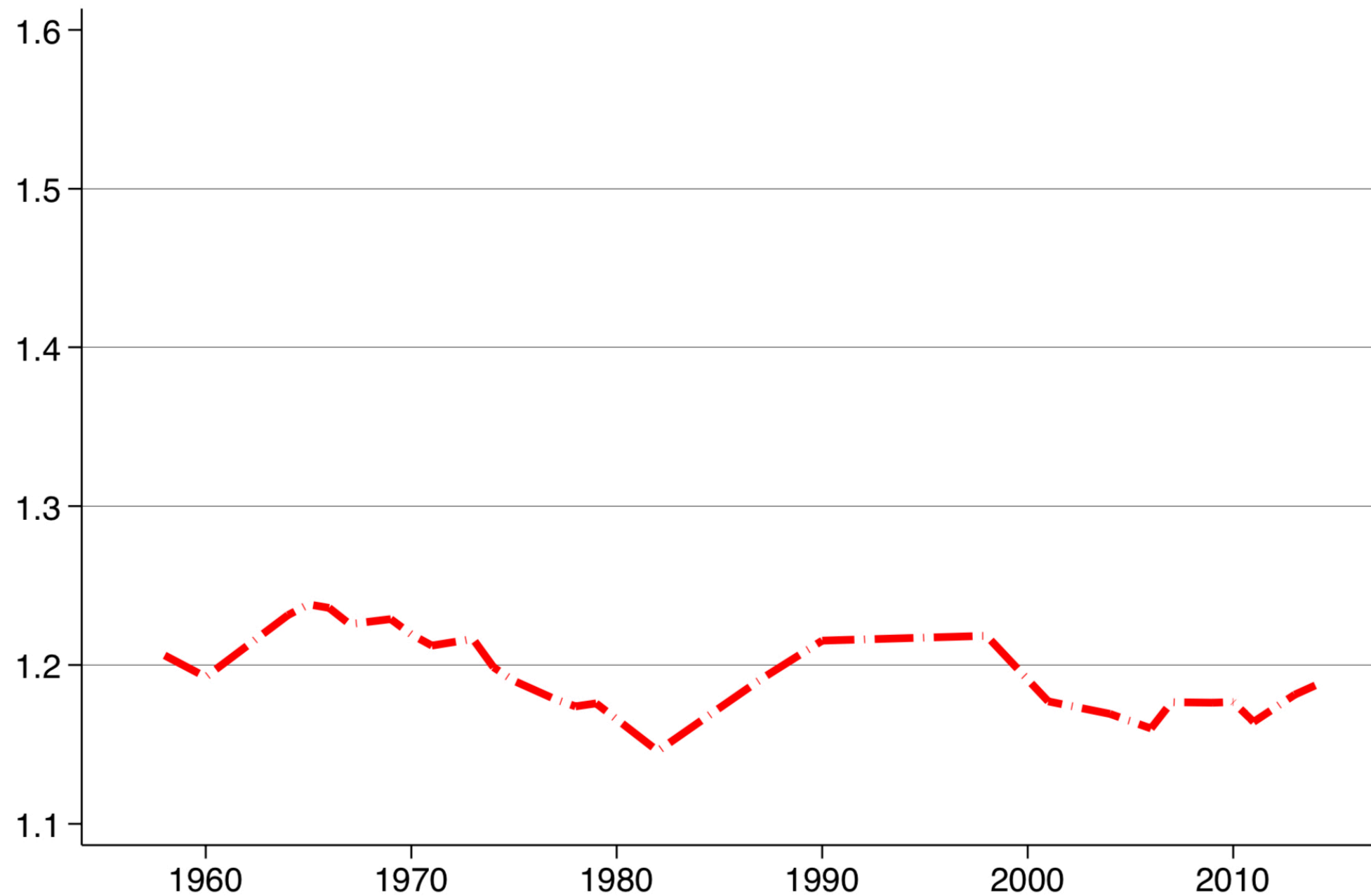
$$\frac{wL}{pQ} = \frac{\mathcal{M}}{\mu} \alpha^L$$

