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Common ownership and uncertainty

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Abstract
This study explores the effects of economic uncertainty on general equilibrium when firms hold market power due to common ownership. By modifying the model of Azar and Vives (2021) and introducing uncertainty as shocks to consumer preferences, we examine how this influences the decisions of both workers and firms. The results clearly show that uncertainty has real effects on the economy, both in a single-sector model and in the multi-sector model. In the single-sector model, uncertainty leads to variations in labor supply based on consumers' expectations regarding the future value of consumption. If consumers assign a higher expected value to future consumption, they increase their labor supply to finance higher levels of consumption. Conversely, a lower expected value of consumption reduces workers' willingness to work, causing a contraction in labor supply and a decrease in total production. In the multi-sector model, uncertainty is more pervasive. Despite the expected value of each shock remaining unchanged, the inability of economic agents to fully diversify risk across different sectors amplifies the effects of uncertainty, leading to a negative impact on overall economic outcomes. In terms of welfare, the introduction of uncertainty results in a decrease in the overall well-being of both workers and firm owners. Although market power can reduce losses due to uncertainty, it simultaneously leads to a lower level of economic welfare.

Keywords: Common ownership, uncertainty, general equilibrium, market power
JEL Codes: D43, D51, D81, L13

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1 Introduction

Following the growing body of empirical evidence documenting the persistent rise in market power (De Loecker and Eeckhout (2018); De Loecker, Eeckhout, and Unger (2020)), researchers have increasingly focused on understanding the underlying causes of this trend. Among various factors, such as technological changes, mergers and acquisitions, and others, common ownership has been identified as a potential driver (Azar, Schmalz, and Tecu (2018); Ederer and Pellegrino (2021, 2023); Antón, Ederer, Giné, and Schmalz (2023)). Traditional economic theory posits that managers make decisions to maximize the value of the firms, fostering competition, encouraging innovation, and often resulting in lower prices for consumers. However, when common ownership comes into play—where the same investors hold significant shares across multiple competing firms—this competitive dynamic might change. When shareholders have stakes in competing firms, their primary interest might no longer be the individual success of a single company but rather the overall profitability of their investment portfolio. This incentivizes firms to engage in cooperative, or even collusive, behavior that limits competition, rather than competing to capture larger market shares. In their seminal paper, Azar, Schmalz, and Tecu (2018) investigate the anti-competitive effects of common ownership in the airline industry. They use data on airline routes and ticket prices, showing that fares are higher when institutional investors hold significant shares in competing airlines. The study provides empirical evidence that common ownership reduces competition and increases market power, resulting in higher consumer prices. The literature has provided various channels through which common ownership could lead to a reduction in competition. One example is the sensitivity of top managers' compensation to profits. Antón, Ederer, Giné, and Schmalz (2023) show that top managers' profit sensitivity negatively correlates with common ownership. Using a difference-in-differences analysis on companies listed in the S&P 500, they show that the entry of a new company into the index further reduces the sensitivity of top managers' compensation.

Over the years, researchers have explored the implications of oligopolistic competition using monopolistic competition Dixit and Stiglitz (1977) as a basic setup, primarily because of its analytical tractability. However, within this model, the only source of market power arises from the rigidity of demand, which is tied to consumer preferences. Such a connection makes it impossible to separate firms' market power from consumer preferences in such models. One possible solution, pointed out by Benassy (1996), could be to modify the CES (Constant Elasticity of Substitution) to separate consumer preferences from firms' market power. However, this approach is not entirely accurate because all firms end up having the same markup, which is at odds with the significant variation in market power observed across firms.[2] Atkeson and Burstein (2008) and De Loecker, Eeckhout, and Mongey (2021) propose a setup with an infinite number of sectors, whereby in each sector, there is competition among a finite number of firms. While these models introduce more complex interactions between firms within each sector, they still have limitations, particularly when considering the empirical evidence on common ownership structures. In these

[2]De Loecker, Eeckhout, and Unger (2020) among the others shows that the rise of market power is driven mostly by firms above the last 75% of markups distribution.

models, economic agents hold the same market portfolio, and managers are modeled to always maximize firm profits, not considering the possible anti-competitive impact of common ownership on firms' strategic behavior.

Our analysis adopts the model proposed by Azar and Vives (2021) as a basic framework. In this model, there are a finite number of sectors, each containing a finite number of firms. In this setup, the decisions made by each firm have a direct impact on the general economic equilibrium[3]. Notably, if the number of sectors tends to infinity under certain conditions, this model converges to the same outcomes as those presented in Dixit and Stiglitz (1977); Atkeson and Burstein (2008). We modify both the one-sector version of the model and the multisector one, where we identify two primary sources of market power. The first is the rigidity of demand for each individual variety, which implies firms' pricing power due to consumers' preferences between products. The second source of market power, which is our focus, is the common ownership structure. In this setup, investors can diversify[4] in two indexes: one intra-sector and the other inter-sector. Higher levels of common ownership intra-sector results in reduced overall competition, leading to lower aggregate wages and employment. This effect arises because firms, when commonly owned, are less incentivized to engage in aggressive competition. Therefore, a greater common ownership structure reduces competitive pressure among firms and leads to higher aggregate market power. This is always true when analyzing partial equilibrium models. However, in general equilibrium models with a common ownership structure across different sectors, increased diversification of investors can potentially lead to pro-competitive effects if we consider diversification in different sectors. Azar and Vives (2021, 2022).

In this paper, we extend the Azar and Vives (2021) model by introducing uncertainty due to demand shocks, which we model in a similar way as Casares, Deidda, and Galdon-Sanchez (2023). The main purpose of this paper is to provide a framework in which it is possible to analyze the effects of common ownership in scenarios of uncertainty. Relatedly, the original framework we derive, allows us to identify some interesting insights about the effects of common ownership in the presence of undiversifiable risk due to the exogenous preference shocks we introduce. The way in which we introduce demand shocks implies that firms are exposed to risk as they must decide their production levels before these shocks occur and pay labor wages in advance. Similarly, workers need to choose their labor supply before they can observe the shocks' realization. Accordingly, in this setup, agents face economic risk when making their decisions, as they must act without full knowledge of the future value of consumption.

Our findings suggest that an increase in either demand rigidity or common ownership level leads to a reduction in aggregate welfare, as highlighted in the existing literature. However, it also results in a simultaneous decrease in the losses caused by uncertainty. Despite this, reducing uncertainty losses is insufficient to offset the welfare losses suffered by consumers, leading to an overall negative effect on welfare.

This paper is structured as follows: In Section 2, we present the basic model with only one

[3]Different from Dixit and Stiglitz (1977); Atkeson and Burstein (2008) in this model firms are not price taker.

[4]Note that the term diversification in this paper indicates the level of common ownership and thus the level of market power.

sector to establish the core dynamics. Section 3 extends the model to include uncertainty in the multiple sector model and, in Section 4, we simulate the model with multiple sectors and compare the results with the original Azar and Vives (2021) model.

2 Model setup

Consider two-periods economy with two types of agents: owners and workers, both of whom live for two periods. In the economy, there are of two types of goods: consumer good and leisure, with prices denoted by P and w, respectively. Workers are endowed with a fixed amount of time T, which they can allocate between leisure and labor. The utility function of worker i is given by:

$$U^w(C_i^w, L_i) = eC_i^w - \chi \frac{L_i^{1+\frac{1}{\eta}}}{1+\frac{1}{\eta}}, \tag{1}$$

where C_i^w is the level of consumption of consumer good of worker i, L_i is the amount of labor, $\chi > 0$ is a parameter that weights labor disutility, e is an idiosyncratic shock of consumers' preference, $\eta > 0$ is the elasticity of labor supply. Owners are endowed with the property of groups which hold the firms' share and their only source of income comes from these holdings. They do not work and derive utility from consumption according to the following function

$$U^o(C_i^o) = eC_i^o \tag{2}$$

We assume that shock is common across people and it is uniformly distributed between $[\underline{e}, \overline{e}]$. Its probability density function and expected value are respectively

$$f(e) = \frac{1}{\overline{e} - \underline{e}} \tag{3}$$

$$\mathbb{E}(e) = \int_{\underline{e}}^{\overline{e}} e\frac{1}{\overline{e} - \underline{e}} de = \frac{\overline{e} + \underline{e}}{2}. \tag{4}$$

2.0.1 Ownership structure

The firms' ownership structure is organized as follows. Owners are equally distributed across groups and there is one groups for each firm. More specifically the ownership structure is such that each j group owns a $(1-\phi) + \phi/J$ share of the j firm and, a ϕ/J share of all other firms, where $\phi \in [0, 1]$ denotes the level of portfolio diversification. When $\phi = 0$ all groups will only hold shares in one firm, and for a sufficiently large number of J this model will tend toward a model of perfect competition. Instead, when the level of portfolio diversification is perfect ($\phi = 1$) all firms perfectly internalize the production choices of other firms and, the results of this model are analogous to those of a monopolistic model.
The managers of each firm maximize the indirect utility of their respective owners, weighted by the fraction of equity capital they control. In this scenario, greater portfolio diversification within

each group results in firms holding more concentrated portfolios, which reduces their incentive to compete. As competitive pressures decrease, this ultimately leads to an increase in market power. The objective function of the manager of firm j is

$$\frac{\Pi_j}{P} + \lambda \sum_{k \neq j} \frac{\Pi_k}{P}, \tag{5}$$

where $\frac{\Pi_j}{P}$ and $\frac{\Pi_k}{P}$ are the real profit of firm j and k respectively and, $\lambda \in [0, 1]$ is a weight that capture the fact that firm j and k might have common ownership. In the model we present, λ represents the level of market power held by firms as a result of common ownership structure. When no group owns shares in firms other than the one in which it holds a majority, we have $\phi = 0, \lambda = 0$, and the managers choose the quantity that maximizes the indirect utility of their respective owners. Since all belong to the same group, this is equivalent to maximizing the firm's profits. Conversely, if all groups held the same shares in each firm into the market, managers would all maximize the same objective function, and the outcome would be analogous to that of a single monopolistic firm operating in the market.

2.1 Agents Behavior

2.1.1 Timing

The timing of events is the following:

- at t=0, firms decide how much to produce and workers decide how much labor to supply in order to finance consumption at time 1. At this time firms pay wages;
- at t=1, the preference's shock is realized and workers and owners decide how much consumer good to demand.

