General Equilibrium with Market Power

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Introduction

On the effect of the rise of market power in recent times:

▷Eeckhout, J.: *The Profit Paradox. How Thriving Firms Threaten the Future of Work*, Princeton University Press, 2021.)

(... over the past forty years, a handful of companies have reaped the rewards of technological advancements ... "superstar" companies charge high prices ... stagnating wages rise inequality and severely limit social mobility.)

▷Azar, J. and X. Vives: General Equilibrium Oligopoly and Ownership Structure, *Econometrica* 89 (2021): 999-1048.

(The influence of common interest of large investors increases the negative effects of market power)

The Economy

Toy example based on:

▷Moreno, D, and E. Petrakis: General Equilibrium, Welfare and Policy Analysis when Firms have Market Power, uc3m wp 2024-17.

In an economy there are two goods, labor (ℓ) and consumption (c). The economy has no endowment of consumption, but there is a technology that allows to produce consumption using labor ℓ as input, according to the production function

$$f(\ell) = 2\ell.$$

The Economy

There are several firms producing consumption with the existing technology. These firms are owned by consumers who supply no labor and only care about the consumption they can procure using their share of profits of the firms.

Consistently with *owners*' interests, firms' objective is to maximize the real profits (i.e., the profits in units of consumption).

There also a unit measure of *workers* who have no resources other than their labor income, and their preferences over consumption and labor (the counterpart of leisure) are represented by the utility function

$$u(\ell, c) = -\ell^3/3 + c.$$

(If it facilities understanding, you may think that there is a single worker providing all the labor used in production.)

Worker

Note that the worker's marginal rate of substitution,

$$MRS(\ell, c) = \ell^2.$$

gives the number of units of consumption for which the worker is willing to supply an additional (infinitesimal) unit of labor.

Let us denote by w the real wage, that is, the nominal wage divided by the price of consumption. (Equivalently, set $p_c = 1$.)

Worker

We calculate a worker's supply of labor and demand of consumption by solving the problem:

$$\max_{(c,\ell)\in\mathbb{R}^2_+} u(\ell, c)$$
$$\text{subject to: } w\ell \geq c.$$

Solving the system

$$\begin{aligned} \ell^2 &= w \\ c &= w\ell \end{aligned}$$

we get

$$\ell^s(w) = \sqrt{w} \text{ and } c(w) = w\ell^s(w) = w^{3/2}.$$

Competitive Equilibrium

Since firms have constant returns to scale, in a competitive equilibrium firms' profits are zero – and so is owners' consumption.

Moreover, the equilibrium wage equals the value of a worker's marginal productivity, i.e.,

$$w_{CE} := 2.$$

Thus, workers supply of labor and consumption are

$$\ell_{CE} := \ell^s(w_{CE}) = \sqrt{2} \text{ and } c(w_{CE}) = w_{CE}^{3/2} = 2\sqrt{2}.$$

The economy's output of consumption (GDP) is

$$Y_{CE} = 2\ell_{CE} = 2\sqrt{2},$$

and the *surplus* generated by the economic activity is

$$S_{CE} = Y_{CE} - \frac{\ell_{CE}^3}{3} = 2\sqrt{2} - \frac{\left(\sqrt{2}\right)^3}{3} = \frac{4\sqrt{2}}{3}.$$

where the substracting term is the worker's disutility of labor.

Obviously, the CE surplus is the maximum surplus that the economic active may achieve.

The *surplus* captured by workers is

$$W_{CE} = c\left(w_{CE}\right) - \frac{\left(\ell^{s}\left(w_{CE}\right)\right)^{3}}{3} = 2\sqrt{2} - \frac{\left(\sqrt{2}\right)^{3}}{3} = \frac{4\sqrt{2}}{3} = S_{CE}.$$

Owners' surplus is just the aggregate real profits),

$$\Pi_{CE} = 0.$$

(Note $S \equiv W + \Pi$.)

Monopoly

Suppose that there is single firm exercising monopoly (monopsony) power in the market for consumption (labor).