$$\frac{p^v X^v}{pQ} = \frac{1}{\mu} \alpha^v$$

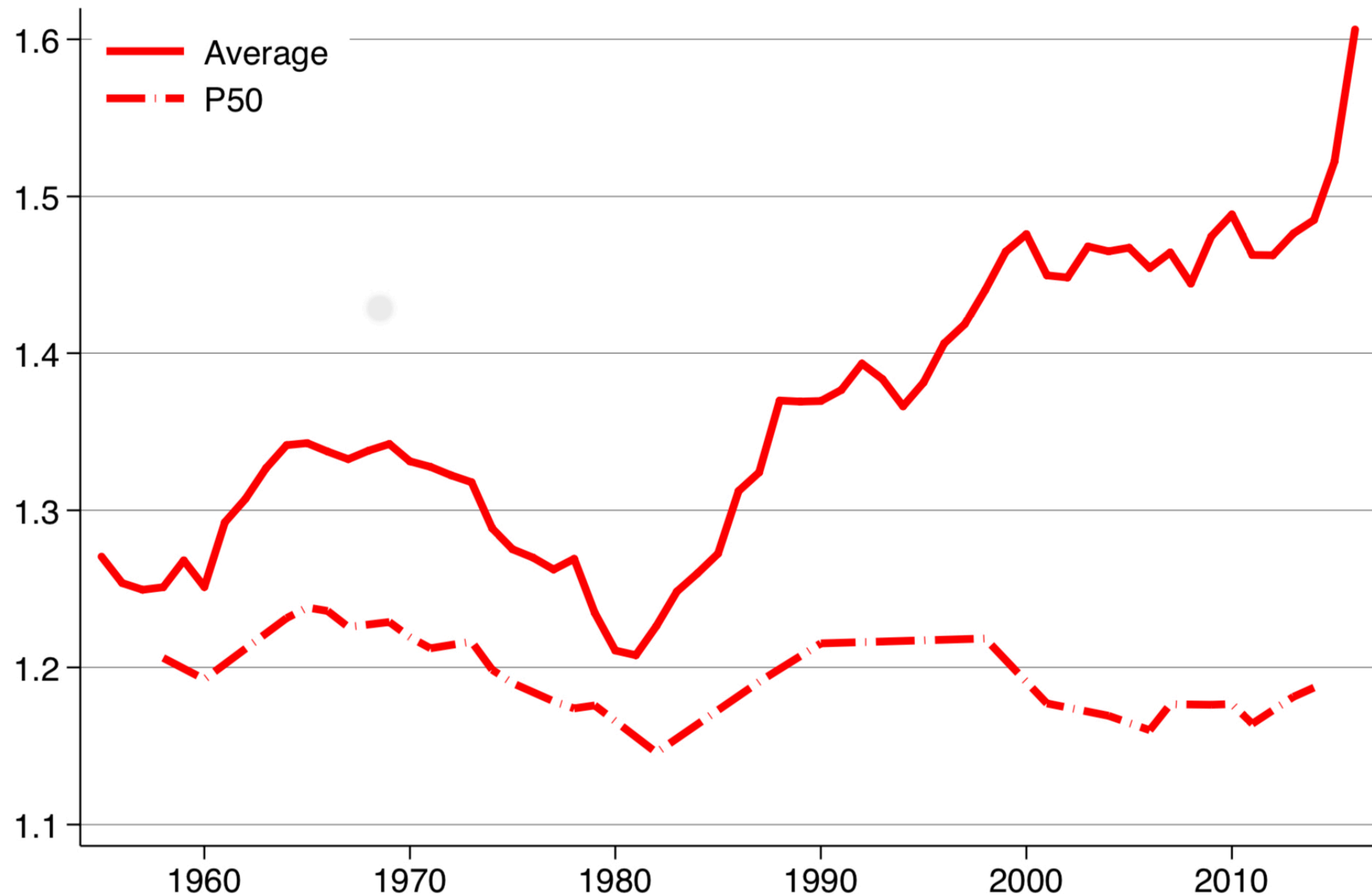
Discussion about U.S. Markups

- ▶ **Heterogeneity**: Sharp rise for few firms, no rise for most
- ▶ **Reallocation** of sales from low to high markup firms (2/3)
- ▶ **Magnitude**:
 1. Weighing and aggregation is crucial
 2. Profit rate (+7-8 ppts) $\neq$ Markup (+30-40 ppts)

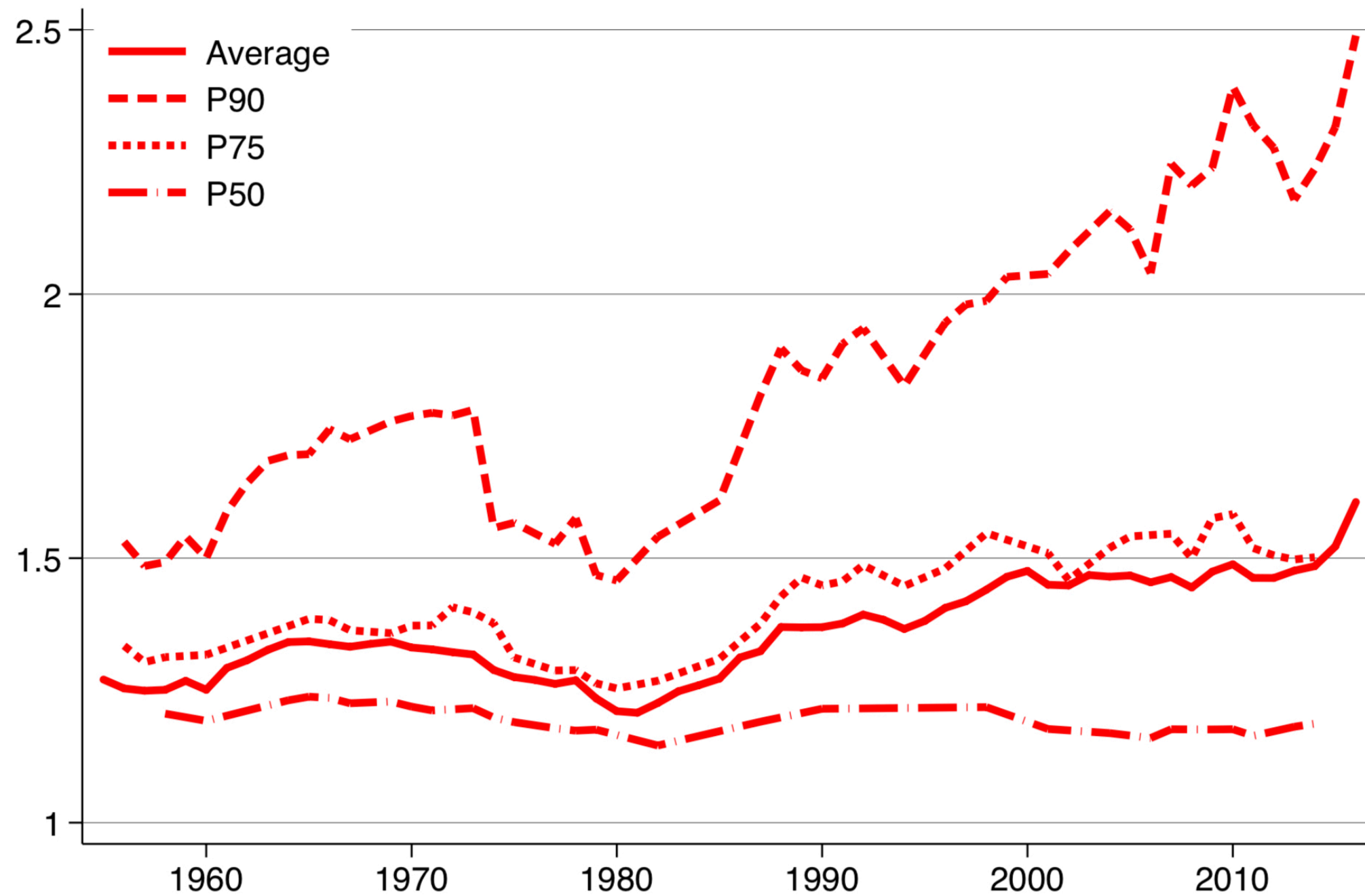
Median Markup in the U.S.



Average Markups in the U.S.