Workers decide how much to work without knowing the value of their future consumption, and firms decide how much to produce without knowing the real value of the good they will sell. Since there is no a continuum of consumption good, agents cannot fully diversify aggregate risk. Given the structure of the economy, workers determine how much to work by considering the optimal choice they make in the second period. Therefore, the problem is solved using backward induction.

2.1.2 Workers' problem at time 1

At time 1, workers take labor supply L_i, which they decided at time 0, and the labor income wL_i as given, therefore, worker i chooses how much to consume by solving the following problem

$$\max_{C_i^w} U^w(C_i^w, L_i) = eC_i^w - \chi \frac{L_i^{1+\frac{1}{\eta}}}{1+\xi} \tag{6}$$

$$s.to.$$

$$wL_i \geq PC_i, \tag{7}$$

where w is the nominal wage and P is the price of consumer good.
We note that U^w is monotonically strictly increasing in C_i^w so, to maximize the utility function each worker will choose to spend the whole income. The solution of the above maximization problem yields the following individual demand function

$$C_i^w = \omega L_i, \tag{8}$$

where $\omega = \frac{w}{P}$ is the real wage.

2.1.3 Workers' time 0 problem

At time 0, workers have to choose how much labor to supply in order to maximize their expected utility. Hence, the problem faced by worker i is to maximize his expected utility function taking into account the optimal choice that he makes at the next stage. Formally,

$$\max_{C_i^w, L_i} \mathbb{E}\left[U^w\left(C_i^w, L_i\right)\right] = \int_{\underline{e}}^{\overline{e}} \left(C_i^w e - \chi \frac{L_i^{1+\frac{1}{\eta}}}{1+\frac{1}{\eta}} \right) \frac{1}{\overline{e}-\underline{e}} de \tag{9}$$

$$s.to.$$

$$C_i^w = \omega L_i \tag{10}$$

By substituting the constraint (10) into objective function (9) and solving the integral, we can rewrite the previous problem as

$$\max_{L_i} \mathbb{E}\left[U^w\left(L_i\right)\right] = \omega L_i \mathbb{E}(e) - \chi \frac{L_i^{1+\frac{1}{\eta}}}{1+\frac{1}{\eta}} \tag{11}$$

The solution of this problem yields the individual inverse labor supply

$$\omega = \left(\frac{\chi}{\mathbb{E}(e)}\right) L_i^{\frac{1}{\eta}}. \tag{12}$$

Given $L = \int_0^1 L_i di$, the correspondent aggregate inverse labor supply is

$$\omega = \left(\frac{\chi}{\mathbb{E}(e)}\right) L^{\frac{1}{\eta}}. \tag{13}$$

Firms' Problem

Firms need a period to produce consumer good, so they set their production schedule at time 0 before the shock is realized. Firm j produces consumer goods according to the following production function $F(L_j) = AL_j^\alpha$. Each manager chooses how much to produce in order to maximize the shareholders' utility of the firm they control. The problem faced by manager of firm j is therefore

$$\max_{L_j} g(L_j) = F(L_j) - \omega(L)L_j + \sum_{k \neq j}^{J} \lambda[F(L_k) - \omega(L)L_k]. \tag{14}$$

The first order condition associated with the above problem is

$$\frac{\delta g(L_j)}{\delta L_j} = F^{'}(L_j) - \omega(L) - \omega'(L)\left(L_j + \sum_{k \neq j}^{J} \lambda L_k\right) = 0. \tag{15}$$

Solving the FOC we obtain the inverse labor demand

$$\omega(L) = \frac{F^{'}(L^d/J)}{1+\mu} \tag{16}$$

2.1.4 General equilibrium

Equivalent to Azar and Vives (2021) we characterize the Walras-Cournot equilibrium with shareholders representation.

Definition 1. *A competitive equilibrium relative to* $(L_1, ..., L_J)$ *is a price system and allocation* $[\{w, P\}; \{C_i^w, L_i\}_{i \in I_w}, \{C_i^o\}_{i \in I_O}]$ *such that the following statements hold:*

(i) For $i \in I_W$, (C_i^w, L_i) *maximizes* $U^w(C_i^w, wL_i$ *subject to* $pC_i^w \leq wL_i$ *for* $i \in I_O, W_i/P$*;*

(ii) Labor supply equals labor demand by the firms: $\int_{i \in I_W} L_i di = \sum_{j=1}^{J} L_j$*;*

(iii) Total consumption equals total production : $\int_{i \in I_W \cup I_O} C_i di = \sum_{j=1}^{J} F(L_j)$.

Definition 2. *A Cournot-Walras equilibrium whit shareholder representation is a price function* $\mathbb{W}(.)$,$\mathbb{P}(.))$*, an allocation* $(\{C_i^{w*}, L_i\}_{i \in I_W}, \{C_i^{o*}\}_{i \in I_O})$*, , and a set of plans* L^* *such that:*

(i) $[\mathbb{W}(L^*), \mathbb{P}(L^*); \{C_i^{w*}, L_i\}_{i \in I_W}, \{C_i^{o*}\}_{i \in I_O}]$ *is a competitive equilibrium relative to* L^**;*

(ii) the production plans vector L^* *is a pure-strategy space of firm j is* $[0, T]$*, and the firm's payoff function is*

$$\frac{\Pi_j}{P} + \lambda \sum_{k \neq j} \frac{\Pi_k}{P}.$$

Proposition 1 of Azar and Vives (2021) holds[5] and it guarantees the existence of unique, symmetric, and local stable under continuous adjustment equilibrium such that:

(a) total employment under symmetric equilibrium is

$$L^* = \left[\left(\frac{\mathbb{E}(e)}{\chi} \right) J^{1-\alpha} \frac{\alpha A}{1 + \frac{H}{\eta}} \right]^{\frac{1}{1-\alpha+\frac{1}{\eta}}}; \tag{17}$$

(b) the real wage is

$$\omega^* = \left[\left(\frac{\chi}{\mathbb{E}(e)} \right)^{\eta} \left(\frac{1}{\alpha A} \right)^{\frac{1}{\alpha-1}} J^{\eta} \right]^{\frac{1}{\eta+\alpha-1}}; \tag{18}$$

(c) the markdown of real wage is given by

$$\mu = \frac{F'(L^*/J) - \omega(L^*)}{\omega(L*)} = \frac{H}{\eta(L^*)}; \tag{19}$$

where $H = (1 + \lambda(J-1))/J$ is the modified HHI of the market labor.

We note that when the expected values is normalized to one, i.e. $\mathbb{E}(e) = 1$, our model yields the same result as that of Azar and Vives (2021). By focusing on total employment, we can better understand the impact of preference shock in this economy.

If $\mathbb{E}(e) > 1$, total employment in our model exceeds that in Azar and Vives (2021). This is because people place a higher value on the consumption good. Therefore, workers want to work more hours to finance a higher level of consumption. In this case, the real wage, ω, is lower than in Azar and Vives (2021).

On the other hand, if $\mathbb{E}(e) < 1$, total employment is lower than in Azar and Vives (2021) because people assign less value to the consumption good. By placing a lower value, workers are less willing to work compared the previous case, leading to a lower level of employment L^* and higher unemployment. Clearly, if $\mathbb{E}(e) = 0$, no workers are willing to work because they place no value on consumption.

At time 1, the realization of shock does not affect P and C because, regardless of the shock's value (unless it is zero), aggregate consumption C is still equal to ωL. At this stage, the shock only affects the utility that people derive from consuming the good. If $\mathbb{E}(e) = 0$, the utility people get from consumption is zero, and in this case, the entire economy might collapse because no value is placed on consumption.

[5]The condition of unique equilibrium existence is that the elasticity of the inverse of labor supply is less then 1 and objective function of firms is strictly concave ($E_{\omega'<1}$, $F'' < 0$). See Appendix and Vives(1999) for analitical demonstration

3 Multiple sector model

3.1 Model setup

In this subsection we introduce uncertainty as a demand preference shocks also in the Azar and Vives (2021) multiple sector model. Similarly, we extend the one sector model from previous section by assuming that there are N sectors, with each sector producing a distinct variety of consumption good. Within each sector, there are J firms that produce the same good. Different from the previous model, there is a continuum of both owners and workers, each with a mass of N. To increase the number of sectors, the number of people must also increase proportionally. The utility function of worker i is:

$$U^w(C_i^w, L_i) = C_i^w - \chi \frac{L_i^{1+\frac{1}{\eta}}}{1+\frac{1}{\eta}}, \tag{20}$$

where

$$C_i^w = \left[\sum_{n=1}^{N} \left(\frac{1}{N} \right)^{\frac{1}{\theta}} (e_n)^{\frac{1}{\theta}} \left(c_{ni}^w\right)^{\frac{\theta-1}{\theta}} \right]^{\frac{\theta}{\theta-1}}, \tag{21}$$

c_{ni}^w is the consumption of worker i of variety n, e_n is the preferences shock of variety n and $\theta > 1$ is the elasticity of substitution across variety. The shocks are iid and each shock is uniformly distributed between$[\underline{e}, \overline{e}]$. They are common among people, this means that all workers and all owners have the same preferences about how to consume even after the realization of the shock and makes, as we also saw in the model with only one sector, the value of future consumption uncertain.[6]

As in the model with only one sector, owners derive utility by consuming the goods produced by firms $U^o(C_i^o) = C_i^o$ while, the only source of income comes from the shares they own. The profit of firm j in sector n is

$$\Pi_{nj} = p_n F(L_{nj}) - wL_{nj}, \tag{22}$$

where $F(L_{nj}) = AL_{nj}^{\alpha}$ is the production function, A is the technology of production, w is the nominal wage, p_n is the nominal price of variety n and $\alpha \in [0, 1]$.

The price index of the economy has the following form

$$P = \left[\sum_{n=1}^{N} \frac{1}{N} e_n \left(p_n\right)^{1-\theta} \right]^{\frac{1}{1-\theta}}. \tag{23}$$

[6] If we had used a specific shock for each individual, it would have been able to perfectly diversify the risk.

3.2 Ownership structure

The ownership structure is different from the single sector model because each groups can have in their portfolio shares of firms of different sectors . As Azar and Vives (2021), the ownership structure is building such that each group nj directly owns a share $(1-\widetilde{\phi}-\phi)$ of firm nj and , an industry index of all firms in the same sector $(\widetilde{\phi}/J)$ and an economy-wide index found of all firms (ϕ/NJ). In this case ϕ and $\widetilde{\phi}$ represent the level of portfolio diversification in the whole economy and in the same sector, respectively. It is obvious that the sum of the two indices can never be greater than 1.