The monopoly, chooses strategically its labor to solve the problem

$$\max_{\ell \in \mathbb{R}_+} \; \pi_M(\ell) = 2\ell - w(\ell)\ell,$$

where

$$w(\ell) := \ell^2$$

is the inverse of the labor supply. (Recall that $\ell^s(w) = \sqrt{w}$.)

Hence in the monopoly equilibrium

$$2 - 3\ell^2 = 0 \Leftrightarrow \ell_{ME} = \sqrt{\frac{2}{3}} \Rightarrow w_{ME} = \frac{2}{3}.$$

Since

$$w_{ME} = 2/3 < 2 = w_{CE},$$

monopoly power leads to a wage *markdown*, i.e., the wage is below the value of workers' marginal productivity.

The economy's output of consumption (GDP) is

$$Y_{ME} = 2\ell_{ME} = 2\sqrt{\frac{2}{3}} < 2\sqrt{2} = Y_{CE},$$

and the *surplus* generated by the economic activity is

$$S_{ME} = Y_{ME} - \frac{(\ell_{ME})^3}{3} = 2\sqrt{\frac{2}{3}} - \frac{\left(\sqrt{\frac{2}{3}}\right)^3}{3} = \frac{16}{9}\sqrt{\frac{2}{3}} < \frac{4}{3}\sqrt{2} = S_{CE},$$

i.e., this allocation is NOT Pareto optimal.

Monopoly

Workers' surplus is

$$W_{ME} = c(w_{ME}) - \frac{(\ell_{ME})^3}{3} = \frac{2}{3}\sqrt{\frac{2}{3}} - \frac{\left(\sqrt{\frac{2}{3}}\right)^3}{3} = \left(\frac{2}{3}\right)^{\frac{3}{2}} \frac{2}{3} < \frac{2}{3} = W_{CE}$$

and owners' surplus

$$\Pi_{ME} = 2\ell_{ME} - w_{ME}\ell_{ME} = 2\sqrt{\frac{2}{3}} - \frac{2}{3}\sqrt{\frac{2}{3}} = \frac{12}{9}\sqrt{\frac{2}{3}} > 0 = \Pi_{CE}.$$

Now assume that there are $n > 1$ firms producing consumption using the existing technology.

In this *oligopolisitic* economy firms exercise market power both the markets for consumption and labor.

In an oligopolistic equilibrium each firms' labor profile $\ell^* = (\ell_1^* ..., \ell_n^*)$ is such that for each $i \in \{1, ..., n\}$, ℓ_i^* solves the problem

$$\max_{\ell \in \mathbb{R}_+} \pi(\ell, \ell^*_{-i}) = 2\ell - w(\ell^*_{-i} + \ell)\ell = 2\ell - \left(\ell^*_{-i} + \ell\right)^2 \ell,$$

where

$$\ell^*_{-i} = \sum_{j \in \{1,...,n\} \setminus i} \ell_j.$$

Oligopoly

Each firm's *reaction function* is identified by the solution to the equation

$$-3\ell^2 - 4\left(\ell^*_{-i}\right)\ell + 2 - \left(\ell^*_{-i}\right)^2 = 0.$$

Since the equilibrium is symmetric, i.e., $\ell_i^* = \ell_j^*$ for all $(i,j) \in \{1, ..., n\}^2$, we may find the equilibrium labor of a firm by solving the equation

$$-3\ell^2 - 4\left(\left(n-1\right)\ell\right)\ell + 2 - \left(\left(n-1\right)\ell\right)^2 = 0.$$

whose positive solution is

$$\ell_i^* := \ell_{OE}\left(n\right) = \sqrt{\frac{2}{n\left(n+2\right)}}.$$

Oligopoly

Hence, aggregate labor is

$$n\ell_{OE}(n) = \sqrt{\frac{2n}{n+2}}$$

and the wage and workers' consumption are

$$w_{OE}(n) = \frac{2n}{n+2} \text{ and } c_{OE}(n) = \left(\frac{2n}{n+2}\right)^{\frac{3}{2}}.$$