All action in the upper-tail

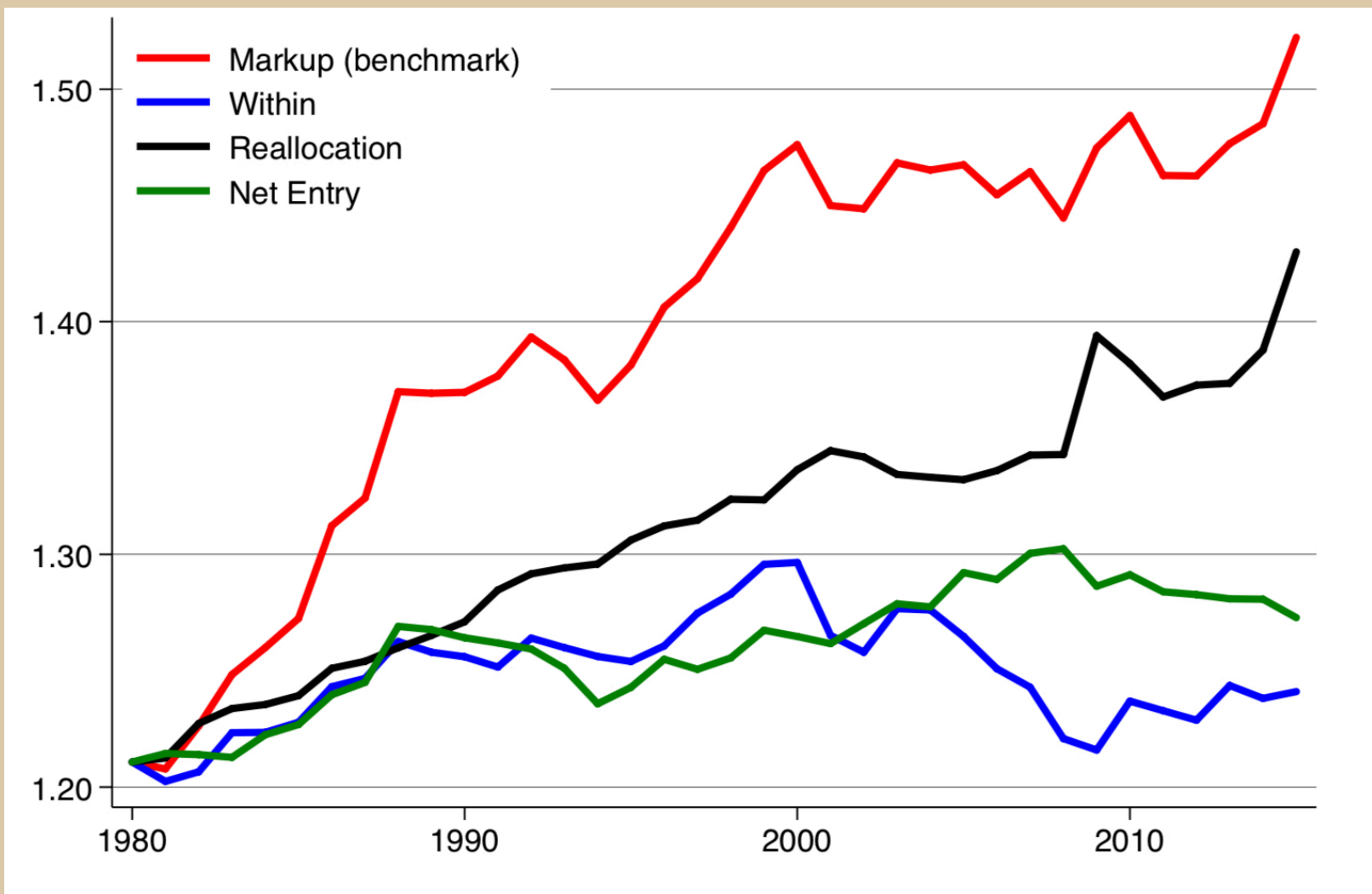


Reallocation

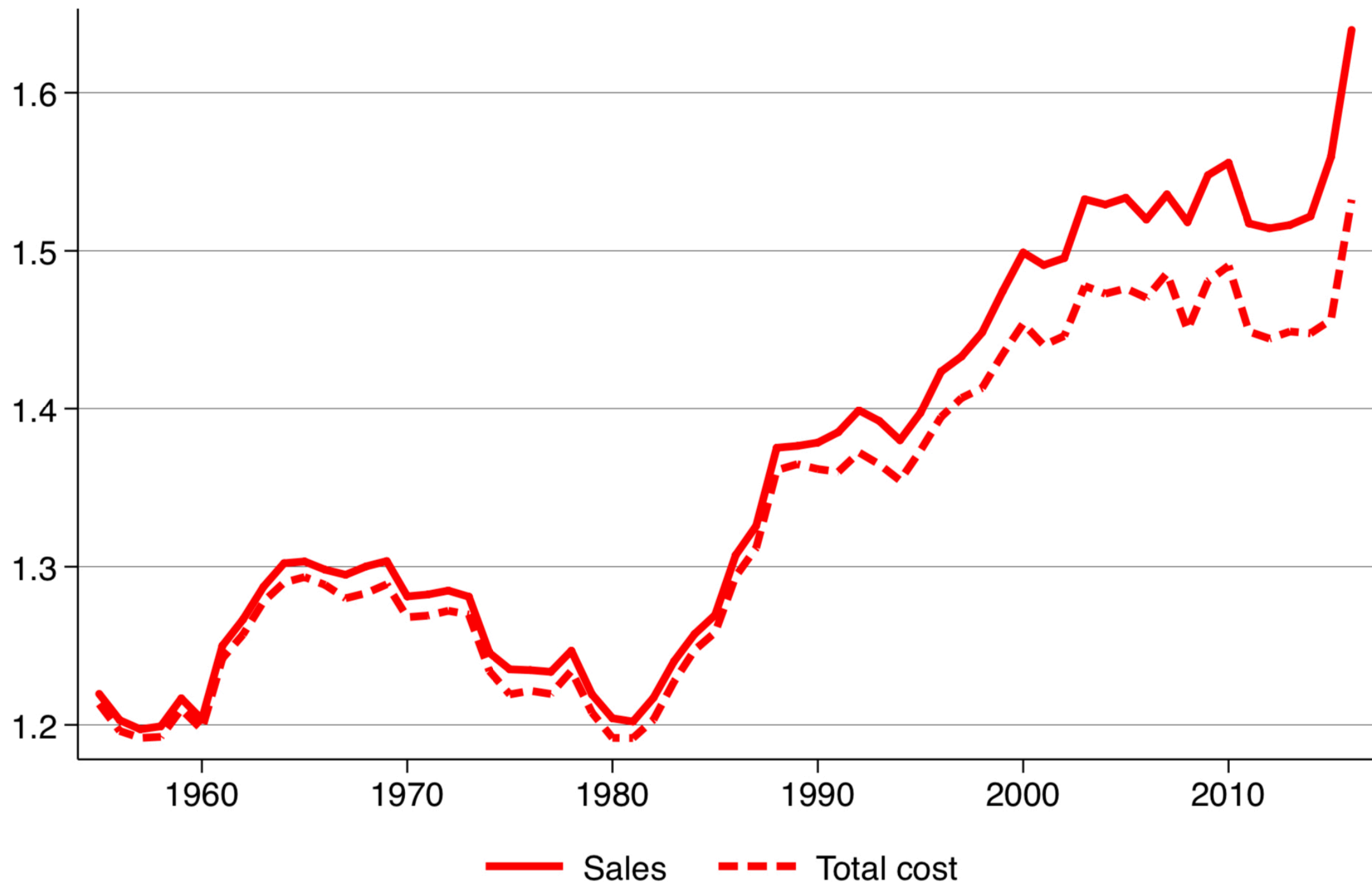
► Why are average markups rising?