3.3 Agents behavior

Timing

The timing of our economy is the following:

- at t=0, firms decide how much to produce and workers decide how much labor to supply in order to finance consumption;
- at t=1, preferences' shocks occur and people decide, given the income they obtained in the previous period, how much to consume of each variety.

The function that aggregates the consumption of all sector is homothetic so, the choices of how allocate consumption across variety and how much to consume in aggregate are separable. This means that optimal choice at time 1 does not depend by optimal choice at time 0. As explained in the previous section workers solve this problem by backward induction.

3.3.1 Workers problem at time 1

At time 1, workers choose how much to consume across variety after observing shocks' realization. The problem faced by worker i is the following

$$\max_{c_{ni}^{w}} C_i^w = \left[\sum_{n=1}^{N}\left(\frac{1}{N}\right)^{\frac{1}{\theta}}(e_n)^{\frac{1}{\theta}}\left(c_{ni}^{w}\right)^{\frac{\theta-1}{\theta}}\right]^{\frac{\theta}{\theta-1}} \tag{24}$$

s.to.

$$wL_i = \sum_{n=1}^{N} p_n c_{ni}^{w}. \tag{25}$$

The FOC (First Order Condition) associated with problem (24) yields the optimal level of consumption of variety n conditional to shocks realization and aggregate level of consumption,

$$c_{ni}^{w} = \frac{1}{N} e_n \left(\frac{p_n}{P}\right)^{-\theta} C_i^w. \tag{26}$$

Furthermore the total expenditure is equal to price index multiplied the total level of consumption, so that

$$PC_i^w = wL_i. \tag{27}$$

Conditional on the aggregate consumption level, the demand for each variety by workers is the same as that of the owners. By aggregating all individual demands, we obtain the total demand.

$$\underbrace{\int_{I_w \bigcup I_o} c_{ni} di}_{c_n} = \frac{1}{N} e_n \left(\frac{p_n}{P}\right)^{-\theta} \underbrace{\int_{I_w \bigcup I_o} C_i di}_{C}. \tag{28}$$

Using this equation, we can determine the relative prices in a competitive equilibrium.

$$\frac{p_n}{P} = \left(\frac{1}{N}\right)^{\frac{1}{\theta}} e_n^{\frac{1}{\theta}} \left(\frac{c_n}{C}\right)^{-\frac{1}{\theta}}. \tag{29}$$

In a competitive equilibrium total production is equal to total consumption

$$c_n = \sum_{j=1}^{J} F(L_{nj}). \tag{30}$$

Therefore, in equilibrium, the relative price of variety n relative to production plans is given by the following equation

$$\frac{p_n}{P} = \left(\frac{1}{N}\right)^{\frac{1}{\theta}} e_n^{\frac{1}{\theta}} \left(\frac{\sum_{j=1}^{J} F(L_{nj})}{\left[\sum_{m=1}^{N} \left(\frac{1}{N}\right)^{\frac{1}{\theta}} (e_m)^{\frac{1}{\theta}} \left(\sum_{j=1}^{J} F(L_{mj})\right)^{\frac{\theta-1}{\theta}}\right]^{\frac{\theta}{\theta-1}}} \right)^{-\frac{1}{\theta}}. \tag{31}$$

At time 1, production schedules are already fixed and the realization of shocks only affects relative prices. The relative price of sector n depends on the realization of the shock associated with variety n but also on the realization of all $(N-1)$ shocks.

As we show in the appendix, a positive shock of variety n produces an increase in the relative price of that specific variety and, at the same time, generates an increase in the price level that makes it possible for all other firms producing variety $m \neq n$ to increase their prices. The intensity of this relationship depends on the elasticity of substitution among varieties. At a higher level of the elasticity of substitution between varieties, the impact of a positive shock of variety n on the relative price of variety n and m decreases. This means that the impact on the relative price of variety n/m of a positive shock on variety n is zero for a sufficiently high value of θ. This is because when θ tends to infinity all products become close to perfect substitutes and it is like in the economy there is just one market and its relative price is equal to one.

3.3.2 Workers' problem at time 0

At time 0, workers decide how much to consume and how much labor to provide to maximize their expected utility. In doing so, they consider the optimal decisions they will make at time 1. The optimization problem for each worker i is

$$\max_{C_i^w, L_i} \mathbb{E}(U^w) = \mathbb{E}\left(C_i^w - \chi \frac{{L_i}^{1+\frac{1}{\eta}}}{1+\frac{1}{\eta}}\right) \tag{32}$$

$$s.to.$$

$$PC_i^w = wL_i. \tag{33}$$

Dividing both side of equation (33) for P and replacing it into $\mathbb{E}(U^w)$ we can rewrite the maximization problem in a way that it depends only on L_i. The solution of this problem gives us the individual inverse individual labor supply as a function of expected real wage

$$\mathbb{E}(\omega) = \chi L_i^{\frac{1}{\eta}}. \tag{34}$$

Since workers are identical, the aggregate inverse labor supply is

$$\mathbb{E}(\omega) = \chi \left(\frac{L^s}{N}\right)^{\frac{1}{\eta}}. \tag{35}$$

Firms problem

Firms need a period to produce consumer goods, so they set their production schedule at time 0 before the shocks' realization. Firms produce according to the follow production function

$$F(L_{nj}) = AL_{nj}^{\alpha}.$$

As in the single sector model, the manager of firm nj maximize the real wealth of shareholders. At time 1 it is equal to

$$\frac{\Pi_{nj}}{P} + \lambda_{intra} \sum_{k\neq j}^{J} \frac{\Pi_{nk}}{P} + \lambda_{inter} \sum_{m\neq n}^{N} \sum_{k=1}^{J} \frac{\Pi_{mk}}{P}, \tag{36}$$

where λ_{intra} and λ_{inter} represent the weights that capture the common ownership across and intra sectors. In this case real profit of firm nj is a random variable because price index is affected by shocks so, the objective function that manager of firm nj maximizes is the expected value of function (36), that is

$$\mathbb{E}\left(\frac{\Pi_{nj}}{P}\right) + \lambda_{intra}\mathbb{E}\left(\sum_{k\neq j}^{J} \frac{\Pi_{nk}}{P}\right) + \lambda_{inter}\mathbb{E}\left(\sum_{m\neq n}^{N} \sum_{k=1}^{J} \frac{\Pi_{mk}}{P}\right). \tag{37}$$

Using equation (22) and substituting it into equation (37) faced by managers of firm nj is the following

$$\max_{L_{nj}} \mathbb{E}\left(\frac{p_n}{P}\right) F(L_{nj}) - \mathbb{E}(\omega) L_{nj} + \left[\lambda_{intra} \sum_{k\neq j}^{J} \mathbb{E}\left(\frac{p_n}{P}\right) F(L_{nk}) - \mathbb{E}(\omega) L_{nk}\right] \\ + \left[\lambda_{inter} \sum_{m\neq n}^{N} \sum_{k=1}^{J} \mathbb{E}\left(\frac{p_n}{P}\right) F(L_{mk}) - \mathbb{E}(\omega) L_{mk}\right] \tag{38}$$

The FOC of this problem is

$$\mathbb{E}\left(\frac{p_n}{P}\right) F'(L_{nj}) - \mathbb{E}(\omega) - \frac{d\mathbb{E}(\omega)}{dL_{nj}} \left[L_{nj} + \lambda_{intra} \sum_{k\neq j}^{J} L_{nk} + \lambda_{inter} \sum_{m\neq n}^{N} \sum_{k=1}^{J} L_{mk}\right] \\ + \frac{d\mathbb{E}\left(\frac{p_n}{P}\right)}{dL_{nj}} \left[F(L_{nj}) + \lambda_{intra} \sum_{k\neq j}^{J} F(L_{nk})\right] + \lambda_{inter} \sum_{m\neq n} \frac{d\mathbb{E}\left(\frac{p_m}{P}\right)}{dL_{nj}} \left[\sum_{k=1}^{J} F(L_{mk})\right] = 0. \tag{39}$$

As in Azar and Vives (2021), when the manager of a firm chooses how much to produce, it must take into account the fact that more production means a higher quantity offered, which leads to a reduction in the expected real price at which that variety can be sold at time 1. Furthermore, a greater demand for labor would increase wages and cause an increase in the expected demand for consumer goods with a consequent increase in the expected prices of other varieties. Solving the FOC we obtain the inverse of labor demand as a function of expected real wage markdown

$$\mathbb{E}(\omega) = \frac{\mathbb{E}\left(\frac{p_n}{P}\right) F'\left(\frac{L^d}{JN}\right)}{(1 + \mathbb{E}(\mu))}. \tag{40}$$

3.4 General Equilibrium

In this subsection we characterize a Walras-Cournot equilibrium with shareholders representation in an economy with N sectors.

Definition 3. *A competitive equilibrium relative to* $(L_1, ..., L_J)$ *is a price system and allocation* $[\{\mathbb{E}(\omega), \frac{p_n}{P}\}; \{C_i^w, L_i\}_{i\in I_w}, \{C_i^o\}_{i\in I_O}]$ *such that the following statements hold:*

(i) For $i \in I_W, (C_i^w, L_i)$ *maximizes* $\mathbb{E}(U^w)[(C_i^w, wL_i)]$ *subject to* $PC_i^w \leq wL_i$ *for* $i \in I_O, W_i/P$*;*

(ii) Labor supply equals labor demand by the firms: $\int_{i\in I_W} L_i di = \sum_{j=1}^{J} L_j$*;*

(iii) Total consumption equals total production : $\int_{i\in I_W \cup I_O} C_i di = \sum_{j=1}^{J} F(L_j)$*.*

As in the single sector model, the conditions of Azar and Vives (2021) hold, which guarantees the existence of unique, symmetric and local stable equilibrium where:

a) the total level of employment is

$$L^* = \left[\frac{1}{\chi} J^{1-\alpha} \frac{\mathbb{E}\left(\frac{p_n}{P}\right) \alpha A}{(1 + \mathbb{E}(\mu))}\right]^{\frac{1}{\frac{1}{\eta}+1-\alpha}} N; \tag{41}$$

b) the expected value of real wage is

$$\mathbb{E}^*(\omega) = \left[(\chi)^\eta \left(\frac{\mathbb{E}\left(\frac{p_n}{P}\right) \alpha A}{(1+\mathbb{E}(\mu))} \right)^{\frac{1}{1-\alpha}} J \right]^{\frac{1}{\eta + \frac{1}{1-\alpha}}}; \tag{42}$$

c) the expected markdown of real wage is

$$\mathbb{E}(\mu) = \frac{\frac{1}{\eta} H_{labor} + 1}{1 - \frac{\tau\left(H_{product} - \lambda_{inter}\right)}{\mathbb{E}\left(\frac{p_n}{P}\right)}} - 1. \tag{43}$$

Where $H_{product} = (1 + \lambda_{intra}(J-1))/J$ and $Hlabor = (1 + \lambda_{intra}(J-1) + \lambda_{inter}(N-1)J)/NJ$ represent respectively the modified HHI for each sector and for the labor market. Notice that the markdown of real wages is positively correlated with common ownership within the single sector ($\tilde{\phi}$) but it might be not monotone in diversification iter sectors (ϕ)[7]. An increase in common ownership structures within an industry ($\tilde{\phi}$) raises the weight of the profits of other firms in the same industry (λ_{intra}) in each firm's objective function. This reduces the firms' incentives to compete and allows them to impose greater markdowns on wages. Through this ownership structure, firms are able to extract wealth from workers, thereby increasing their own profits.

