The General Equilibrium Effects of Market Power (joint with Diego Moreno)

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Structure of the Lecture

- Motivation and Related Literature
- The Model
- Preliminary Analysis
- The competitive equilibrium
- Monopoly equilibrium
- Cournot-Warlas equilibrium
- Main Findings – Discussion

Motivation (1)

- Perfectly competitive markets induce an efficient allocation of (scarce) resources and lead to Pareto optimal outcomes
- Firms' *Market Power* reduces output, increases price mark-ups and leads to dead-weight losses, i.e., it reduces consumer surplus and welfare as compared to perfect competition
- **Exception**: A perfectly price discriminating monopolist does not decrease welfare, but leaves consumers with zero surplus
- The partial equilibrium analysis dictates that the more concentrated a market is, the higher is the consumer surplus and social welfare reduction

Motivation (2)

- The common wisdom is that a merger to monopoly is anti-competitive and welfare reducing, *unless* it generates significant efficiency gains
- There are only few exceptions: Markets for goods whose production generates negative externalities such as pollution (see e.g. Schoonbeek and de Vries, 2009), or vertically differentiated markets in which there are status and envy effects (Skartados and Zacharias, 2022).
- **Our research question**: Is common wisdom confirmed in a general equilibrium setting?
- Our answer is: It depends!

The model (1)

Following Azar and Vives (2021), we consider a general equilibrium model in which firms have market power in *both* the goods and labor markets

- There is a continuum of *workers-consumers* who supply labor and use their labor income to buy goods (Their measure is normalized to 2)
- There are two sectors in the economy, each comprising of N firms, which produce differentiated goods, c_1 and c_2
- There are a few small *capitalists*, i.e., firms' owners, who buy goods using their share of the firms' profits as their exclusive source of income
- Each firm produces its good using exclusively labor as input, with a production function $F(l) = l^{\alpha}$, where $\alpha \in (0, 1]$ and l is its employment level

The model (2)

- Both workers and capitalists care about their consumption of a composite good c:

$$c = v\left(c_1, c_2\right) := \left(\frac{1}{2}\right)^{\frac{1}{\theta-1}} \left(c_1^{\frac{\theta-1}{\theta}} + c_2^{\frac{\theta-1}{\theta}}\right)^{\frac{\theta}{\theta-1}}$$

- The parameter $\theta \in (1, \infty)$ is the elasticity of substitution between c_1 and c_2, indicating a preference for variety. The higher is θ, the more workers and capitalists value variety.
- Workers also care about their leisure (or its counterpart, labor l) and their preferences are represented by the utility function

$$u(l, c) = \frac{c^{1-\sigma}}{1-\sigma} - \frac{l^{1+\xi}}{1+\xi},$$

where $\sigma \in (0, 1)$ and $\xi > 0$.

Preliminary Analysis (1)

- Let p_i the price of good c_i. By solving the problem

$$\min_{(c_1,c_2)\in\mathbb{R}_+^2} p_1 c_1 + p_2 c_2, \text{ subject to: } v\left(c_1, c_2\right) = c,$$

  we get

$$c_i^* = \frac{1}{2}\left(\frac{1}{2}\left(p_1^{1-\theta} + p_2^{1-\theta}\right)\right)^{\frac{\theta}{1-\theta}} p_i^{-\theta} c$$

- Hence, $p_1 c_1^* + p_2 c_2^* = pc$, where

$$p = \left(\frac{1}{2}\left(p_1^{1-\theta} + p_2^{1-\theta}\right)\right)^{\frac{1}{1-\theta}}$$

  is the effective price of c – *the Dixit-Stiglitz price index.*

- Denoting by $\rho_i := p_i/p$ the real price of good i, we get

$$c_i(\rho_1, \rho_2) = \frac{1}{2}\rho_i^{-\theta} c(\rho_1, \rho_2)$$

Preliminary Analysis (2)

