The Effect of Market Concentration on Prices

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Introduction

What is the effect of market concentration on prices?

- Relationship between market share and market power?
- Role of formal properties of search process?

Contribution: General model of markets with

1. Granularity: firms differ in market share;
2. Search frictions: buyers meet random number of representatives from each firm.
3. 'Localised' price competition: price set separately for each buyer.

E.g. job market, market for intermediate inputs, loan market.

Relation to literature

- We build on existing models of search with many-one meetings.
- Wolinsky (1988), Peters and Severinov (1997), Julien, Kennes, and King (2000), Burdett, Shi, and Wright (2001), Eeckhout and Kircher (2010b), Mangin (2017).
- We add granularity: finitely many firms, which differ in market share.
- Allows us to study market concentration.
- Jarosch, Sorkin, and Nimczik (2019) models granular search, but with bilateral meetings.

What does market concentration mean?

- Let $s_i \in [0, 1]$ denote **market share** of firm i.
- Market share $=$ fraction of sales representatives from firm i.
- Allocations in two different markets: $\mathbf{s} = (s_1, ..., s_K)$, $\mathbf{s}' = (s'_1, ..., s'_{K'})$.
- When is $\mathbf{s}$ 'more concentrated' than $\mathbf{s}'$?

What does market concentration mean?

Two rules:

1. **Principle of transfers**: $\mathbf{s}$ more concentrated than $\mathbf{s}'$ if $\mathbf{s}'$ obtained from $\mathbf{s}$ by transferring share from big firm to small;
2. **Zero-share independence**: $\mathbf{s}$ equivalent in concentration to $\mathbf{s}'$ if $\mathbf{s}'$ obtained from $\mathbf{s}$ by adding firms with zero market share.

Function $f(\mathbf{s})$ **increasing in concentration** if $\mathbf{s}$ more concentrated than $\mathbf{s}'$ implies $f(\mathbf{s}) \geq f(\mathbf{s}')$.

Environment

- Market for indivisible good.
- Static, perfect information, zero outside option for buyers/firms.
- Continuum of buyers.
- Firms $i = 1, ..., K$.
- Common production cost $c = 0$.

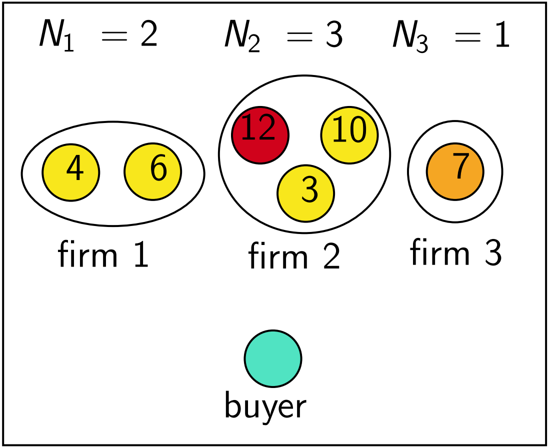
Environment

- Each firm consists of many *representatives*.
  - Labour market: representative = vacancy.
  - Mortgage market: representative = bank branch.
- Buyer meets random number N_i of representatives from each firm i.
- Measure of representatives per buyer at firm i denoted θ_i.
- Probability that N_i equals n denoted $\mathbb{P}_n(\theta_i)$.

General meeting technology

- **Meeting technology** $\mathbb{P}_n(\theta_i)$ can be any distribution with mean θ_i.
- As in Eeckhout and Kircher (2010a), Eeckhout and Kircher (2010b), Lester, Visschers, and Wolthoff (2015), Cai, Gautier, and Wolthoff (2017), Albrecht, Cai, Gautier, and Vroman (2020)
- Allows us to study how meeting technology determines effect of concentration.
- Assume: $\mathbb{P}_0(\theta_i)$ decreasing, convex, tends to zero.

Price-setting



$M = 12$

$\hat{S} = 7$

$Price = 12 - 7 = 5$

Price-setting

- Each representative in meeting has a random utility drawn.
- Let M = highest draw, S = second highest draw.
- Let $\widehat{S}$ = highest draw from firm other than firm with draw M.

Prices determined by Bertrand competition between *firms*:

- **Unmatched**: If $N_1 = ... = N_K = 0$, buyer receives nothing.
- **Local monopoly**: If $N_i > 0$, $N_j = 0$ for $j \neq i$, buyer buys from highest representative at price M.
- **Local competition**: $N_i > 0$, $N_j > 0$ for some $j \neq i$, buyer buys from highest representative at price $M - \widehat{S}$.

Note: in standard model, there is competition between *representatives*: price is $M - S \leq M - \widehat{S}$.

Timing

1. For each firm i, N_i realised.
2. Each representative draws random utility from same distribution.
3. Price determined by Bertrand competition between firms.