4 Numerical Simulation

In this section, we aim to numerically simulate both our model and the Azar and Vives (2021) general equilibrium to analyze the impact of uncertainty in a setting with imperfect competition. We calibrate the models using the calibration of Azar and Vives (2022). Total number of sectors is set to $N = 100$, while the number of firms competing within each sector, denoted as J, is fixed at 5. The labor technology of production, A, is set to 0.4976, and the disutility of labor, represented by χ, is assigned a value of 0.3827. The marginal productivity of labor, α, is calibrated to $\frac{2}{3}$. Additionally, the elasticity of substitution across varieties, θ, is fixed at 3, and the elasticity of labor supply, η, is set to 0.59.

To ensure that the expected value of shocks in the model is normalized to one, we assume that shocks follow a uniform distribution where, the lower bound is 0, while the upper bound is 2. This setup guarantees that the average shock level aligns with the model's calibration assumptions.

4.1 Uncertainty and equilibrium outcomes

In Figure (1), we observe the effects of increasing common ownership in the single sector $\tilde{\phi}$ on the main equilibrium outcomes in both models. As $\tilde{\phi}$ increases, there is a significant decline in total employment and real wage, while both markdown and profits show an upward trend. This inverse

[7]See Azar and Vives (2021) for more details

Parameter	Description	Value
N	Number of sectors	100
J	Number of firms per sector	5
A	Technology of production	0.4976
χ	Disutility of labor	0.3827
α	Marginal productivity of labor	$\frac{2}{3}$
θ	Elasticity of substitution across varieties	3
η	Elasticity of labor supply	0.59

Table 1: Parameter Calibration

relationship can be attributed to the fact that increased common ownership within an industry reduces competition and, in turn, increases the firms' market power in the labor market, allowing them to exert greater markdown over real wage. However, this change in competition does not significantly affect the relationship between the two models. The model with uncertainty consistently shows a parallel downward shift relative to the model without uncertainty. This suggests that uncertainty uniformly affects the equilibrium outcomes in both models, without changing the effect that greater common ownership intra sector has on the difference between the two models.

Instead (Figure(2)) show the effects of increasing elasticity of substitution among varieties. An increase in the elasticity of substitution among varieties by affecting relative prices also affects the other equilibrium variables. For θ tending to one, the relative prices of the model with uncertainty tend to infinity. The economic interpretation of this result is that lower substitutability among varieties causes that at time two, when shocks on preferences occur, the value of the consumption index tends to infinity, and given the structure of preferences this implies that the equilibrium price also tends to infinity. This behavior produces a mirror movement of the total employment, real wage and aggregate profit. For θ tending to infinity, on the other hand, we have that the two models converge because, since substitutability is perfect, it is as if there were only one variety in the economy and its price is equal to one.

On the other hand, an increase in the number of firms within each sector has a positive impact in both models Figure(3). It leads to higher total employment, real wages, and aggregate profits. However, while these increases are beneficial, they also amplify the gap between the model with uncertainty and the model without uncertainty, thus making greater the effects of uncertainty. In other words, as the number of firms and sectors grows, the divergence caused by uncertainty becomes more pronounced, enhancing its overall impact on the economy.

4.2 Uncertainty and welfare

Figures (4 , 7) illustrate the effects of common ownership within sector on the welfare of the agents in the economy. Greater intra-sector common ownership tends to produce effects similar to those typically associated with firms' market power. As diversification increases, workers' utility tends to decline while owners utility increase. Despite the positive effect on owners' utility, the overall impact on aggregate welfare is negative. This is because the gains for owners are more than offset by the losses experienced by workers, leading to a decline in total welfare. Interestingly, the relationship between diversification and welfare losses evolves as diversification increases. Moreover, as diversification increases, the absolute and relative losses for workers decrease, while the losses for firm owners rise.

An increase in the substitutability between varieties affect on different way the aggregate welfare. If products become more substitutable, firms' market power is reduced, leading to an improvement in workers' welfare. However, the decrease in market power negatively impacts firm owners' profits, resulting in a decline in their utility. Overall, if the expected value of relative prices is higher than in the Azar and Vives (2021) model—specifically, less than one—the losses from uncertainty are reduced for both workers and firm owners. After the expected relative prices hit their lowest point, any further increase in θ causes workers' utility to grow more than owners' utility decline. This results in an overall improvement in aggregate welfare.

Lastly, an increase in the number of sectors and firms per sector generates positive effects for all agents in the economy. This increase in variety stimulates competition, improving conditions for workers through more job opportunities and limiting the control that firms can exert over prices. Firm owners benefit as well since they face an increase in profit since the market becomes bigger. However, despite these positive effects, the addition of more companies and sectors produces an increase in the gap between the welfare in the model of Azar and Vives (2021) and that one presented in the paper thus producing an increase in losses.

5 Conclusion

This paper explored the effects of economic uncertainty on general equilibrium when firms have market power due by common ownership. By modifying the model of Azar and Vives (2021)), introducing uncertainty as shocks to consumer preferences, we study how it influences the decisions of both workers and firms. The results clearly show that uncertainty has real effects on the economy, both in a one-sector model and a multi-sector model.

In the one-sector economy, uncertainty leads to variations in labor supply based on consumers' expectations about the future value of consumption. If consumers assign a higher expected value to future consumption, they increase their labor supply to finance higher levels of consumption. Conversely, a lower expected value of consumption reduces workers' willingness to work, resulting in a contraction of labor supply and a corresponding decrease in total production.

In the multi-sector model, uncertainty is more pervasive. Despite the expected value of each shock remaining unchanged. The inability of economic agents to fully diversify risk across different sectors amplifies the effects of uncertainty, leading to a negative effect on overall economic outcomes.

In terms of welfare, the introduction of uncertainty leads to a decrease in the overall well-being of both workers and firm owners. Market power reduces losses from uncertainty but at the same time brings the economy to a lower level of welfare.

In summary, this paper highlights how uncertainty influences the real economy, both in a one-sector and a multi-sector model. While market power can provide some protection against uncertainty, its overall impact on welfare remains negative. These findings have important implications for economic policy, suggesting that increasing market power is not an optimal solution to mitigate the effects of uncertainty.

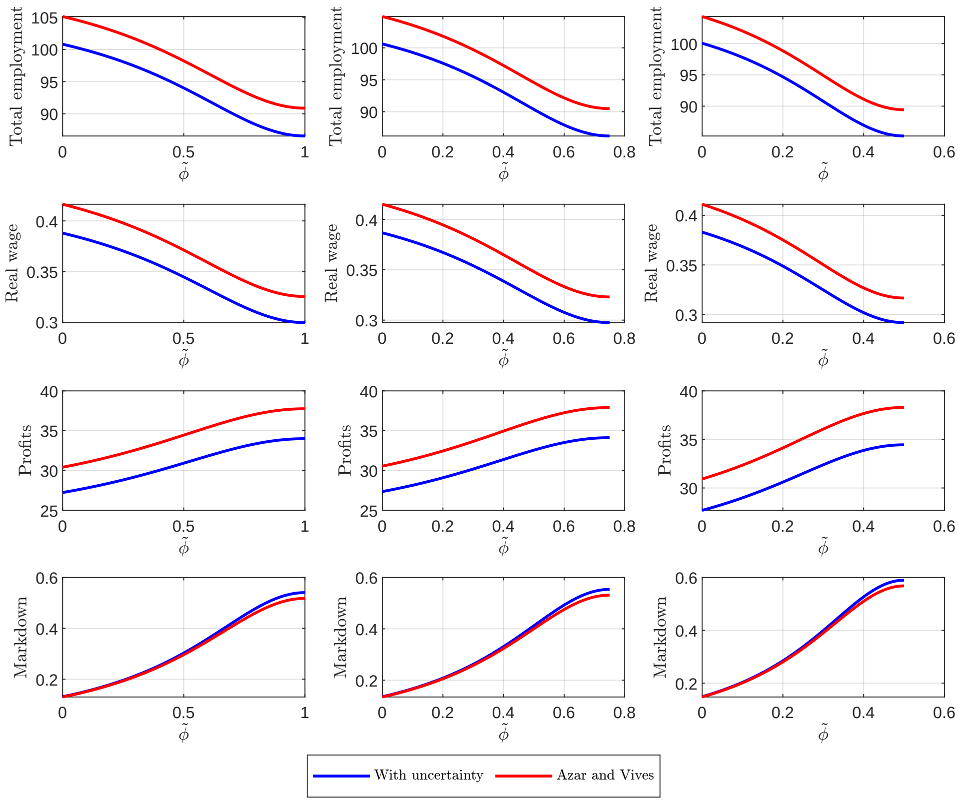

Figure 1: This figure illustrates the impact of increasing intra-sector diversification on equilibrium variables at different levels of diversification inter-sector. The first column represents $\phi = 0$, the second column shows $\phi = 0.25$, and the third column depicts $\phi = 0.5$.