Oligopoly

Thus, the economy's output of consumption (GDP) is

$$Y_{OE}(n) = 2\ell_{OE}(n) = 2\sqrt{\frac{2n}{n+2}} < 2\sqrt{2} = Y_{CE},$$

and the *surplus* generated by the economic activity is

$$\begin{aligned} S_{OE}(n) &= Y_{OE}(n) - \frac{(n\ell_{OE}(n))^3}{3} \\ &= 2\sqrt{\frac{2n}{n+2}} - \frac{\left(\sqrt{\frac{2n}{n+2}}\right)^3}{3} \\ &= \left(\frac{n+3}{n+2}\sqrt{\frac{n}{n+2}}\right)\frac{4}{3}\sqrt{2} \\ &< \frac{4}{3}\sqrt{2} \\ &= S_{CE}. \end{aligned}$$

Thus, this allocation is NOT Pareto optimal.

The worker's surplus is

$$
\begin{aligned}
W_{OE}(n) &= c(w_{OE}(n)) - \frac{(n\ell_{OE}(n))^3}{3} \\
&= \left(\frac{2n}{n+2}\right)^{\frac{3}{2}} - \frac{1}{3}\left(\frac{2n}{n+2}\right)^{\frac{3}{2}} \\
&= \frac{2}{3}\left(\frac{2n}{n+2}\right)^{\frac{3}{2}}
\end{aligned}
$$

and owners surplus is

$$\begin{aligned}\Pi_{OE}(n) &= 2n\ell_{OE}(n) - w_{OE}(n)n\ell_{OE}(n) \\ &= 2\sqrt{\frac{2n}{n+2}} - \left(\frac{2n}{n+2}\right)^{\frac{3}{2}} \\ &= \left(2 - \frac{2n}{n+2}\right)\sqrt{\frac{2n}{n+2}} \\ &= \frac{4}{n+2}\sqrt{\frac{2n}{n+2}} \\ &> 0.\end{aligned}$$

Clearly, the oligopolistic equilibrium converges to the competitive equilibrium as $n \to \infty$.

Policy: Minimum Wages

Let us assume that the government sets a minimum wage $\bar{w} \in [0, 2]$. This implies that the wage as a function of firms' profile of labor is now

$$\hat{w}(\ell) = \begin{cases} \bar{w} & \text{if } \left(\sum_j \ell_j\right)^2 \leq w \\ \left(\sum_j \ell_j\right)^2 & \text{otherwise.} \end{cases}$$

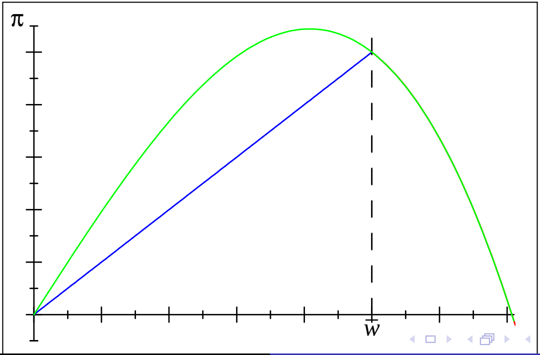
Policy: Minimum Wages

Let us study the impact of a minimum wage on a monopolistic economy ($n = 1$).

The monopoly's profit as a function of its labor is now

$$\hat{\pi}(\ell) = \begin{cases} 2\ell - \bar{w}\ell & \text{if } \ell^2 < \bar{w} \\ 2\ell - \ell^3 & \text{otherwise} \end{cases}.$$