1. Within effects: Some firms have raised markups a lot
2. Between effects: Reallocation towards high-markup firm

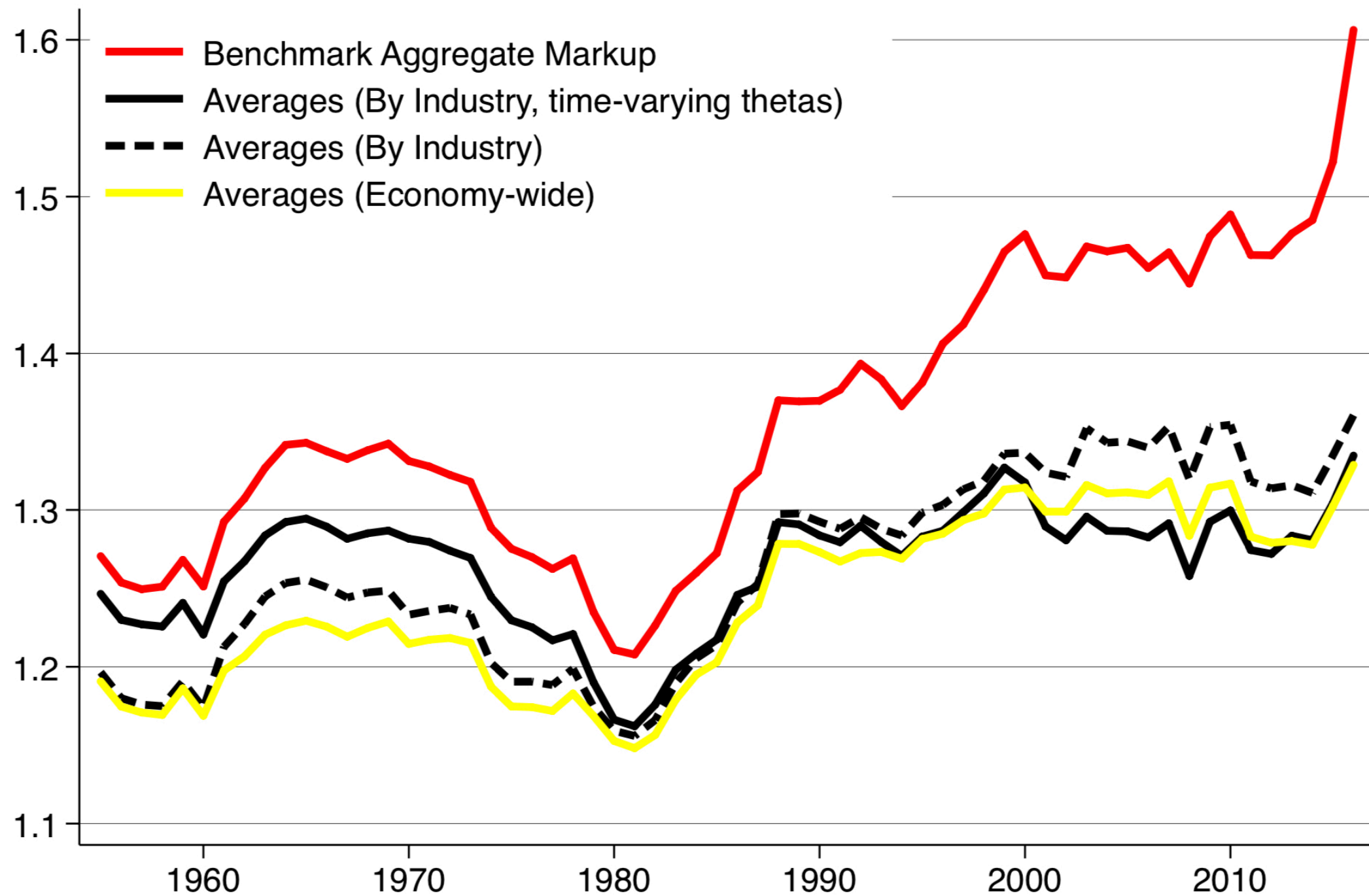
$$\Delta\mu_{it} = \sum_i m_{i,t-1} \Delta\mu_{it} + \sum_i \mu_{i,t-1} \Delta m_{it} + \text{Cross-Terms} + \text{Net entry}$$



Weights matter!



Weights matter!



Heterogeneous Markups - Theory

Modeling markups

- ▶ Workhorse models of heterogeneous firms feature
 1. CES demand
 2. Monopolistic competition

- ▶ Implies homogeneous and exogenous markups

$$p_{it} = \frac{\sigma}{\sigma - 1} mc_{it}$$

- ▶ Non-starter to think about the previous facts
- ▶ Now: Two departures and examples
 1. CES demand + oligopoly
 2. Non-CES demand + monopolistic competition
- ▶ Again, you can think of these as “modules” that can be incorporated into larger quantitative models

Atkeson Burstein 2008

- ▶ Nested CES demand with a continuum of sectors and upper tier elasticity $\eta > 1$
- ▶ Finite number of firms within each sector with EoS $\rho > \eta$

$$C = \left(\int_0^1 \alpha_s^{1/\eta} Q_s^{\frac{\eta-1}{\eta}} ds \right)^{\frac{\eta}{\eta-1}}, \quad Q_s = \left[\sum_{i=1}^N \xi_s^{1/\rho} Q^{\frac{\rho-1}{\rho}} \right]^{\frac{\rho}{\rho-1}}$$

- ▶ Implies that firm i faces demand

$$Q_i = \xi_i P_i^{-\rho} P_s^{\rho-\eta} D_s, \quad D_s \equiv \alpha_s P^\eta C$$

Bertrand Competition

- ▶ Firms compete in prices:

$$P_i = \max_P P Q_i - TC_i(q_i)$$

- ▶ The optimal price satisfies:

$$P_i = \frac{\sigma_i}{\sigma_i - 1} MC_i, \quad \sigma_i = - \frac{d \log Q_i}{d \log P_i} = \rho - (\rho - \eta) S_i$$

$$S_i = \frac{P_i Q_i}{\sum_{j=1}^N P_j Q_j} \text{ is the sales share of firm } i \text{ in its own industry}$$

- ▶ The elasticity of the mark-up (important for pass-through of cost shocks, say)

$$\rho_i = - \frac{\partial \log \mu_i}{\partial \log p_i} = \frac{(\rho - \eta)(\eta - 1) S_i}{\sigma_i(\sigma_i - 1)}$$

Cournot Competition

- ▶ Firms compete in quantities
- ▶ Implies that demand elasticity becomes

$$\sigma_i = \left[\frac{1}{\rho}(1 - S_i) + \frac{1}{\eta}S_i \right]^{-1}$$

- ▶ Implies that the inverse of the markup is linear in the market share (useful for quantitative calibration)

$$\frac{1}{\mu_i} = (1 - 1/\rho) - (1/\rho - \frac{1}{\eta}S_i)$$

- ▶ Pass-through:

$$\rho_i = - \frac{\partial \log \mu_i}{\partial \log p_i} = \frac{(\rho - \eta)(\eta - 1)\sigma_i S_i}{\rho \eta (\sigma_i - 1)}$$

Atkeson Burstein

► Pros:

- Sufficient statistic for markups (sales share) providing a link between empirical concentration and markup literatures
- Can be mapped to granular data

► Cons:

- If number of firms is endogenous, modeling entry is a hassle
 - Multiple equilibria as sequence of entrants matters
 - Example: AB assume that firms enter in descending order of productivity (?)