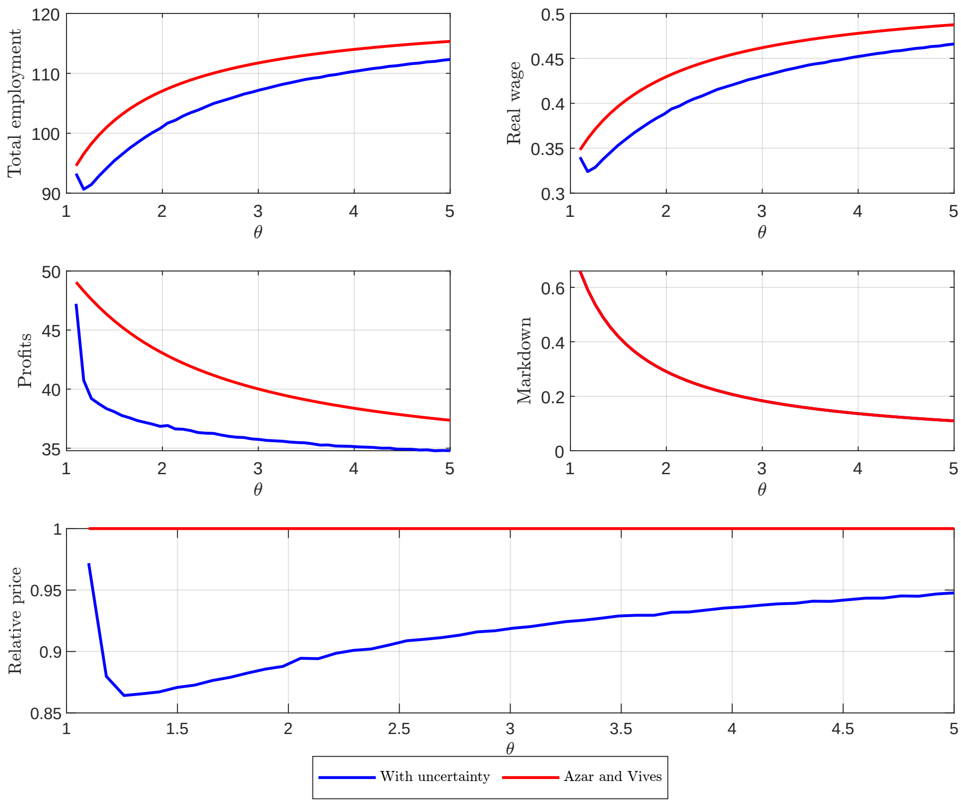

Figure 2: This figure shows the relationship between elasticity of substitution across variety and equilibrium outcome

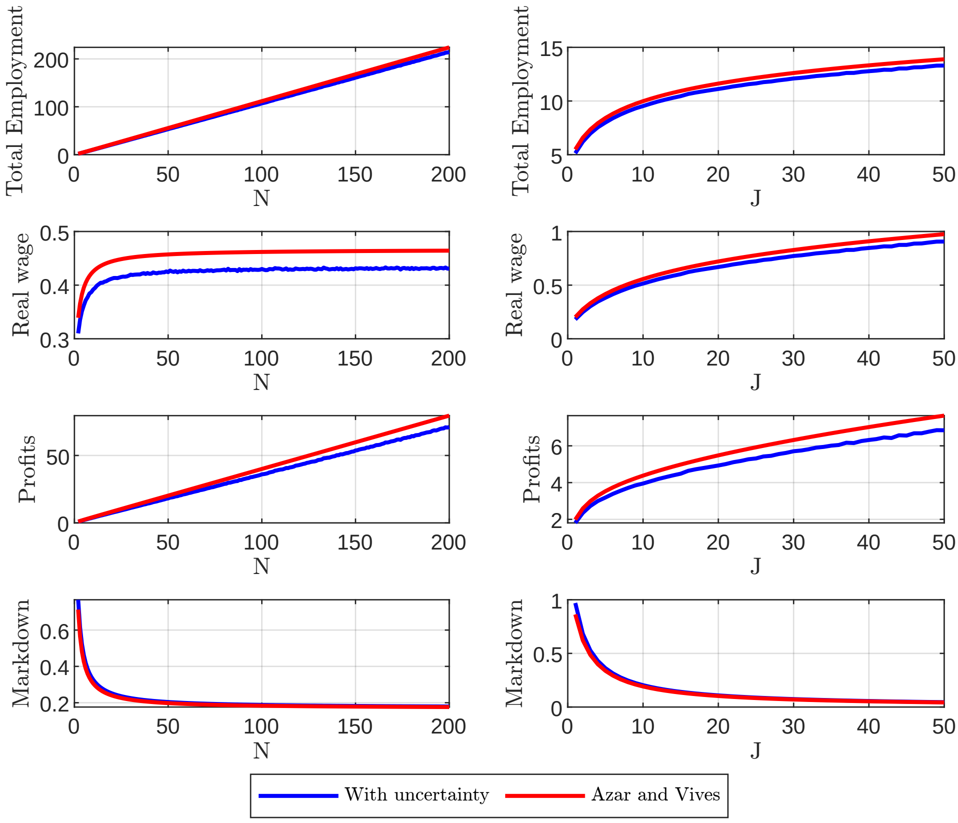

Figure 3: This figure shows the relationship between number of sector and firms within a sector and equilibrium outcomes

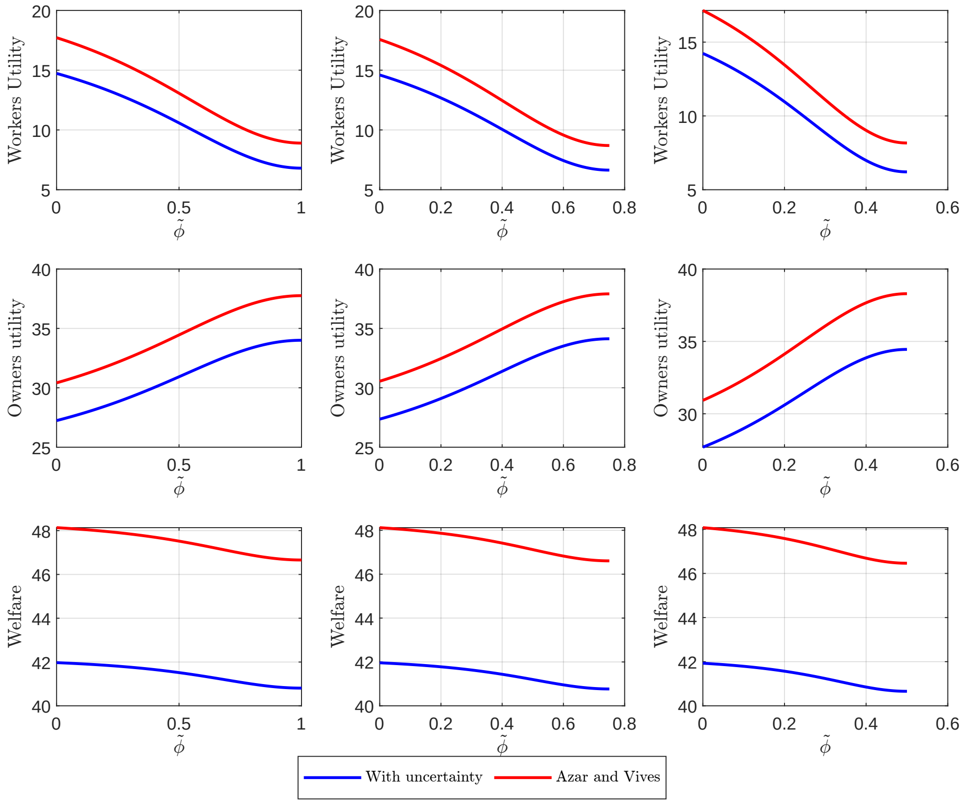

Figure 4: This figure illustrates the impact of increasing intra-sector diversification on welfare at different levels of diversification inter-sector. The first column represents $\phi = 0$, the second column shows $\phi = 0.25$, and the third column depicts $\phi = 0.5$.

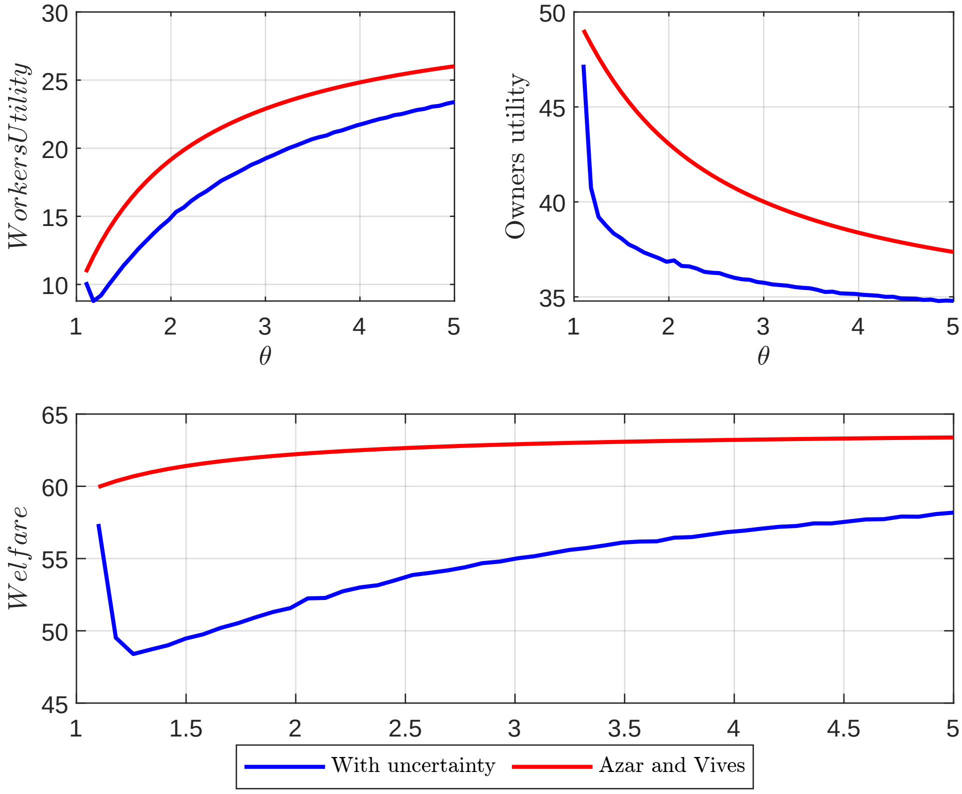

Figure 5: This figure shows the relationship between elasticity of substitution across variety and welfare

