General Equilibrium with Market Power: An Example

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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 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

$$f(l) = 2l.$$

There is a *worker* that has no resources other than her labor income, and her preferences over consumption and labor (the counterpart of leisure) are represented by a utility function

$$u(l, c) = -l^2/2 + c.$$

The Economy

There are also *n owners* each of whom manages a firm that produces consumption with the existing technology. Owners supply no labor and only care about the consumption they can procure using the profits of the firms they manage.

Owners (i.e., firms) are aware of their market power in both the markets for consumption and labor, and their objective is to maximize their real profits (their profits in units of consumption).

Worker

Let us denote by ω the real wage, that is, the nominal wage divided by the price of consumption. Worker's demand of consumption and supply of labor are obtained by solving the problem:

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

We calculate the worker's marginal rate of substitution,

$$MRS(l,c) = l.$$

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

Worker

Solving the system

$$\begin{aligned} l &= \omega \\ c &= \omega l \end{aligned}$$

we get the worker's demand of consumption and supply of labor,

$$c(\omega) = \omega^2, \; l(\omega) = \omega,$$

Competitive Equilibrium

In the competitive equilibrium constant returns to scale imply that firms profits are zero.

Hence the owners consumption is zero.

Since a unit of labor allows to produce 2 units of consumption, in equilibrium the real wage is

$$\omega_{CE} = 2 = l_{CE}.$$

and the worker's consumption is

$$c\left(\omega_{CE}\right) = \omega_{CE}^2 = 4.$$

Competitive Equilibrium

The economy's output of consumption (GDP) is

$$Y_{CE} = 2l_{CE} = 4,$$

and the *surplus* generated by the economic activity is

$$S_{CE} = Y_{CE} - \frac{(l_{CE})^2}{2} = 2.$$

where the sustracting term is the worker's desutility of labor. The worker's surplus (i.e., utility) is

$$W_{CE} = \omega^2_{CE} - \frac{(l_{CE})^2}{2} = 2,$$

and onwers surplus (i.e., the aggregate real profits) is

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

(Note $S = W + \Pi$ always.) It is easy to see that S_{CE} is the maximum surplus that the economic active may achieve.

Suppose now that $n = 1$, and the single firms exercises monopoly (monopsony) power in the market for consumption (labor).

In this monopolisitic economy the real wage depends on the amount of labor the firm uses according to equation

$$l = l(\omega) \Leftrightarrow \omega(l) = l.$$

The monopolist, aware of the impact of labor on the real wage,chooses its labor to solve the problem

$$\max_{l \in \mathbb{R}_+} \pi(l) = 2l - \omega(l)l = 2l - l^2.$$

Hence in the monopoly equilibrium

$$2 - 2l = 0 \Leftrightarrow l_M = 1 = \omega_M,$$

The economy's output of consumption (GDP) is

$$Y_{ME} = 2l_{ME} = 2,$$

and the *surplus* generated by the economic activity is

$$S_{ME} = Y_{ME} - \frac{(l_{ME})^2}{2} = \frac{3}{2} < 2,$$

i.e., this allocation is NOT Pareto optimal.
The worker's surplus is

$$W_{ME} = \omega_{ME}^2 - \frac{(l_{ME})^2}{2} = \frac{1}{2},$$

and onwers surplus is

$$\Pi_{ME} = 2l_{ME} - \omega_{ME} l_{ME} = 1.$$

Oligopoly

Assume that $n > 1$. In an equilibrium of the the *oligopolisitic* economy each firm maximizes its real profit given its rivals' labor decision.

That is, an equilibrium profile $\ell = (l_1, ..., l_n)$ is such that l_i solves the problem

$$\max_{l \in \mathbb{R}_+} \pi(l, \ell_{-i}) = 2l - \omega(l, \ell_{-i})l,$$

where

$$\ell_{-i} = \sum_{j \neq 1} l_j$$

and (by labor market clearing)

$$\omega(\ell_{-i} + l) = \ell_{-i} + l.$$

Oligopoly

Since

$$\frac{\partial \omega(\ell)}{\partial l_i} = 1,$$

the first order condition for a solution to this problem is

$$2 - l - \omega(\ell) = 0 \Leftrightarrow l(\ell_{-i}) = \frac{1}{2}\left(2 - \sum_{j \neq i} l_j\right).$$

It is easy to show equilibrium is symmetric, i.e., $l_i = l$ for all i.