For $\bar{w} \in (w_{ME}, w_{CE})$ this is how this function looks like

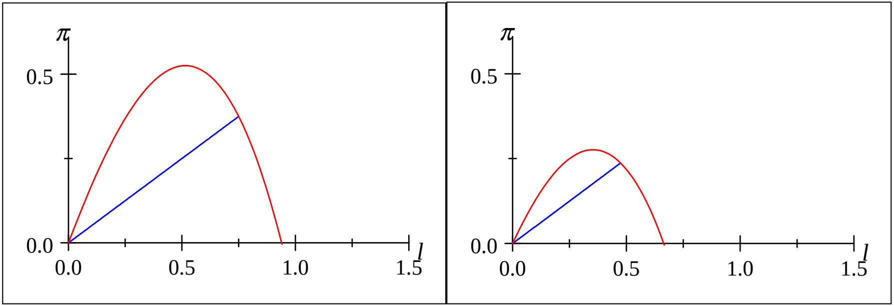


Policy: Minimum Wages

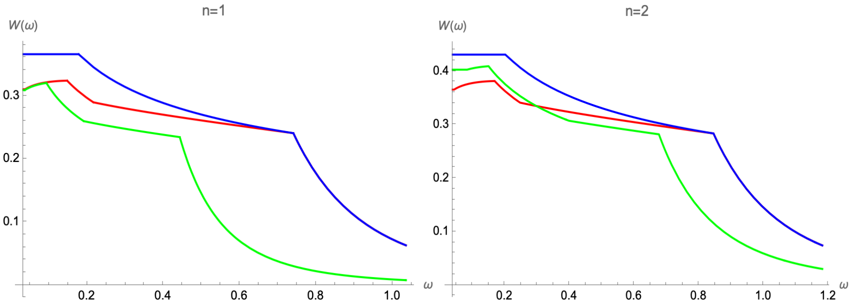
If $n = 2$, for $\bar{w} \in (w_{OE}(2), w_{CE})$ then there is a symmetric equilibrium, $\ell_1 = \ell_2 = \sqrt{\bar{w}}/2$.

But that are also asymmetric equilibria.

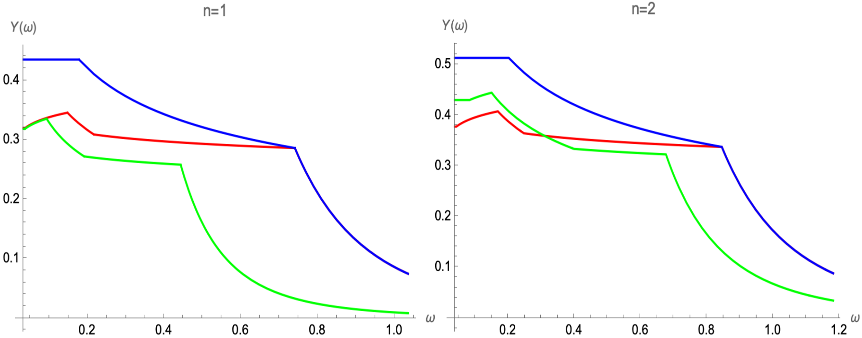
Example: $\bar{w} = 1$. Take $w = 3/2$. Then $\ell_1 = 3/4$, $\ell_2 = \sqrt{3/2} - 3/4$ forms an equilibrium. To see this, we graph firms' profits.