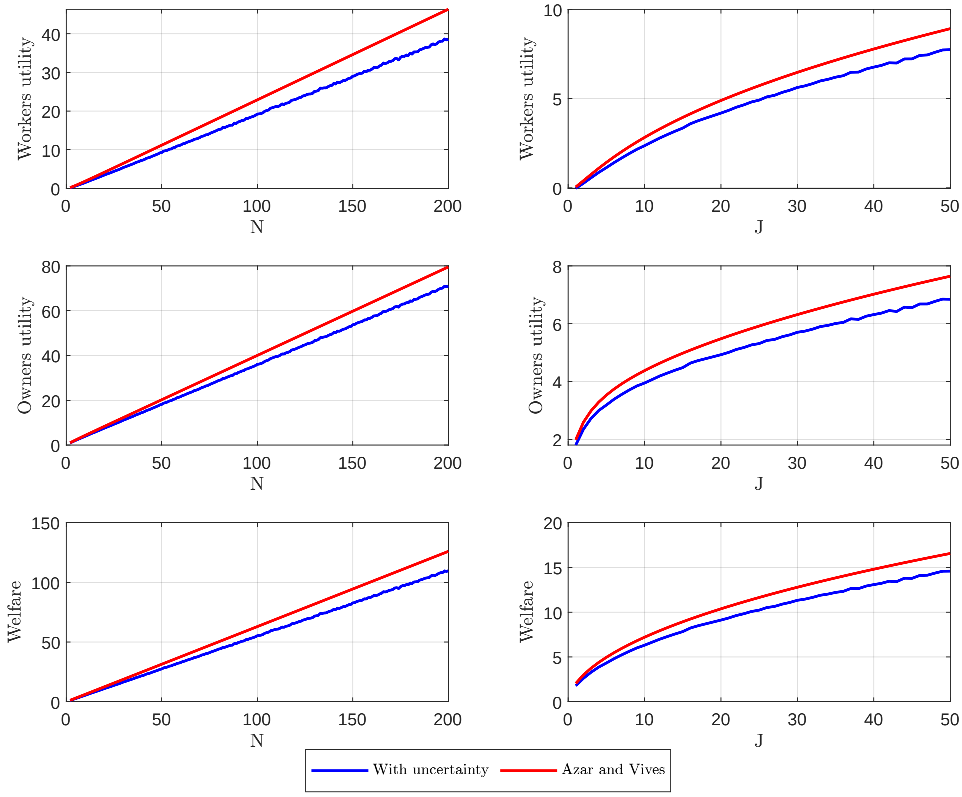

Figure 6: This figure shows the relationship between number of sector and firms within a sector and welfare

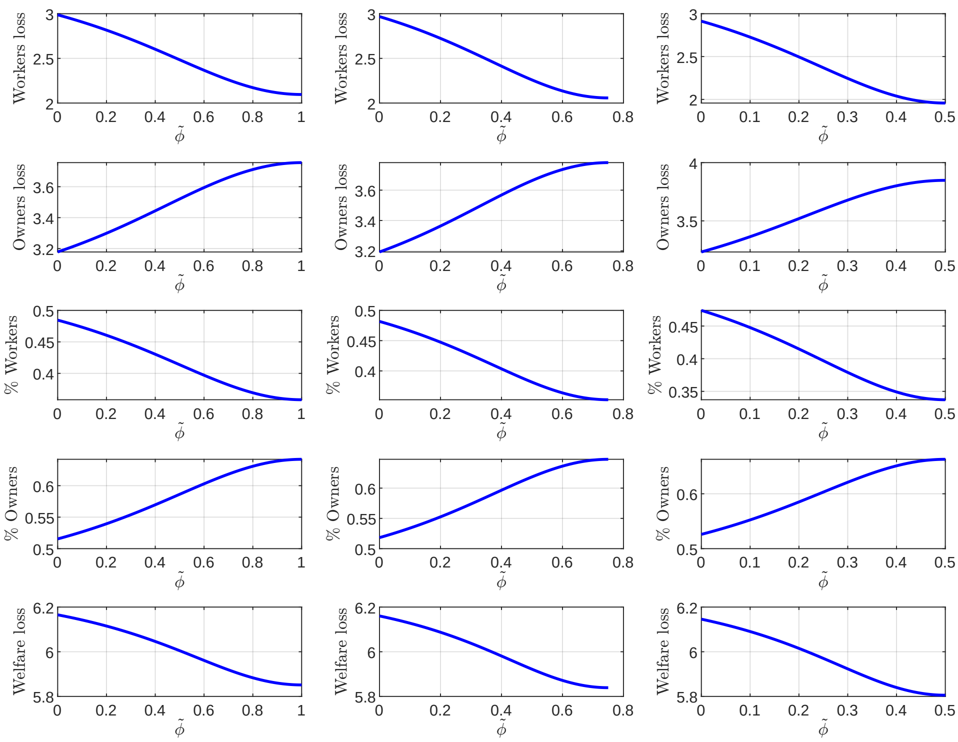

Figure 7: This figure illustrates the impact of increasing intra-sector diversification on welfare loss at different levels of diversification inter-sector. The first column represents $\phi = 0$, the second column shows $\phi = 0.25$, and the third column depicts $\phi = 0.5$.

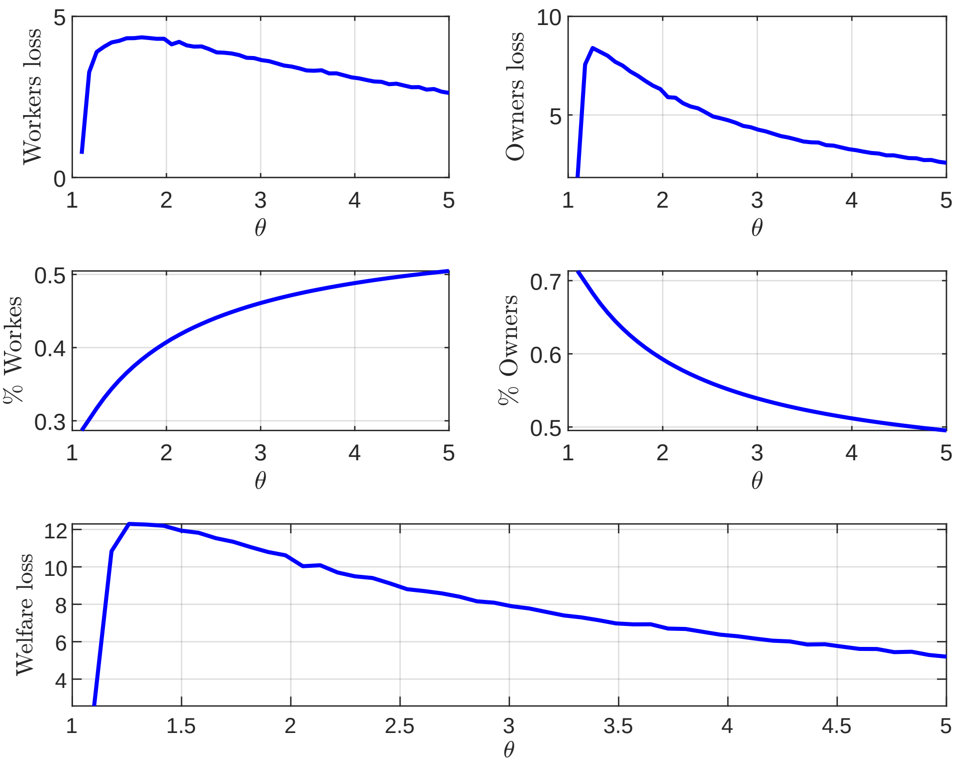

Figure 8: This figure shows the relationship between elasticity of substitution across variety and welfare loss

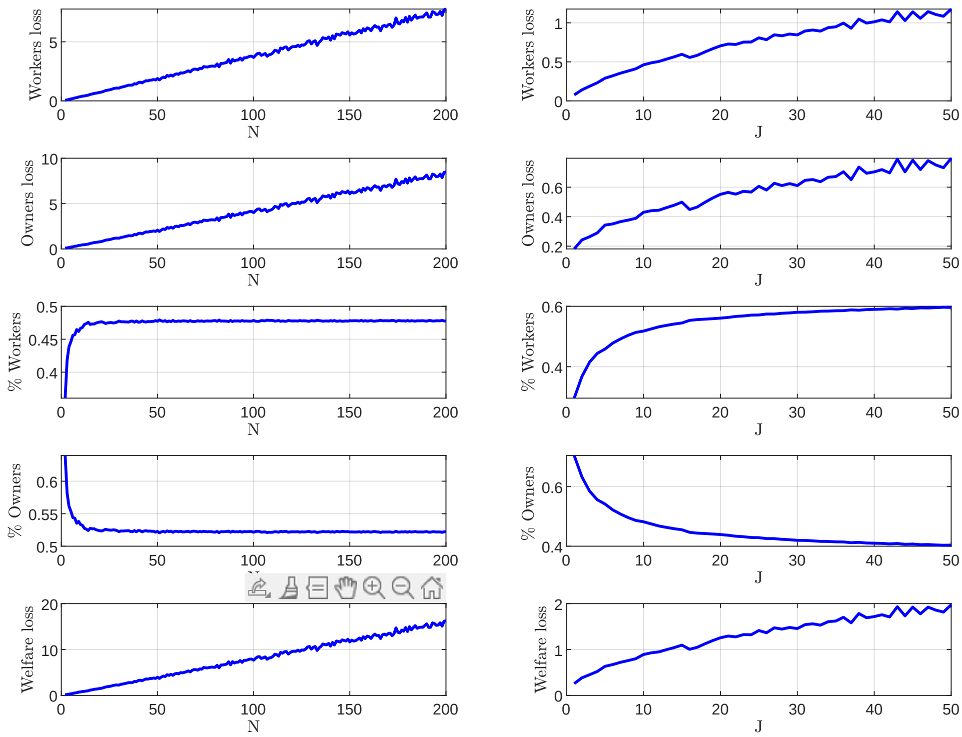

Figure 9: This figure shows the relationship between number of sector and firms within a sector and welfare loss

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A Multiple sectors model: workers' problem at time 1

At time 1 worker i solves the following problem:

$$\begin{array}{ll} \max & C_i^w = \left(\sum_{n=1}^N \left(\frac{1}{N}\right)^{\frac{1}{\theta}} (e_n)^{\frac{1}{\theta}} (c_{ni}^w)^{\frac{\theta-1}{\theta}}\right)^{\frac{\theta}{\theta-1}} \\ \text{s.t.} & wL_i = \sum_{n=1}^N p_n c_{ni}^w \end{array} \tag{44}$$

The Lagrangian is:

$$\mathcal{L} = \left(\sum_{n=1}^N \left(\frac{1}{N}\right)^{\frac{1}{\theta}} (e_n)^{\frac{1}{\theta}} (c_{ni}^w)^{\frac{\theta-1}{\theta}}\right)^{\frac{\theta}{\theta-1}} - \lambda \left(\sum_{n=1}^N p_n c_{ni}^w - wL_i\right) \tag{45}$$