- Let w be the nominal wage and $\omega := w/p$ be the real wage. Solving the problem

$$\max_{(l,c)\in\mathbb{R}^2_+} u(l,c), \text{ subject to: } c = \omega l.$$

- A worker's labor supply and demand of the composite good,

$$l^s(\omega) = \omega^\eta, \; c_w(\omega) = \omega^{\eta+1},$$

  where $\eta := (1-\sigma)/(\xi+\sigma) > 0$ is the elasticity of labor supply, with η decreasing in both σ and ξ.
- The workers' aggregate supply of labor is

$$L^S(\omega) = 2\omega^\eta,$$

  and is strictly increasing in ω, and is convex in ω if and only if $\eta > 1$.
- Note that if η is large, a small increase in wage leads to a large increase in employment level

Preliminary Analysis (3)

- Each worker's indirect utility,

$$U(\omega) := u(c_w(\omega), l^s(\omega)) = \frac{\omega^{\eta(1+\xi)}}{\eta(1+\xi)}$$

  is increasing in ω

- The capitalists' aggregate demand of the composite good is the firms' aggregate *real profits*.

Competitive equilibrium (1)

- A firm producing good $i \in \{1,2\}$ chooses its labor to solve:

$$\max_{l \in \mathbb{R}_+} \rho_i l^\alpha - \omega l$$

- If $\alpha < 1$, then its labor demand is $l(\rho_i, \omega) = \left(\frac{\alpha \rho_i}{\omega}\right)^{\frac{1}{1-\alpha}}$
- In our symmetric setting $p_1 = p_2 = p$, and hence $\rho_1 = \rho_2 = 1$.
- The aggregate labor demand is

$$L^D(\omega) = 2N\left(\frac{\alpha}{\omega}\right)^{\frac{1}{1-\alpha}},$$

- The labor market clearing condition is

$$L^S(\omega) = L^D(\omega) \Leftrightarrow 2\omega^\eta = 2N\left(\frac{\alpha}{\omega}\right)^{\frac{1}{1-\alpha}}.$$

- Letting $\beta := \frac{1}{1+(1-\alpha)\eta}$, the equilibrium real wage is,

$$\omega_{CE} = \left(N^{1-\alpha}\alpha\right)^\beta$$

Competitive equilibrium (2)

- In the competitive equilibrium each firm uses labor

$$l_{CE} := l\left(1, \omega_{CE}\right) = \left(\frac{\alpha^{\eta}}{N}\right)^{\beta}.$$

- The workers' aggregate consumption of the composite good is

$$C_{CE}^{w} = 2\left(N^{1-\alpha}\alpha\right)^{\beta(\eta+1)}$$

- The capitalists' aggregate consumption of the composite good is

$$\pi_{CE} = 2N\left(\left(\frac{\alpha^{\eta}}{N}\right)^{\alpha\beta} - \left(\frac{\alpha^{\eta+1}}{N^{\alpha}}\right)^{\beta}\right)$$

Monopoly Equilibrium (1)

- A single firm controls the $2N$ plants, behaving as a (multi-product, multi-plant) monopoly in the goods markets and as a monopsony in the labor market
- If the monopoly's labor profile is $\ell = (l_{11}, ...l_{1N}, l_{21}, ...l_{2N})$, then using the labor supply curve, we determine the real wage that clears the labor market:

$$2\omega^{\eta} = \sum_{j=1}^{N} l_{1j} + \sum_{j=1}^{N} l_{2j} \Leftrightarrow \omega(\ell) = \left(\frac{\sum_{j=1}^{N} l_{1j} + \sum_{j=1}^{N} l_{2j}}{2} \right)^{\frac{1}{\eta}}.$$

- As the monopoly supplies all outputs, market clearing requires that the aggregate demand of good i, C_i, satisfies:

$$C_i = \sum_{j=1}^{N} l_{ij}^{\alpha} =: C_i(\ell)$$

Monopoly equilibrium (2)