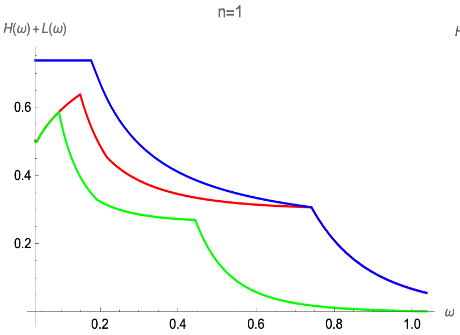
Minimum Wages: Surplus

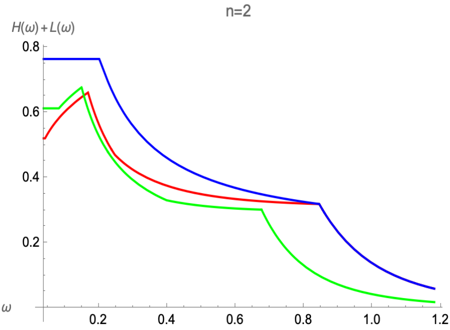


Minimum Wages: Aggregate Income

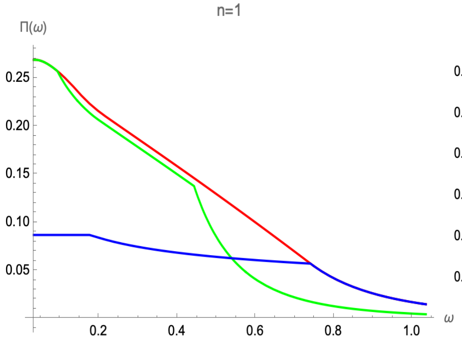


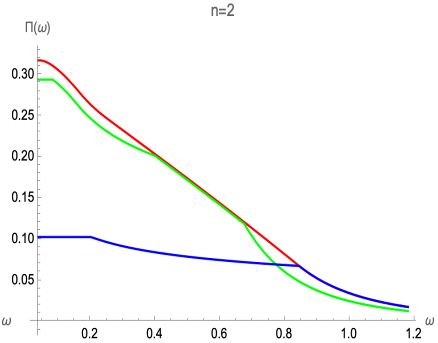
Minimum Wages: Employment



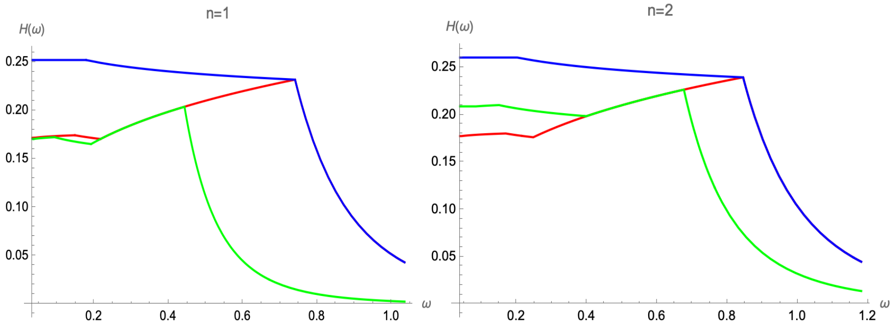


Minimum Wages: Profits

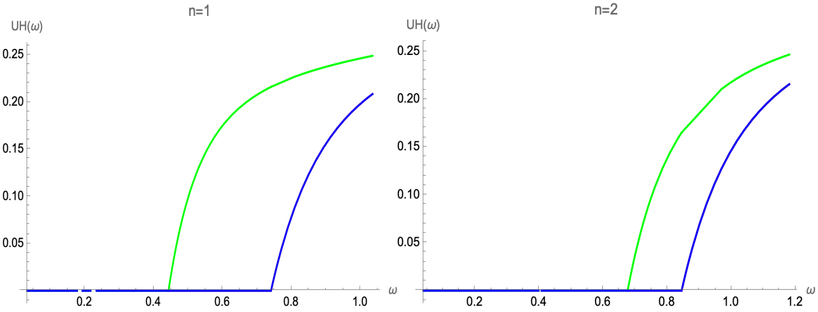




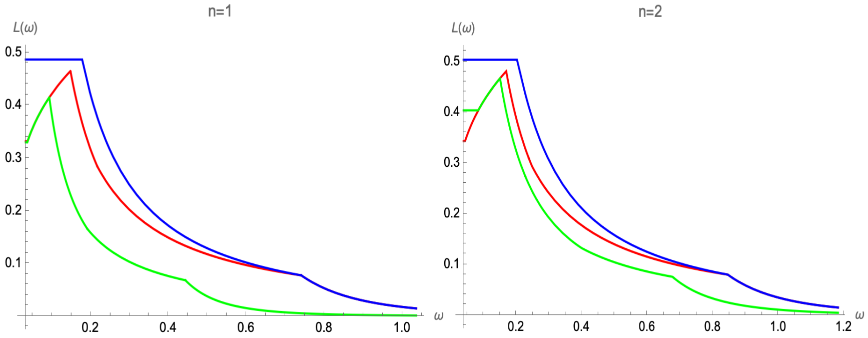
Minimum Wages: Employment of High-Skilled Labor