The first-order conditions (FOC) are:

$$\frac{\partial \mathcal{L}}{\partial c_{ni}^w} = \left(\frac{1}{N}\right)^{\frac{1}{\theta}} (e_n)^{\frac{1}{\theta}} (c_{ni}^w)^{\frac{\theta-1}{\theta}-1} \left(\sum_{n=1}^N \left(\frac{1}{N}\right)^{\frac{1}{\theta}} (e_n)^{\frac{1}{\theta}} (c_{ni}^w)^{\frac{\theta-1}{\theta}}\right)^{\frac{\theta}{\theta-1}-1} - \lambda p_n = 0 \tag{46}$$

$$\frac{\partial \mathcal{L}}{\partial \lambda} = \sum_{n=1}^N p_n c_{ni}^w - wL_i = 0 \tag{47}$$

Taking the ratio between the first two equations for two different goods n and m, we obtain:

$$\frac{p_n}{p_m} = \left(\frac{e_n}{e_m}\right)^{\frac{1}{\theta}} \left(\frac{c_{ni}^w}{c_{mi}^w}\right)^{-\frac{1}{\theta}} \tag{48}$$

We solve for c_{ni}^w:

$$c_{ni}^w = \left(\frac{e_n}{e_m}\right) \left(\frac{p_n}{p_m}\right)^{-\theta} c_{mi}^w \tag{49}$$

Multiplying by p_n and summing over n:

$$\sum_{n=1}^N p_n c_{ni}^w = p_m^\theta c_{mi}^w \frac{1}{e_m} \sum_{n=1}^N p_n^{1-\theta} e_n \tag{50}$$

We know that the price index is given by:

$$P = \left(\sum_{n=1}^N \frac{1}{N} e_n (p_n)^{1-\theta}\right)^{\frac{1}{1-\theta}} \tag{51}$$

Thus, we can rewrite the equation as:

$$c_{mi}^w = \frac{1}{N}\left(\frac{p_m}{P}\right)^{-\theta} e_m \frac{1}{P}\sum_{n=1}^{N} p_n c_{ni}^w \tag{52}$$

Using this result, we find that:

$$\sum_{n=1}^{N} p_n c_{ni}^w = PC_i^w \tag{53}$$

Therefore, the optimal choice of consumption of variety n is:

$$c_{ni}^w = \frac{1}{N} e_n \left(\frac{p_n}{P}\right)^{-\theta} C_i^w \tag{54}$$

B Multiple sectors model: workers' problem at time 0

The problem faced by each worker is:

$$\max_{C_i^w, L_i} \quad \mathbb{E}(U) = \mathbb{E}\left(C_i^w - \chi \frac{L_i^{1+\frac{1}{\eta}}}{1+\frac{1}{\eta}}\right) \tag{55}$$

$$\text{s.t.} \quad PC_i^w = wL_i \tag{56}$$

Replacing $PC_i^w = wL_i$ into $\mathbb{E}(U)$, the objective function becomes dependent only on L_i. The maximization problem is:

$$\max_{L_i} \quad \mathbb{E}(U^w) = \mathbb{E}(w)L_i - \chi \frac{L_i^{1+\frac{1}{\eta}}}{1+\frac{1}{\eta}} \tag{57}$$

The FOC is:

$$\frac{d\mathbb{E}(U^w)}{dL_i} = \mathbb{E}(w) - \chi L_i^{\frac{1}{\eta}} = 0 \tag{58}$$

Solving for $\mathbb{E}(w)$, we obtain:

$$\mathbb{E}(w) = \chi L_i^{\frac{1}{\eta}} \tag{59}$$

Since workers are homogeneous, we have $\int_0^N L_i \, di = NL_i = L$. Thus, the aggregate labor supply is:

$$\mathbb{E}(w) = \chi \left(\frac{L}{N}\right)^{\frac{1}{\eta}} \tag{60}$$

C Multiple sector model: firms' problem

At time 0, each firm chooses L_{nj} to maximize the following function:

$$\begin{aligned}
\max_{L_{nj}} \quad & \mathbb{E}\left(\frac{p_n}{P}\right) F(L_{nj}) - \mathbb{E}(\omega) L_{nj} \\
& + \lambda_{\text{intra}} \sum_{k \neq j}^{J} \left(\mathbb{E}\left(\frac{p_n}{P}\right) F(L_{nk}) - \mathbb{E}(\omega) L_{nk} \right) \\
& + \lambda_{\text{inter}} \sum_{m \neq n}^{N} \sum_{k=1}^{J} \left(\mathbb{E}\left(\frac{p_m}{P}\right) F(L_{mk}) - \mathbb{E}(\omega) L_{mk} \right)
\end{aligned} \tag{61}$$

The FOC of this problem is:

$$\begin{aligned}
\mathbb{E}\left(\frac{p_n}{P}\right) F'(L_{nj}) - \mathbb{E}(\omega) - \frac{d\mathbb{E}(\omega)}{dL_{nj}} \left(L_{nj} + \lambda_{\text{intra}} \sum_{k \neq j}^{J} L_{nk} + \lambda_{\text{inter}} \sum_{m \neq n}^{N} \sum_{k=1}^{J} L_{mk} \right) \\
+ \frac{d\mathbb{E}\left(\frac{p_n}{P}\right)}{dL_{nj}} \left(F(L_{nj}) + \lambda_{\text{intra}} \sum_{k \neq j}^{J} F(L_{nk}) \right) + \lambda_{\text{inter}} \sum_{m \neq n}^{N} \sum_{k=1}^{J} F(L_{mk}) = 0
\end{aligned} \tag{62}$$

Now we have to calculate $\frac{d\mathbb{E}\left(\frac{p_n}{P}\right)}{dL_{nj}}$ and $\frac{d\mathbb{E}\left(\frac{p_m}{P}\right)}{dL_{nj}}$. We know that

$$\mathbb{E}\left(\frac{p_n}{P}\right) = \mathbb{E}\left(\left(\frac{1}{N}\right)^{\frac{1}{\theta}} e_n^{\frac{1}{\theta}} \left(\frac{c_n}{C}\right)^{-\frac{1}{\theta}} \right). \tag{63}$$

Using Leibniz's rule, we can see that

$$\frac{d}{dL_{nj}} \mathbb{E}\left(\frac{p_n}{P}\right) = \mathbb{E}\left(\frac{d}{dL_{nj}} \frac{p_n}{P} \right). \tag{64}$$

Hence,

$$
\begin{aligned}
\frac{d\mathbb{E}\left(\frac{p_n}{P}\right)}{dL_{nj}} &= \mathbb{E}\left(-\frac{1}{\theta}\left(\frac{1}{N}\right)^{\frac{1}{\theta}} e_n^{\frac{1}{\theta}}\left(\frac{c_n}{C}\right)^{-\frac{1}{\theta}-1}\right. \\
&\quad \left.\times\left(\frac{F'(L_{nj})C - \frac{\theta-1}{\theta}c_n^{\frac{\theta-1}{\theta}-1}\left(\frac{1}{N}\right)^{\frac{1}{\theta}} e_n^{\frac{1}{\theta}}\frac{\theta}{\theta-1}\frac{C}{C^{\frac{\theta-1}{\theta}}}F'(L_{nj})c_n}{C^2}\right)\right) \\
&= \mathbb{E}\left(-\frac{1}{\theta}\left(\frac{1}{N}\right)^{\frac{1}{\theta}} e_n^{\frac{1}{\theta}}\left(\frac{c_n}{C}\right)^{-\frac{1}{\theta}}\right. \\
&\quad \left.\times\left(1-\left(\frac{1}{N}\right)^{\frac{1}{\theta}} e_n^{\frac{1}{\theta}}\left(\frac{c_n}{C}\right)^{-\frac{1}{\theta}}\frac{c_n}{C}\right)\frac{F'(L_{nj})}{c_n}\right) \\
&= \mathbb{E}\left(-\frac{1}{\theta}\frac{p_n}{P}\left(1-\frac{p_n}{P}\frac{c_n}{C}\right)\frac{F'(L_{nj})}{c_n}\right).
\end{aligned} \tag{65}
$$

Similarly,

$$
\begin{aligned}
\frac{d\mathbb{E}\left(\frac{p_m}{P}\right)}{dL_{nj}} &= \mathbb{E}\left(-\frac{1}{\theta}\left(\frac{1}{N}\right)^{\frac{1}{\theta}} e_m^{\frac{1}{\theta}}\left(\frac{c_m}{C}\right)^{-\frac{1}{\theta}-1}\right. \\
&\quad \left.\times\left(\frac{0 - \frac{\theta-1}{\theta}c_n^{\frac{\theta-1}{\theta}-1}\left(\frac{1}{N}\right)^{\frac{1}{\theta}} e_m^{\frac{1}{\theta}}\frac{\theta}{\theta-1}\frac{C}{C^{\frac{\theta-1}{\theta}}}F'(L_{nj})c_m}{C^2}\right)\right) \\
&= \mathbb{E}\left(\frac{1}{\theta}\left(\frac{1}{N}\right)^{\frac{1}{\theta}} e_m^{\frac{1}{\theta}}\left(\frac{c_m}{C}\right)^{-\frac{1}{\theta}}\times\frac{C}{c_m}\times\left(\frac{1}{N}\right)^{\frac{1}{\theta}} e_n^{\frac{1}{\theta}}\left(\frac{c_n}{C}\right)^{-\frac{1}{\theta}}\frac{F'(L_{nj})}{c_m}\right) \\
&= \mathbb{E}\left(\frac{1}{\theta}\frac{p_n}{P}\left(\frac{p_m}{P}\frac{c_m}{C}\right)\frac{F'(L_{nj})}{c_m}\right).
\end{aligned} \tag{66}
$$

As Azar and Vives (2021), we have to show the following relation:

$$
\frac{d\mathbb{E}\left(\frac{p_m}{P}\right)}{dL_{nj}}c_n = -\sum_{m\neq n}\frac{d\mathbb{E}\left(\frac{p_m}{P}\right)}{dL_{nj}}c_m. \tag{67}
$$

From workers' maximization at time 1, we know that $\sum_n \frac{p_n c_n}{PC} = 1$, so we can write this relation as follows:

$$
\frac{p_n c_n}{PC} + \sum_{m\neq n}\frac{p_m c_m}{PC} = 1. \tag{68}
$$

Using this relation, it is easy to verify that the previous relation holds.