Hence in equilibrium the equation

$$l = \frac{1}{2}\left(2 - (n-1)\, l\right)$$

holds, and the labor of a firm is

$$l_{OE}(n) = \frac{2}{n+1}.$$

The equilibrium real wage is

$$n l_{OE}(n) = \frac{2n}{n+1} = \omega_{OE}(n),$$

Therefore workers consumption is

$$c_{OE}(n) = \left(\frac{2n}{n+1}\right)^2 = 4\left(\frac{n}{n+1}\right)^2,$$

and a firms' real profit is

$$\pi_{OE}(n) = (2 - \omega_{OE}(n))\, l_{OE}(n) = \left(2 - \frac{2n}{n+1}\right)\frac{2}{n+1} = \frac{2}{(n+1)^2}$$

Hence

$$\lim_{n\to\infty} \omega_{OE}(n) = 2, \quad \lim_{n\to\infty} c_{OE}(n) = 4, \quad \lim_{n\to\infty} \pi_{OE}(n) = 0.$$

The economy's output of consumption (GDP) is

$$Y_{OE}(n) = n(2l_{OE}(n)) = \frac{4n}{n+1},$$

and the *surplus* generated by the economic activity is

$$S_{OE} = Y_{OE} - \frac{(nl_{OE}(n))^2}{2} = \frac{4n}{n+1} - \frac{1}{2}\left(\frac{2n}{n+1}\right)^2 = 2\frac{n(n+2)}{(n+1)^2},$$

i.e., this allocation is NOT Pareto optimal.
The worker's surplus is

$$W_{OE}(n) = \omega_{OE}^2(n) - \frac{(nl_{OE}(n))^2}{2} = \left(\frac{2}{n+1}\frac{2n}{n+1}\right)^2 - \frac{1}{2}\left(\frac{2n}{n+1}\right)^2 = 2\left(\right.$$

and onwers surplus is

$$\Pi_{OE} = n(2l_{OE}(n) - \omega_{OE}(n)l_{OE}(n)) = n\left(\frac{4}{n+1} - \left(\frac{2n}{n+1}\right)\left(\frac{2}{n+1}\right)\right)$$

Policy: Minimum Wages

Let us assume that the government sets a minimum **real** wage $\bar{\omega} \in (\omega^*(n), 2]$. This implies that the real wage is now

$$\omega(\ell) = \begin{cases} \bar{\omega} & \text{if } \sum_j l_j \leq \bar{\omega} \\ \sum_j l_j & \text{otherwise.} \end{cases}$$

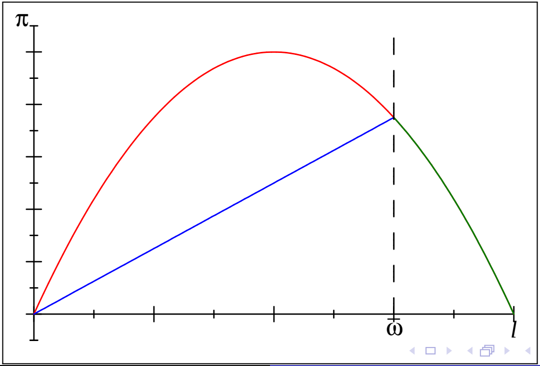
Policy: Minimum Wages

If $n = 1$ (monopoly), $\bar{\omega} \in (1, 2]$. Then $\hat{\omega}(l) = (2 - \bar{\omega})\, l$ for $l \leq \bar{\omega}$ and $\hat{\omega}(l) = (2 - l)\, l$ for $l > \bar{\omega}$.
Hence the solution to the firm's problem