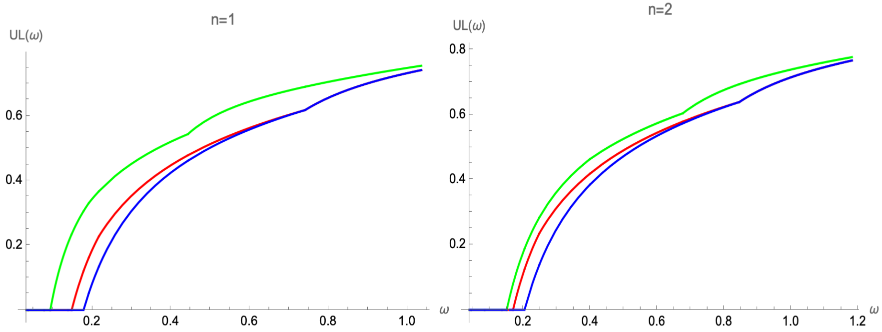
Minimum Wages: Unemployment of High-Skilled Labor



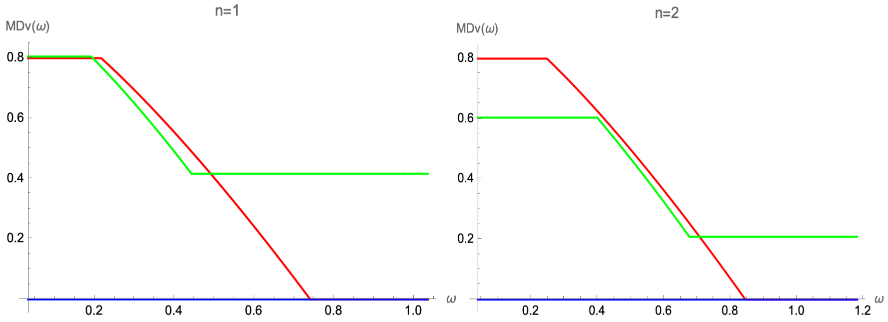
Minimum Wages: Employment of Low-Skilled Labor



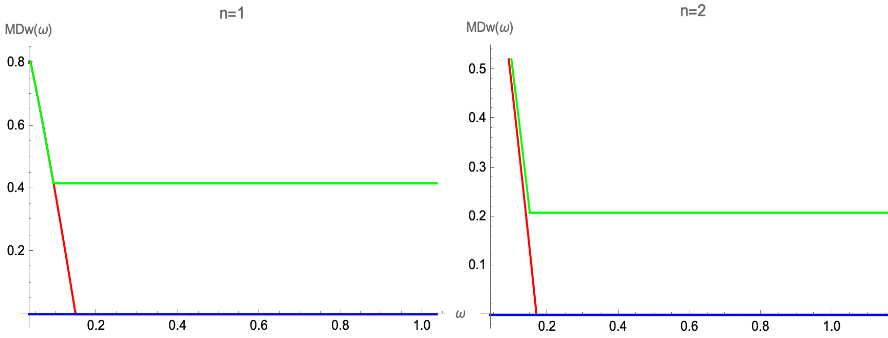
Minimum Wages: Unemployment of Low-Skilled Labor



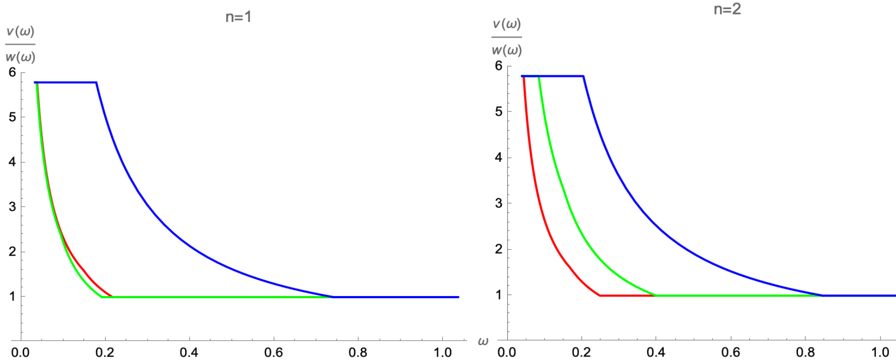
Minimum Wages: Wage Markdown of High-Skilled Workers



Minimum Wages: Wage Markdown of Low-Skilled Workers



Minimum Wages: Skill Premium



Minimum Wages: Labor Share