► Cournot quantitatively gives rise to larger markup variation

Gaubert Itskhoki 2020 (& Vogler 2021)

- ▶ A recent example of AB in action
- ▶ **Motivation:** Exports are granular
 - The largest exporter accounts on average for 17 % of sector's exports in 32 developing countries
- ▶ **Questions:**
 - Should government policies target individual firms rather than sectors?
 - Are there international spillovers and need for coordination?
- ▶ **Method:**
 - A quantitative model that takes seriously the granular nature of exports
 - Model is estimated using French firm-level data

Gaubert Itskhoki: Model Structure

1. Two countries, Home and RoW

- Inelastic labor supply L and L^*

2. Sector-level comparative advantage (like in DFS)

- Continuum of sectors $z \in [0,1]$

$$Q = \exp \left\{ \int_0^1 \alpha_z \log Q_z dz \right\}$$

- Sectors vary in comparative advantage $\log T_z/T_z^* \sim \mathcal{N}(\mu_T, \sigma_T)$

3. Granular heterogeneous firms within sectors

- A finite number of firms in each sector K_z

$$Q_z = \left[\sum_{i=1}^K q_{z,i}^{\frac{\sigma-1}{\sigma}} \right]^{\frac{\sigma}{\sigma-1}}$$

- Each sector has oligopolistic market structure

GI: Sectors

- ▶ Productivity draws in a given sector z
 - Number of potential entrants: $\text{Poisson}(M_z)$
 - Entrants productivity draws: $\text{Pareto}(\theta, \underline{\varphi}_z)$
- ▶ Expected sectoral productivity is summarized by:
$$T_z = M_z \underline{\varphi}_z^\theta$$
- ▶ Marginal cost: $c = w/\varphi$ at home and $\tau c/\varphi$ abroad
- ▶ Fixed cost of production and exports: F in local labor
- ▶ Oligopolistic competition and variable markups
 - Atkeson Burstein: $\{c_i\}_{i=1}^{K_z} \longrightarrow \{s_i, \mu_i, p_i\}_{i=1}^{K_z}$

GI: Market entry and GE

- ▶ Assumption: Sequential entry in increasing order of unit cost

$$c_1 < c_2 < \dots < c_K < \dots, \text{ where } c_i = \begin{cases} w/\varphi_i & \text{if Home} \\ \tau w^*/\varphi_i^* & \text{if Foreign} \end{cases}$$

- ▶ Profits: $\Pi_i = \frac{s_i}{\sigma_i(s_i)} \alpha_z Y - wF$

- ▶ Entry: $\Pi_K^K \geq 0$ and $\Pi_{K+1}^{K+1} < 0 \longrightarrow$ determines K_z

- ▶ General equilibrium

- GE vector: $X = (Y, Y^*, w, w^*)$
- Within sector allocations: $Z = \{K_z, \{s_{z,i}\}_{i=1}^K\}_{z \in [0,1]}$
- Labor market clearing and trade balance

Properties of the Granular Model

- ▶ Home export share - realized comparative advantage

$$\Lambda_z^* = \frac{EX_z}{\alpha_z Y^*}$$

- ▶ Expected home export share (fundamental comparative advantage - this is the limit with monopolistic competition)

$$\mathbb{E}\Lambda_z^* = \frac{1}{1 + (\tau w/w^*)^\theta T_z^*/T_z}$$

- ▶ Realized home share depends on idiosyncratic realizations of firm productivity: Measure granularity by how much realized differs from fundamental comparative advantage

$$\Gamma_z^* \equiv \Lambda_z^* - \mathbb{E}\Lambda_z^*$$

Gaubert Itskhoki Vogler: Granular Policies

1. Merger of two large home firms
2. Granular import tariff on individual large foreign exporter
3. Industrial policy of promoting national champions

► Welfare analysis

$$\begin{aligned}\hat{W} &\equiv \frac{d \log Y}{d \log P} && \text{Producer surplus} && \text{Consumer surplus} \\ &= \frac{d\text{GovRev}}{Y} + \int_0^1 \alpha_z \frac{d\Pi_z}{\alpha_z Y} dz - \int_0^1 \alpha_z d \log P_z dz\end{aligned}$$

► partial equilibrium, sector level effect:

$$\hat{W}_z = \frac{d\text{GR} + d\Pi_z}{\alpha_z Y} - d \log P_z$$

Merger

- ▶ Consider a merge of the two largest domestic firms in a sector
- ▶ Merger leads to a productivity spillover

$$\varphi'_{z,2} = \varphi_{z,2} + \gamma(\varphi_{z,1} - \varphi_{z,2})$$

- ▶ Merged firm produces both products and sets common markup

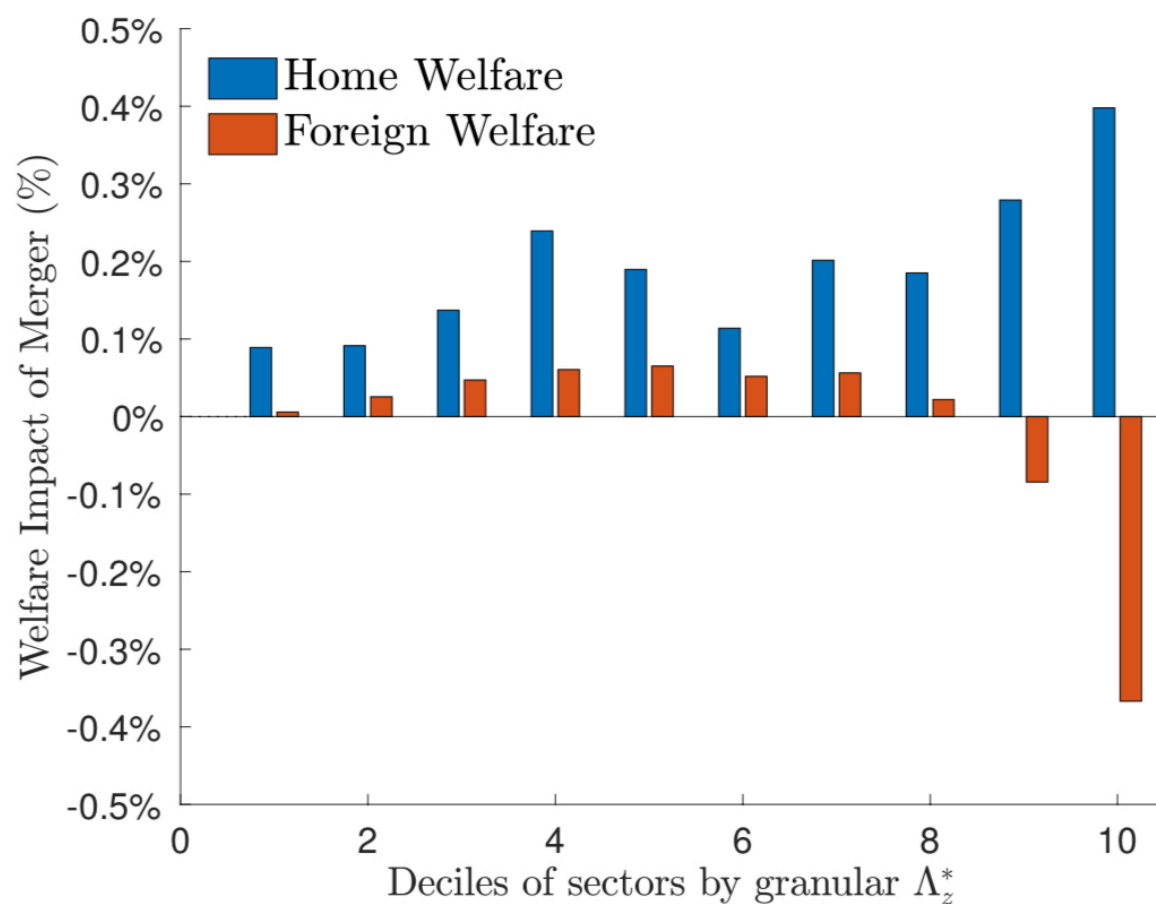
$$\mu'_{z,1} = \mu'_{z,2} = \frac{\sigma(s'_{z,1} + s'_{z,2})}{\sigma(s'_{z,1} + s'_{z,2}) - 1}$$