$$\max_{l_i \in \mathbb{R}_+} (2 - \hat{\omega}(l))\, l.$$

is

$$l = \bar{\omega}.$$

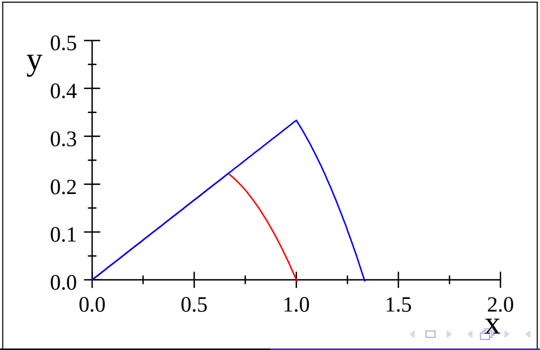


If $n = 2$, then

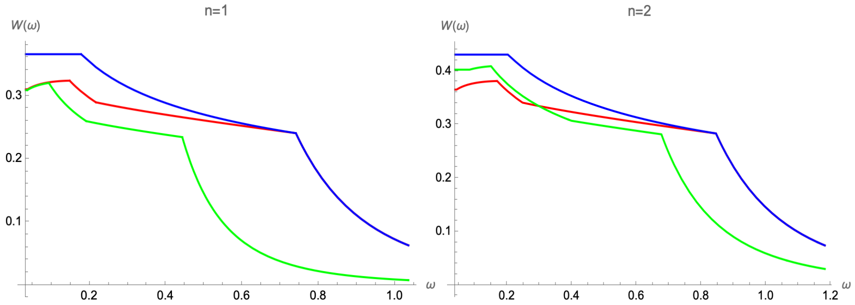
$$\max_{l_i \in \mathbb{R}_+} \left(2 - \hat{\omega}(l_1, l_2)\right) l_i.$$

Then there is a symmetric equilibrium, $l_1 = l_2 = \bar{\omega}/2$, but that are also asymmetric equilibria.

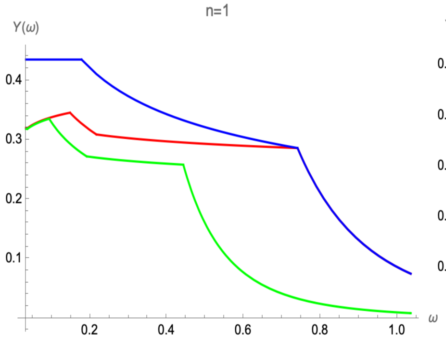
Example: $\omega^*(2) = 4/3$. Take $\bar{\omega} = 5/3$. Then $l_1 = 2/3$, $l_2 = 1$ forms an equilibrium. To see this, we graph the profits of both firms:

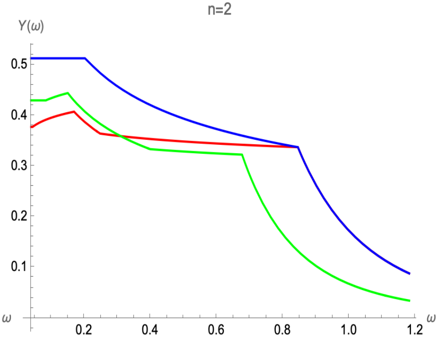


Minimum Wages: Surplus

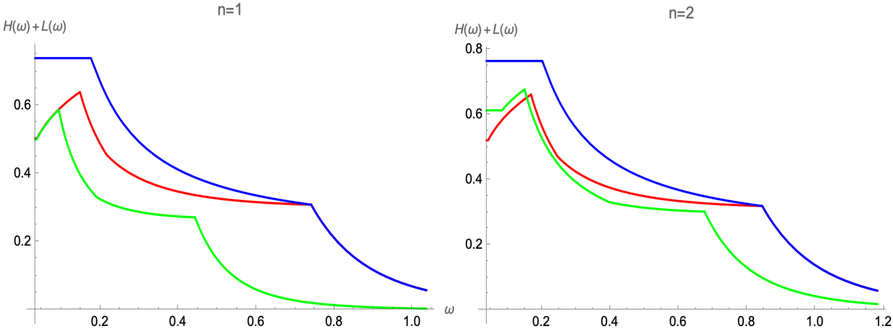


Minimum Wages: Aggregate Income

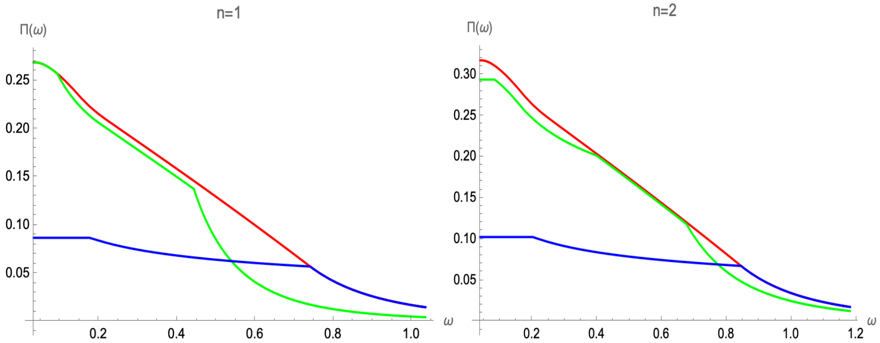




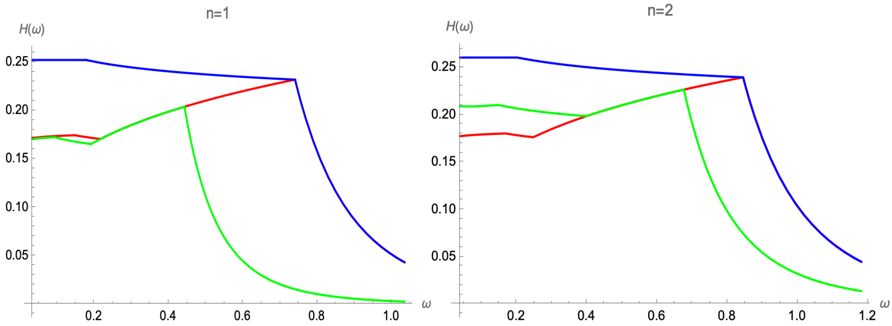
Minimum Wages: Employment



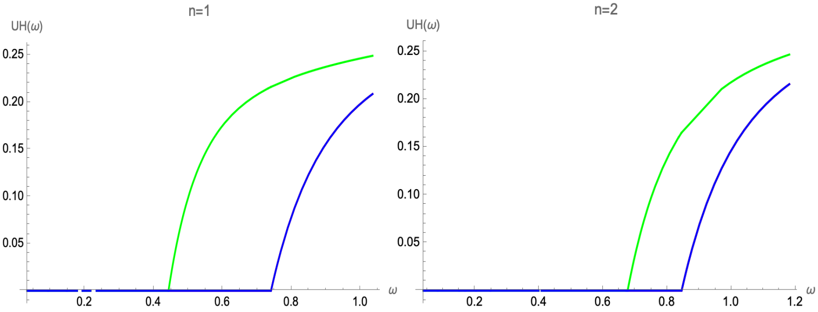
Minimum Wages: Profits



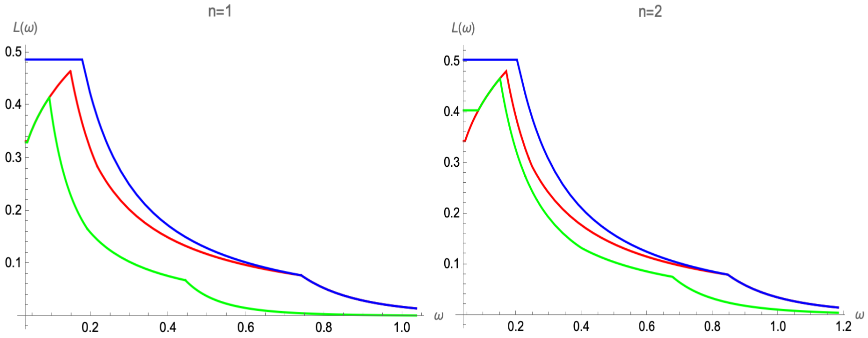
Minimum Wages: Employment of High-Skilled Labor