Example

- Suppose $\mathbb{P}_n$ Poisson:

$$\mathbb{P}_n(\theta_i) = (e^{-\theta_i}\theta_i^n)/n.$$

- Suppose all draws equal constant $z > 0$.
- Case studied in Julien et al. (2000), Burdett et al. (2001) *without* granularity.
- Let $\theta = \sum_{i=1}^{K} \theta_i$.
- The expected price equals:

$$\overbrace{\frac{\sum_{i=1}^{K}(e^{\theta_i} - 1)}{\theta}}^{\text{Granularity}} \times \overbrace{\frac{\theta}{e^{\theta} - 1} \times z}^{\text{Price w/o granularity}} \quad .$$

- Price is increasing in concentration.

Main theorem

- In general, when is price increasing in concentration?
- Suppose $\mathbb{P}_n(\theta)$ satisfies 'invariance' Lester et al. (2015):

$$\sum_{n=0}^{\infty} \mathbb{P}_n(\theta) y^n = \mathbb{P}_0(\theta(1-y)).$$

- Let $\eta_{\mathbb{P}_0}(\theta)$ denote elasticity of $\mathbb{P}_0(\theta)$; likewise $\eta_{\mathbb{P}_0'}(\theta)$.
- Convexity of $\mathbb{P}_0$ measured by $\eta_{\mathbb{P}_0'}(\theta)/\eta_{\mathbb{P}_0}(\theta) = \mathbb{P}_0''(\theta)\mathbb{P}_0(\theta)/(\mathbb{P}_0'(\theta))^2$.

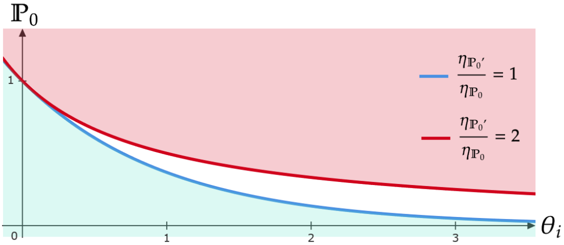
Main theorem

Theorem

The expected price is increasing in concentration if for all $\theta \in \mathbb{R}_+$,

$$1 \leq \frac{\eta_{\mathbb{P}_0'}(\theta)}{\eta_{\mathbb{P}_0}(\theta)} \leq 2.$$

Equivalently, if $\mathbb{P}_0$ *is log-convex and* $1/\mathbb{P}_0$ *is convex.*

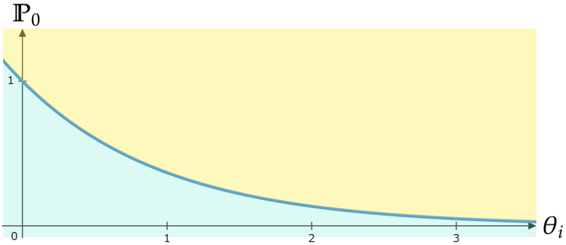


Market concentration and market coverage

- Let coverage by firm i refer to fraction buyers met by firm i: $1 - \mathbb{P}_0(\theta_i)$.
- Greater size θ_i implies more coverage, but non-linear.
- Let **market coverage** refer to fraction buyers met by some firm: $1 - \prod_{i=1}^{K} \mathbb{P}_0(\theta_i)$
- Market coverage depends on $\theta_1, ..., \theta_K$.

Market concentration and market coverage

- More concentration means more market coverage? Depends on $\mathbb{P}_0$.
  1. Log-convex: Negative. Big firm struggles to get full coverage.
  2. Log-linear (Poisson): No effect.
  3. Log-concave: Positive. Big firm can saturate market more easily.



Low convexity

Theorem

The expected price is increasing in concentration if for all $\theta \in \mathbb{R}_+$,

$$1 \leq \frac{\eta_{\mathbb{P}_0'}(\theta)}{\eta_{\mathbb{P}_0}(\theta)} \leq 2.$$

Equivalently, if $\mathbb{P}_0$ *is log-convex and reciprocally convex.*

- What if $0 \leq \eta_{\mathbb{P}_0'}(\theta)/\eta_{\mathbb{P}_0}(\theta) < 1$?

Low convexity

- Market share is $s_i = \frac{\theta_i}{\sum_{j=1}^{K} \theta_j}$.
- Consider (s_1, s_2, s_3), $s_1 < s_2$.
- Consider transfer from firm 2 to firm 1 (fall in concentration).
- What is effect on firm 3?
- Log-concave implies 1,2 collectively have less coverage.
- Less competition for firm 3.

Numerical example

Suppose G deterministic, all representatives sell good with same utility.

- Suppose $\theta_i = s_i$, $\mathbb{P}_1(s_i = s_i$, $\mathbb{P}_0(s_i) = 1 - s_i$.
- So $\eta_{\mathbb{P}_0'}/\eta_{\mathbb{P}_0} = 0 < 1$.
- Compare:

$$\mathbf{s} = (0.01, 0.29, 0.7), \quad \mathbf{s}' = (0.15, 0.15, 0.7).$$

- Price for $\mathbf{s}' \sim 1\%$ higher than $\mathbf{s}$.
- Turns out firm 3 stronger in $\mathbf{s}'$ than $\mathbf{s}$.
- $\mathbb{P}_0$ 'not very convex' means shrinking of firm 2 outweighs growing of firm 1.