- The aggregate demand of the composite good is then:

$$C(\ell) = \left(\frac{1}{2}\right)^{\frac{1}{\theta-1}} \left(C_1(\ell)^{\frac{\theta-1}{\theta}} + C_2(\ell)^{\frac{\theta-1}{\theta}}\right)^{\frac{\theta}{\theta-1}}$$

- The real price of good i is:

$$C_i(\ell) = \rho_i^{-\theta}\frac{C(\ell)}{2} \Leftrightarrow \rho_i(\ell) = \left(\frac{C(\ell)}{2C_i(\ell)}\right)^{\frac{1}{\theta}}.$$

- Thus, the monopoly solves:

$$\max_{\ell\in\mathbb{R}_+^{2N}} \ \rho_1(\ell)C_1(\ell) + \rho_2(\ell)C_2(\ell) - \omega(\ell)\left(\sum_{j=1}^{N} l_{1j} + \sum_{j=1}^{N} l_{2j}\right)$$

Monopoly Equilibrium (3)

- There is a unique solution to this problem which is symmetric:

$$l_{ij}^* = l_M = \left(\frac{1}{N}\left(\frac{\alpha\eta}{1+\eta}\right)^{\eta}\right)^{\beta}, \text{ for } i \in \{1,2\},\ j \in \{1,\ldots,N\}.$$

- The real prices of the goods are equal to 1. The real wage is:

$$\omega_M = \left(\frac{N^{1-\alpha}\alpha\eta}{1+\eta}\right)^{\beta}.$$

- The workers' aggregate consumption of the composite good is

$$C_M^w = 2\left(\frac{N^{1-\alpha}\alpha\eta}{1+\eta}\right)^{\beta(\eta+1)},$$

- The capitalists' aggregate consumption of the composite good is

$$\pi_M = 2N\left(\left[\frac{1}{N}\left(\frac{\alpha\eta}{1+\eta}\right)^{\eta}\right]^{\alpha\beta} - \left[\frac{1}{N^{\alpha}}\left(\frac{\alpha\eta}{1+\eta}\right)^{\eta+1}\right]^{\beta}\right)$$

Cournot-Warlas equilibrium (1)

- There are $2N$ firms, with N firms in each sector, competing a la Cournot by choosing the amount of labor they use. Each firm has market power in both the goods and the labor market
- Let $\ell = (l_{11}, ...l_{1N}, l_{21}, ...l_{2N})$ be the profile of firms' labor level. The real profit of firm $ij \in \{1, 2\} \times \{1, ..., N\}$ is:

$$\pi_{ij}(\ell) = \rho_i(\ell) l_{ij}^{\alpha} - \omega(\ell) l_{ij}$$

- There is a unique *Cournot-Walras* equilibrium, which is symmetric. The labor used by each firm is:

$$l_{ij}^* = l_{CW} = \left[\frac{1}{N} \left(\frac{(2N\theta - 1)\,\alpha\eta}{(2N\eta + 1)\,\theta} \right)^{\eta} \right]^{\beta}.$$

Cournot-Warlas equilibrium (2)

- The goods' real prices are equal to 1 and the real wage is:

$$\omega_{CW} = \left(\frac{N^{1-\alpha}\left(2N\theta - 1\right)\alpha\eta}{\left(2N\eta + 1\right)\theta} \right)^{\beta}.$$

- The workers' aggregate consumption of the composite good is

$$C^{w}_{CW} = 2\left(\frac{N^{1-\alpha}\left(2N\theta - 1\right)\alpha\eta}{\left(2N\eta + 1\right)\theta} \right)^{\beta(\eta+1)},$$

- The capitalists' aggregate consumption of the composite good is:

$$\pi_{CW} = 2N\left(\left[\frac{1}{N}\left(\frac{\left(2N\theta - 1\right)\alpha\eta}{\left(2N\eta + 1\right)\theta} \right)^{\eta} \right]^{\alpha\beta} - \left[\frac{1}{N^{\alpha}}\left(\frac{\left(2N\theta - 1\right)\alpha\eta}{\left(2N\eta + 1\right)\theta} \right)^{\eta+1} \right]^{\beta} \right)$$