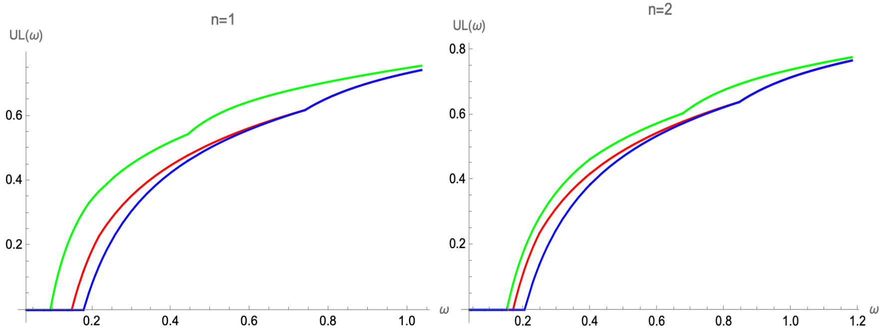
Minimum Wages: Unemployment of High-Skilled Labor



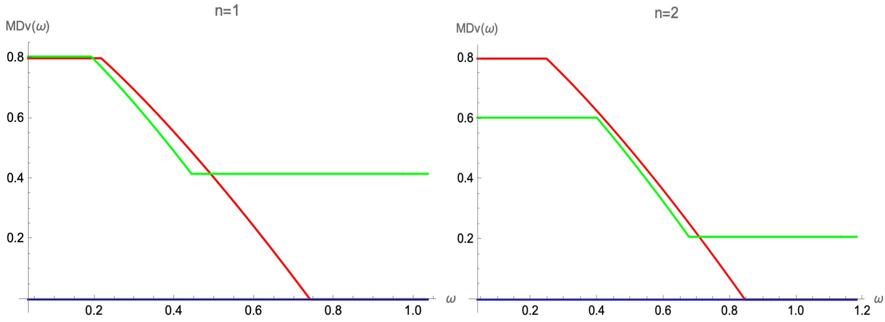
Minimum Wages: Employment of Low-Skilled Labor



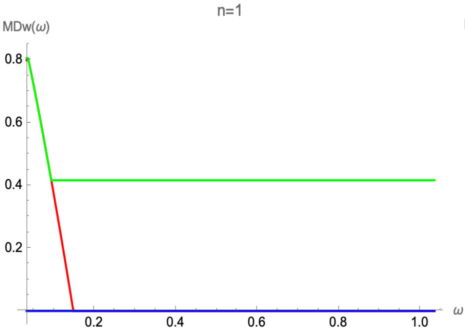
Minimum Wages: Unemployment of Low-Skilled Labor

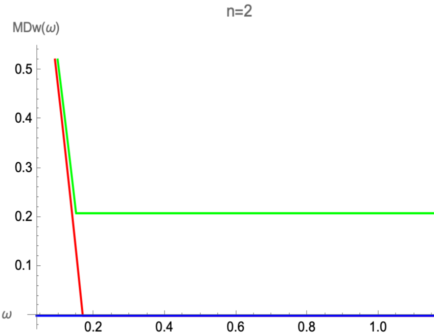


Minimum Wages: Wage Markdown of High-Skilled Workers

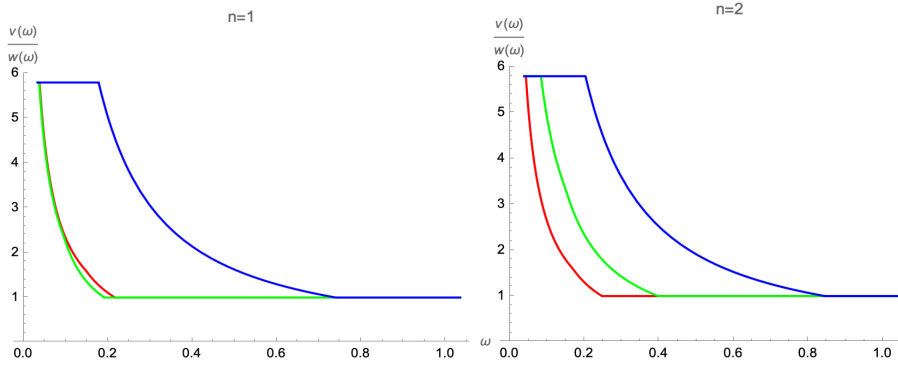


Minimum Wages: Wage Markdown of Low-Skilled Workers





Minimum Wages: Skill Premium



Minimum Wages: Labor Share