- ▶ Tradeoff: Increased productivity vs market power (markups)
- ▶ In an open economy, there is also foreign consumer surplus stealing (“beggar-thy-neighbor”)

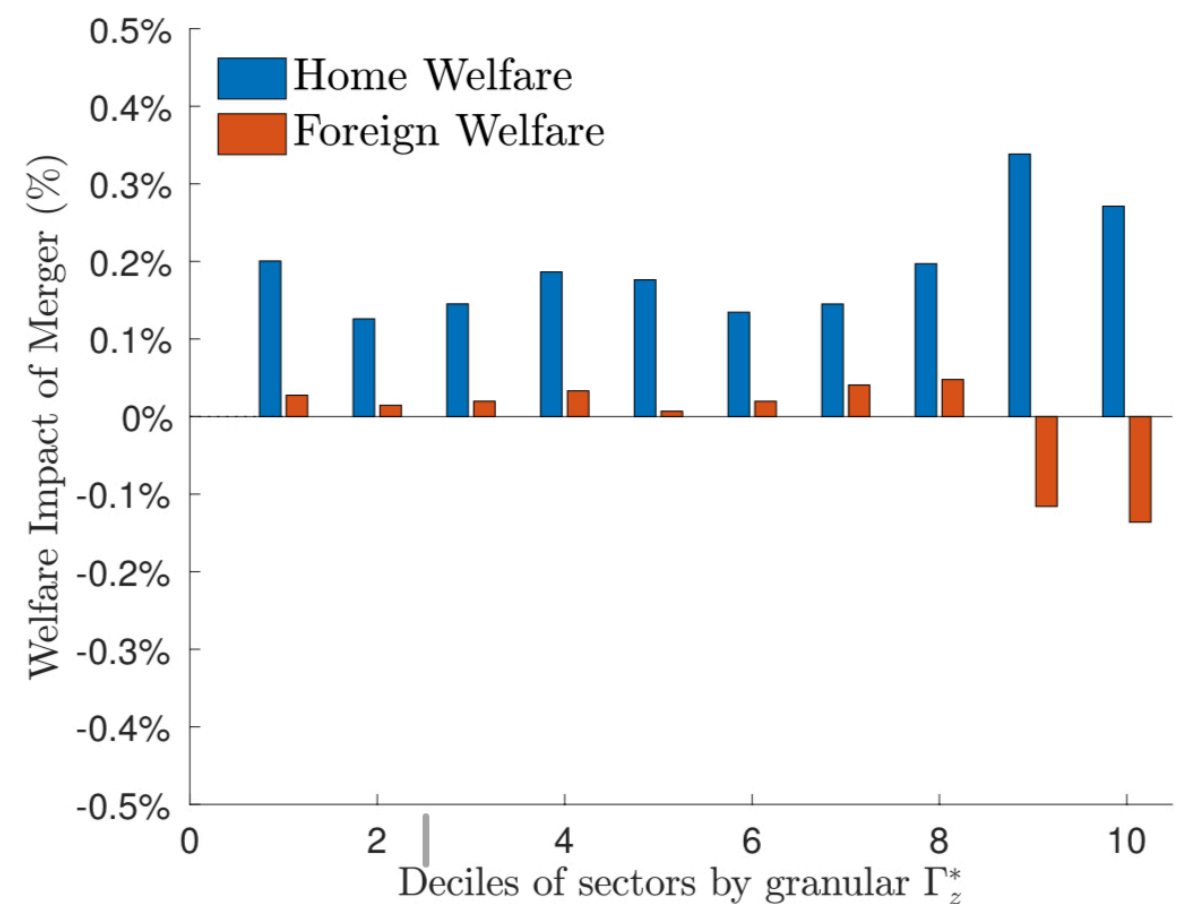
Welfare effects of mergers

- ▶ In the most granular sectors, increased market power outweighs productivity effect
 - Home gains through higher consumer surplus, while foreign consumer surplus is stolen by the merged firms