Main findings - Discussion (1)

- As expected, capitalists are better off under monopoly than under a Cournot-Walras oligopoly and also, better off in the latter than under perfect competition: $\pi_M > \pi_{CW} > \pi_{CE}$
- The equilibrium wage and employment level are higher under perfect competition than under either monopoly or Cournot-Walras oligopoly; hence, workers' welfare is higher too.
- Notably, equilibrium wages, employment level, workers consumption of the composite good and welfare are *not always* higher under Cournot-Walras oligopoly than under monopoly, contradicting common wisdom!
- In particular, $l_M > l_{CW}$, $w_M > w_{CW}$, $c_M > c_{CW}$ and $U_M > U_{CW}$ if and only if $1 + \eta > (2N - 1)\theta$

Main findings - Discussion (2)

A merger to a (multi-product, multi-plant) monopoly leads to a Pareto-superior outcome than the Cournot-Walras equilibrium if and only if $1 + \eta > (2N - 1)\theta$

- The higher the labor supply elasticity (high η), the less differentiated goods are (low θ) and the smaller the number of oligopolists (low N), the more likely is that a merger to monopoly enhances welfare for all the agents in the economy
- *An alternative interpretation*: For a given high η and a given low θ, the impact of market power on welfare is non-monotonic. As the number of firms per sector increases from 1 to N, welfare initially decreases and then increases
- Notably, if $1 + \eta > (2N - 1)\theta$, $\frac{C_M^w}{\pi_M + C_M^w} > \frac{C_{CW}^w}{\pi_{CW} + C_{CW}^w}$, i.e., the labor share of the economy's real output under monopoly is larger than under the Cournot -Walras oligopoly.

Main findings - Discussion (3)

Intuition

- The owners' of a Cournot competitor care only about the firm's real profits, as their consumption of the composite good is equal to the firm's real profits.
- In contrast, the monopolist's owners care about the sum of all firms' real profits. Hence, the monopolist will coordinate all its actions in the goods markets and the labor marker to achieve the highest real industry profits.

Main findings - Discussion (4)

- Consider first a simple economy with one firm per sector ($N = 1$)
- Comparing to the Cournot-Warlas equilibrium, a monopolist should take into account also how a small increase in l_1 will influence its real profits in plant 2 that produces a substitute good
- The monopolist should balance out two effects: The effects of a small increase in l_1 on the real price of good 2 ($\frac{\partial \rho_2}{\partial l_1}$) and on the real wage ($\frac{\partial \omega}{\partial l_1} = \frac{\partial \omega}{\partial l}$)
- The first effect is positive and decreasing in θ, while the second effect is negative and decreasing in η
- When θ is small $\frac{\partial \rho_2}{\partial l_1}$ is large and when η is large $\frac{\partial \omega}{\partial l_1}$ is small. Then the first effect dominates the second as long as $\eta + 1 > \theta$ and the monopolist has incentives to increase l_1 above the level chosen by a Cournot competitor

Main findings - Discussion (5)

- As the number of firms per sector N increases, there is a third negative effect that the monopolist should take into account
- An increase in l_{11} decreases the real price in sector 1 ($\frac{\partial \rho_1}{\partial l_{11}}$), which makes the monopolist more reluctant to choose a higher l_{11}
- The higher is N, the stronger is the latter effect and the more difficult is that the positive effect $\frac{\partial \rho_2}{\partial l_{11}}$ dominates the two negative effects $\frac{\partial \omega}{\partial l} = \frac{\partial \omega}{\partial l_{11}}$ and $\frac{\partial \rho_1}{\partial l_{11}}$
- Hence, the condition for the monopolist to choose a higher level of employment per plant compared to a Cournot competitor becomes more stringent: $\eta + 1 > (2N - 1)\theta$

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THANK YOU!