High convexity

- What if $\eta_{\mathbb{P}_0'}(\theta)/\eta_{\mathbb{P}_0}(\theta) > 2$?
- Consider (s_1, s_2, s_3), $s_1 < s_2$.
- Two effects of transfer from firm 2 to firm 1 (fall in concentration):
  1. More competition over buyers 'already matched': fewer monopolies.
  2. Greater coverage (more buyers matched): more monopolies.
- If $\eta_{\mathbb{P}_0'}(\theta)/\eta_{\mathbb{P}_0}(\theta) > 2$ second effect *could* outweigh first.

Consumer surplus

- Buyers who would otherwise be unmatched not made worse off by monopoly.

Proposition

The expected consumer surplus is decreasing in concentration if for all $\theta \in \mathbb{R}_+$*:*

$$1 \leq \frac{\eta_{\mathbb{P}_0'}(\theta)}{\eta_{\mathbb{P}_0}(\theta)}.$$

Equivalently, if $\mathbb{P}_0$ *is log-convex.*

Conclusion

- Does an increase in market concentration increase the expected price?
- May depend on the search process.
- In particular, depends on ‘convexity’ of search process.

Appendix 1: Heuristic proof

- Consider (s_1, s_2, s_3), $s_1 < s_2$, suppose $\theta_i = s_i$.
- Let $s_1 = \lambda s$, $s_2 = (1-\lambda)s$, $s_3 = 1 - s$, for $\lambda \in [0, 0.5]$, $s \in (0, 1)$.
- Transfer from s_2 to s_1 = increase in λ.
- When is probability of monopoly *by firm 3* increasing in λ?

Appendix 1: Heuristic proof

- When is probability of monopoly *by firm 3* increasing in λ?
- Answer: When

$$0 \leq \frac{\partial}{\partial \lambda} \mathbb{P}_0(\lambda s)\mathbb{P}_0((1-\lambda)s)(1-\mathbb{P}_0(s_3)).$$

- Differentiating and rearranging:

$$\frac{\mathbb{P}_0'(\lambda s)}{\mathbb{P}_0(\lambda s)} \geq \frac{\mathbb{P}_0'((1-\lambda)s)}{\mathbb{P}_0((1-\lambda)s)}.$$

- True when $\mathbb{P}_0$ log-concave.

Appendix 2: Invariance

What does invariance mean?

- Suppose there are two firms 1, 2.
- Suppose two possible utility draws, L and H, with probabilities p_L, p_H.
- Imagine buyer meets representative from firm 1 who draws H.
- Firm 1 cares whether 'high-quality' representatives from firm 2 arrive in meeting.
- If no 'high-quality' representatives from firm 2, can charge price $H - L$.

Appendix 2: Invariance

- Naively pretend low-quality and high-quality representatives from firm 2 are two different firms.
- Sizes $p_L\theta_2$, and $p_H\theta_2$ respectively.
- So probability there are no high-quality competitors is $\mathbb{P}_0(p_H s_2)$.
- Invariance says pretence is valid:

$$\sum_{n=0}^{\infty} \mathbb{P}_n(\theta_2) p_L^n = \mathbb{P}_0(p_H \theta_2).$$

- More generally:

$$\sum_{n=0}^{\infty} \mathbb{P}_n(\theta) G(x)^n = \mathbb{P}_0((1 - G(x))\theta), \quad x \in \text{supp } G.$$

Appendix 3: General theorem

Let

$$\mathbb{G}_{\mathbb{P},y}(\theta) = \sum_{n=0}^{\infty} \mathbb{P}_n(\theta) y^n.$$

Theorem

The expected price is increasing in concentration if for all $\theta \in \mathbb{R}_+$ and all $y \in [0, 1]$,

$$1 \leq \frac{\eta_{\mathbb{G}'_{\mathbb{P},y}}(\theta)}{\eta_{\mathbb{G}_{\mathbb{P},y}}(\theta)} \leq 2.$$

Equivalently, if $\mathbb{G}_{\mathbb{P},y}(\theta)$ is log-convex and $1/\mathbb{G}_{\mathbb{P},y}(\theta)$ is convex.

Appendix 3: General theorem

Theorem

The expected consumer surplus is decreasing in concentration if for all $\theta \in \mathbb{R}_+$ *and all* $y \in [0, 1]$*:*

$$1 \leq \frac{\eta_{\mathbb{G}'_{\mathbb{P},y}}(\theta)}{\eta_{\mathbb{G}_{\mathbb{P},y}}(\theta)}.$$

Equivalently, if $\mathbb{P}_0$ *is log-convex.*

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