(a) Welfare effects by Λ_z^*



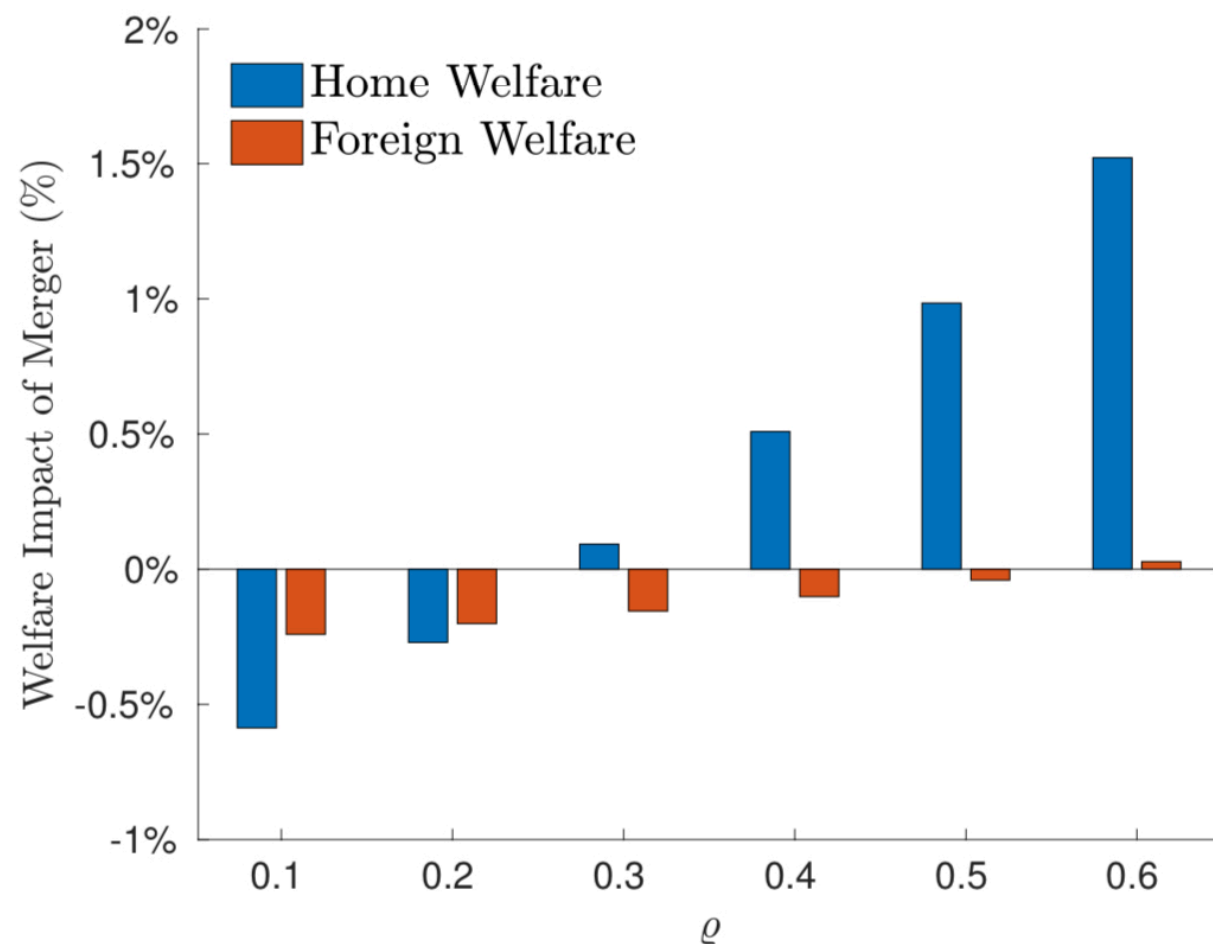
(b) Welfare effects by Γ_z^*



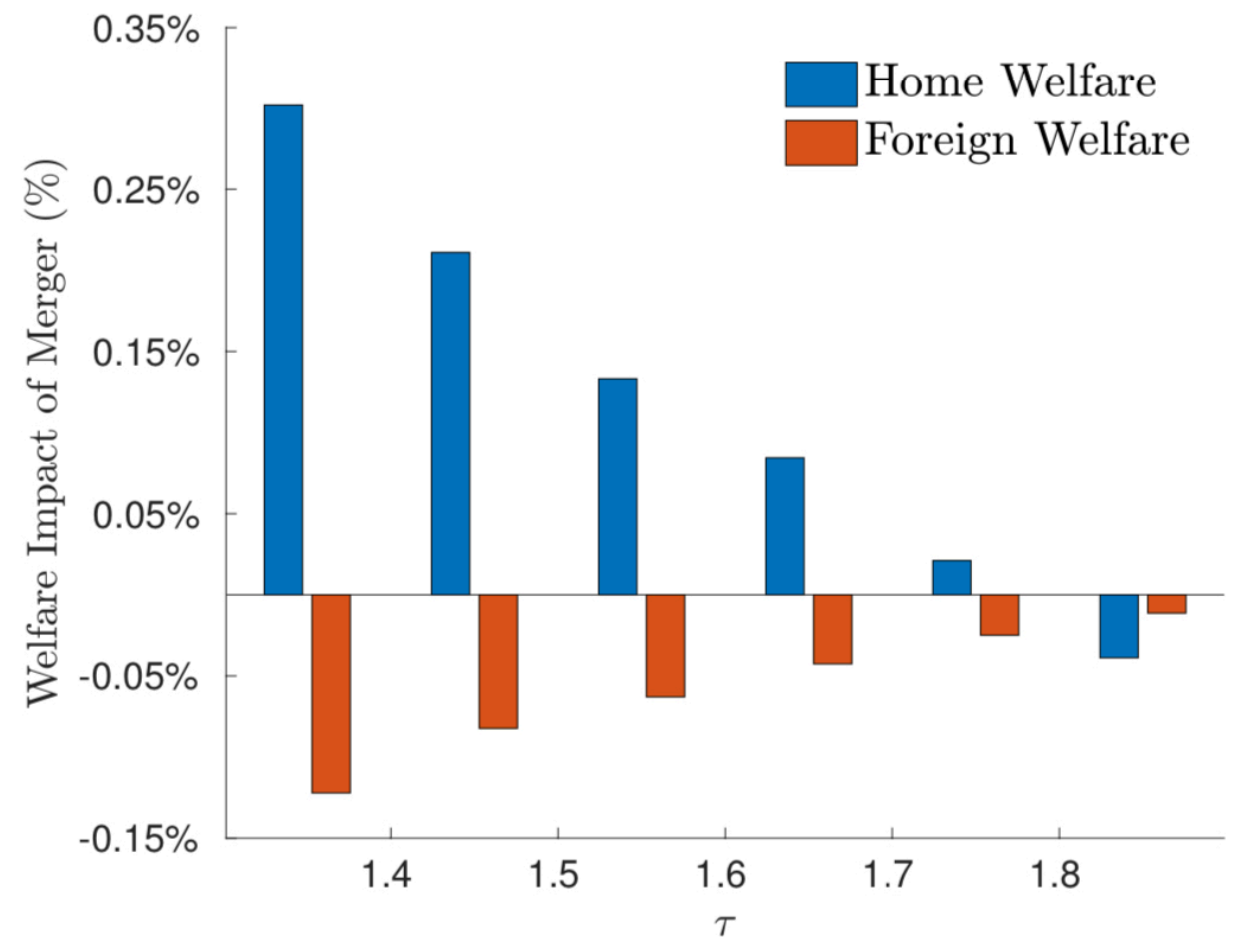
Dependence on parameters

- ▶ Impact of productivity spillovers and trade cost
- ▶ In top-20% of sectors by home comparative advantage

(a) Impact of productivity spillover ϱ



(b) Impact of trade openness τ



Conclusion Gaubert Itskhoki

- ▶ At the sectoral level, granular firms play a central role in the global economy
- ▶ Should government policy be designed at the firm-level?
- ▶ They provide a tractable, quantifiable framework to address a variety of policies
- ▶ Thoughts
 - Can this framework be used to connect to the “place-based” agenda in urban/geography - at the regional level, most firms are “granular”, yet in the aggregate a region might be atomistic.
 - What about labor market power and inequality?
 - What if sector's themselves are granular in the economy?

More on the Atkeson Burstein Phenotype

- ▶ The model has been widely applied in macro and trade,...
 - Amiti, Itskhiki, Konings (2013, 2019): Exchange-rate disconnect (large firms have lower mark-up elasticities, so movements in costs of imported inputs are not passed on to prices)
 - Edmond Midrigan Xu (2018): Trade reduces mark-up distortions by increasing competition, which reduces sales shares and markups
 - de Loecker, Eeckhout Mongey (2021): Business dynamism and markups
 - ...

Monopolistic competition

- ▶ Monopolistic competition models are much (!) more tractable than models with oligopolistic markets
- ▶ With monopolistic competition, a firm's demand elasticity is given by:
$$-\frac{d \log Q_i}{d \log P_i} = -\frac{\partial \log Q_i}{\partial \log P_i} - \int \frac{\partial \log Q_i}{\partial \log P_f} \frac{d \log P_f}{d \log P_i} df = -\frac{\partial \log Q_i}{\partial \log P_i}$$
- ▶ To capture heterogeneity in markups, need varying demand elasticities
- ▶ Two demand systems that have been widely used

1. Additively separable $C = \int u(Q_i) di$

2. Kimball Demand $1 = \int \Psi \left(\frac{Q_i}{C} \right) di$

Additively separable utility

- ▶ Demand under additively separable utility can be written:

$$Q_i = D(P_i \lambda)$$

- λ : Solves $\int P_i D(P_i \lambda) di = \text{Income}$ is a measure of competition and a sufficient statistic for prices of all firms
- $D(\cdot) \equiv (u')^{-1}(\cdot)$

- ▶ Demand elasticity:

$$\sigma_i = - \frac{\partial \log D(p_i \lambda)}{\partial \log p_i}$$

- ▶ Highly (!) flexible

Kimball Demand

- ▶ Demand under Kimball preferences solves

$$\frac{P_i}{P} = \Psi' \left(\frac{Q_i}{C} \right), \quad P = \frac{\delta}{Q}, \quad \frac{1}{\delta} = \int \Psi' \left(\frac{q_i}{C} \right) \frac{q_i}{C} di$$

- ▶ Demand elasticity is given by:

$$\sigma = - \frac{\partial \log(\Psi')^{-1}(\frac{P_i}{P})}{\partial \log(P_i/P)}$$

- ▶ Klenow Willis (2006) specification:

$$(\Psi')^{-1}(x) = \left[1 - \theta \log\left(\frac{\sigma}{\sigma - 1} x\right) \right]^{\sigma/\theta}$$

- Limiting case: $\theta \rightarrow 0$ is CES
- Markup is decreasing in the relative price for $\theta > 0$

More on these Demand Systems

- ▶ Due to their tractability, the previous demand systems have found widespread applications
 - welfare in macro models
 - Edmond Midrigan Xu 2019, Baqaee and Fahri 2019
 - wealth inequality
 - Boar and Midrigan 2020
 - international trade
 - Arkolakis Costinot Donaldson Rodriguez-Clare (2018)
 - Currency choice and exchange-rate pass-through
 - Gopinath & Itskhoki
 - ...

Amiti Itskhoki Konings

- ▶ **Questions:** How large are strategic complementarities across firms in price setting
 - Do firms mostly respond to own cost shocks or put a large weight on the prices of competitors?
- ▶ **Approach:**
 - Theory-based accounting framework that decomposes own price changes into response to own cost shocks and to changes in competitor prices
 - Identification strategy using import price changes as cost-shocks
 - Quantitative framework to evaluate counterfactual scenarios

Price Setting in a General Class of Games

- ▶ Log price identity:

$$p_{it} = mc_{it} + \mu_{it}$$

- ▶ Proposition: For any given

- Invertible demand system $\mathbf{q}_t = \{q_{it}(\mathbf{p}_t, \xi_t)\}$
- Competition structure (monopolistic or oligopolistic)

there exists a markup function $\mu_{it} = \mathcal{M}_i(\mathbf{p}_t, \xi_t)$ such that the profit-maximizing price solves:

$$\tilde{p}_{it} = mc_{it} + \mathcal{M}_i(\tilde{p}_{it}, \mathbf{p}_{-it}; \xi_t)$$

- Fixed point that implicitly defines a „best response“ schedule
- Prices of others are a sufficient statistic (particularly for their marginal costs)
- Industry equilibrium: Solution to this fixed point

Price Change Decomposition

Totally differentiate the best response around some $(\mathbf{p}_t, \xi_t)$ to obtain:

$$dp_{it} = \frac{1}{1 + \Gamma_{it}} dmc_{it} + \frac{\Gamma_{-it}}{1 + \Gamma_{it}} d\mathbf{p}_{-it} + \epsilon_{it}$$

Own markup elasticity: $\Gamma_{it} \equiv -\frac{\partial \mathcal{M}_{it}}{\partial p_{it}}$

Competitor markup elasticity: $\Gamma_{-it} \equiv \sum_{j \neq i} \frac{\partial \mathcal{M}_{it}}{\partial p_{jt}}$

Index of competitor price changes

$$d\mathbf{p}_{-it} = \sum_{j \neq i} \frac{\partial \mathcal{M}_{it} / \partial p_{jt}}{\sum_{k \neq i} \partial \mathcal{M}_{it} / \partial p_{kt}} dp_{jt}$$

Residual demand shock: ϵ_{it} are weighted changes in ξ_{it}

Full pass-through: Under exogenous markups $\Gamma_{it} = 0$, so $dp_{it} = dmc_{it}$

Making this tractable

Totally differentiate the best response around some $(\mathbf{p}_t, \xi_t)$, one obtains:

$$dp_{it} = \frac{1}{1 + \Gamma_{it}} dmc_{it} + \frac{\Gamma_{-it}}{1 + \Gamma_{it}} d\mathbf{p}_{-it} + \epsilon_{it}$$

Proposition:

1. If $q_{it} = q_i(p_{it}, z_t; \xi_t)$, where z_t is log of total expenditures on this

sectors output, then $dp_{it} = \sum_{j \neq i} \frac{S_{jt}}{1 - S_{it}} dp_{jt}$

2. If $\sigma_{it} \equiv \frac{\partial q_{it}}{\partial p_{it}} = \sigma_i(p_{it} - z_t; \xi_t)$, then $\Gamma_{-it} = \Gamma_{it}$.

- These assumptions (surprisingly) hold to a first-order for all the demand systems that we discussed so far in the lecture, and they hold exactly for the Atkeson-Burstein model of oligopolistic competition

Empirical Implementation I

- ▶ Merge three micro-level datasets from Belgium
 - PRODCOM: Product-firm data from 1995-2007 on values and quantities (2500 products), all manufacturing firms with at least 10 employees
 - Costumes: Import and export data on values and quantities
 - Census: Firm-level data on firm characteristics

- ▶ Domestic prices:

$$\Delta p_{it} = \Delta \log \frac{\text{Domestic Value}_{it}}{\text{Domestic Quantity}_{it}}$$

- ▶ Average variable cost as a proxy for marginal cost

$$\Delta mc_{it} = \Delta \log \frac{TVC_{it}}{Y_{it}}$$

- ▶ Instrument for marginal cost: Use information on changes in firm-level import prices

Key Findings

- ▶ Estimate the best-response in changes over time

$$\Delta p_{it} = \alpha \Delta mc_{it} + \gamma \Delta p_{-it} + \epsilon_{it}$$

- ▶ Baseline estimates: $\alpha = 0.65$, $\gamma = \Delta p_{-it}$
- ▶ $\alpha = 0.97$ for small firms, $\alpha = 0.48$ for large firms

Implications for Exchange Rate Pass-through

- ▶ Consider an exchange rate devaluation $\Delta e_t > 0$

$$\mathbb{E} \left(\frac{dp_{it}}{de_t} \right) = \mathbb{E} \left(\frac{1}{1 + \Gamma_{it}} \frac{dmc_{it}}{de_t} \right) + \mathbb{E} \left(\frac{\Gamma_{-it}}{1 + \Gamma_{it}} \frac{dp_{-it}}{de_t} \right)$$

- ▶ Empirically, aggregate pass-through of exchange rate shocks into prices is low
- ▶ Their results suggest this is because:
 1. Large firms are the pre-dominant importers (i.e. their cost are affected by exchange rate changes - but they have lower pass-through rates of cost shocks into prices)
 2. Small firms are not very exposed to import price shocks, and do not respond to changes in competitor prices very much, so their prices do not change much