We define $s_{nj}^L = \frac{L_{nj}}{L}$, $s_{n-j}^L = \frac{\sum_{m\neq n} L_{mk}}{L}$, and $s_{nj} = \frac{F(L_{nj})}{c_n}$.

The First-Order Condition (FOC) becomes

$$\mathbb{E}\left(\frac{p_n}{P}\right) F'(L_{nj}) - \mathbb{E}\left(\frac{w}{P}\right) - \frac{d\mathbb{E}\left(\frac{w}{P}\right)}{dL_{nj}} L \left[s_{nj}^L + \lambda_{\text{intra}} s_{n-j}^L + \lambda_{\text{inter}}\left(1 - s_{nj}^L - s_{n-j}^L\right)\right] + \frac{d\mathbb{E}\left(\frac{p_n}{P}\right)}{dL_{nj}} c_n \left[s_j + \lambda_{\text{intra}}(1 - s_j) - \lambda_{\text{inter}}\right] = 0. \tag{69}$$

Dividing both sides by the expected value of real wages, we obtain:

$$\mathbb{E}(\mu) = \frac{1}{\eta}\left[s_{nj}^L + \lambda_{\text{intra}} s_{n-j}^L + \lambda_{\text{inter}}\left(1 - s_{nj}^L - s_{n-j}^L\right)\right] + \frac{1}{\mathbb{E}\left(\frac{w}{P}\right)} \frac{d\mathbb{E}\left(\frac{p_n}{P}\right)}{dL_{nj}} c_n \left[s_j + \lambda_{\text{intra}}(1 - s_j) - \lambda_{\text{inter}}\right], \tag{70}$$

where $\mathbb{E}(\mu) = \frac{\mathbb{E}\left(\frac{p_n}{P}\right)F'(L_{nj}) - \mathbb{E}\left(\frac{w}{P}\right)}{\mathbb{E}\left(\frac{w}{P}\right)}$ is the expected value of the markdown of real wages, and $\frac{1}{\eta}$ is the elasticity of labor supply with respect to expected real wages.

We want to characterize a symmetric equilibrium where all firms produce the same quantity. In this case, $s_{nj}^L = \frac{L_{nj}}{L} = \frac{1}{JN}$, $s_{n-j}^L = \frac{\sum_{m\neq n} L_{mk}}{L} = \frac{(J-1)}{JN}$, and $s_{nj} = \frac{F(L_{nj})}{c_n} = \frac{1}{J}$.

The FOC becomes

$$\mathbb{E}(\mu) = \frac{1}{\eta}\left[\frac{1}{JN} + \lambda_{\text{intra}}\frac{(J-1)}{J} + \lambda_{\text{inter}}\frac{(N-1)}{N}\right] + \frac{1}{\mathbb{E}\left(\frac{w}{P}\right)} \frac{d\mathbb{E}\left(\frac{p_n}{P}\right)}{dL_{nj}} c_n \left[\frac{1}{J} + \lambda_{\text{intra}}\frac{(J-1)}{J} - \lambda_{\text{inter}}\right] = 0. \tag{71}$$

We define $H_{\text{product}} = \left[\frac{1}{J} + \lambda_{\text{intra}}\frac{(J-1)}{J} - \lambda_{\text{inter}}\right]$ and $H_{\text{labor}} = \left[\frac{1}{JN} + \lambda_{\text{intra}}\frac{(J-1)}{JN} + \lambda_{\text{inter}}\frac{(N-1)}{N}\right]$.

Replacing into the FOC, we obtain

$$\mathbb{E}(\mu) = \frac{1}{\eta} H_{\text{labor}} + \frac{1}{\mathbb{E}\left(\frac{w}{P}\right)} \frac{d\mathbb{E}\left(\frac{p_n}{P}\right)}{dL_{nj}} c_n H_{\text{product}}. \tag{72}$$

Now we have to evaluate $\frac{d\mathbb{E}\left(\frac{p_n}{P}\right)}{dL_{nj}} c_n$ in a symmetric equilibrium:

$$\frac{d\mathbb{E}\left(\frac{p_n}{P}\right)}{dL_{nj}} c_n = \mathbb{E}\left(-\frac{1}{\theta}\frac{p_n}{P}\left(1 - \frac{p_n}{P}\frac{c_n}{C}\right) F'(L_{nj})\right) = \tau F'(L_{nj}), \tag{73}$$

where $\tau = \mathbb{E}\left(-\frac{1}{\theta}\frac{p_n}{P}\left(1 - \frac{p_n}{P}\frac{c_n}{C}\right)\right)$. Using the definition of $\mathbb{E}(\mu)$, we can write $\frac{F'\left(\frac{L}{JN}\right)}{\mathbb{E}\left(\frac{w}{P}\right)} = \frac{\mathbb{E}(\mu)+1}{\mathbb{E}\left(\frac{w}{P}\right)}$.

Hence, the FOC is

$$\mathbb{E}(\mu) = \frac{1}{\eta} H_{\text{labor}} + \frac{\mathbb{E}(\mu) + 1}{\mathbb{E}\left(\frac{p_n}{P}\right)} \tau H_{\text{product}}. \tag{74}$$

$$\mathbb{E}(\mu) = \frac{\frac{1}{\eta} H_{\text{labor}} + \tau \frac{H_{\text{product}}}{\mathbb{E}\left(\frac{p_n}{P}\right)}}{1 - \tau \frac{H_{\text{product}}}{\mathbb{E}\left(\frac{p_n}{P}\right)}}. \tag{75}$$

Using the definition of $\mathbb{E}(\mu)$, we can find the aggregate supply

$$\mathbb{E}(\omega) = \frac{\mathbb{E}\left(\frac{p_n}{P}\right) F'\left(\frac{L^d}{JN}\right)}{1 + \mathbb{E}(\mu)}. \tag{76}$$

C.1 General Equilibrium

Matching aggregate supply and demand, we find total employment in equilibrium

$$L^* = \left[\chi J^{1-\alpha} \frac{\mathbb{E}\left(\frac{p_n}{P}\right) \alpha A}{1 + \mathbb{E}(\mu)}\right]^{\frac{1}{\frac{1}{\eta} + 1 - \alpha}} N. \tag{77}$$

Under symmetric equilibrium,

$$\begin{aligned}
\mathbb{E}\left(\frac{c_n}{C}\right) &= \mathbb{E}\left(\frac{\sum_{j=1}^{J} F\left(\frac{L^*}{NJ}\right)}{\left[\sum_{n=1}^{N} \left(\frac{1}{N}\right)^{\frac{1}{\theta}} e_n^{\frac{1}{\theta}} \left(\sum_{j=1}^{J} F\left(\frac{L^*}{NJ}\right)\right)^{\frac{\theta-1}{\theta}}\right]^{\frac{\theta}{\theta-1}}}\right) \\
&= \mathbb{E}\left(\frac{JF\left(\frac{L^*}{NJ}\right)}{JF\left(\frac{L^*}{NJ}\right) \left[\sum_{n=1}^{N} \left(\frac{1}{N}\right)^{\frac{1}{\theta}} e_n^{\frac{1}{\theta}}\right]^{\frac{\theta}{\theta-1}}}\right) \\
&= \mathbb{E}\left(\frac{1}{\left[\sum_{n=1}^{N} \left(\frac{1}{N}\right)^{\frac{1}{\theta}} e_n^{\frac{1}{\theta}}\right]^{\frac{\theta}{\theta-1}}}\right).
\end{aligned} \tag{78}$$

$$
\begin{aligned}
\mathbb{E}\left(\frac{p_n}{P}\right) &= \mathbb{E}\left(\left(\frac{1}{N}\right)^{\frac{1}{\theta}} e_n^{\frac{1}{\theta}} \left(\frac{c_n}{C}\right)^{-\frac{1}{\theta}}\right) \\
&= \mathbb{E}\left(\left(\frac{1}{N}\right)^{\frac{1}{\theta}} e_n^{\frac{1}{\theta}} \left(\frac{1}{\left[\sum_{n=1}^{N} \left(\frac{1}{N}\right)^{\frac{1}{\theta}} e_n^{\frac{1}{\theta}}\right]^{\frac{\theta}{\theta-1}}}\right)^{-\frac{1}{\theta}}\right) \\
&= \mathbb{E}\left(\left(\frac{1}{N}\right)^{\frac{1}{\theta}} e_n^{\frac{1}{\theta}} \left[\sum_{n=1}^{N} \left(\frac{1}{N}\right)^{\frac{1}{\theta}} e_n^{\frac{1}{\theta}}\right]^{\frac{1}{\theta-1}}\right).
\end{aligned} \tag{79}
$$

$$
\begin{aligned}
\tau &= \mathbb{E}\left(-\frac{1}{\theta}\frac{p_n}{P}\left(1-\frac{p_n}{P}\frac{c_n}{C}\right)\right) \\
&= \mathbb{E}\left(\frac{1}{\theta}\left(\frac{1}{N}\right)^{\frac{1}{\theta}} e_n^{\frac{1}{\theta}} \left[\sum_{n=1}^{N} \left(\frac{1}{N}\right)^{\frac{1}{\theta}} e_n^{\frac{1}{\theta}}\right]^{\frac{1}{\theta-1}} \frac{e_n^{\frac{1}{\theta}}}{\sum_{m\neq n} e_m^{\frac{1}{\theta}}}\right).
\end{aligned} \tag{80}
$$

D Mathematical Proofs

We want to show that $\frac{d\left(\frac{p_n}{P}\right)}{de_n}$ and $\frac{d\left(\frac{p_n}{P}\right)}{de_m}$ are both greater than zero.

$$
\begin{aligned}
\frac{d\left(\frac{p_n}{P}\right)}{de_n} &= \frac{1}{\theta}\left(\frac{1}{N}\right)^{\frac{1}{\theta}} e_n^{\frac{1}{\theta}-1}\left(\frac{c_n}{C}\right)^{-\frac{1}{\theta}} \\
&\quad - \frac{1}{\theta}\left(\frac{1}{N}\right)^{\frac{1}{\theta}} e_n^{\frac{1}{\theta}}\left(\frac{c_n}{C}\right)^{-\frac{1}{\theta}-1}\left(\frac{-\frac{1}{\theta} c_n^{\frac{\theta-1}{\theta}}\left(\frac{1}{N}\right)^{\frac{1}{\theta}} e_n^{\frac{1}{\theta}-1}\frac{\theta}{\theta-1}\frac{C}{C^{\frac{\theta-1}{\theta}}} c_n}{C^2}\right) \\
&= \frac{1}{\theta}\left(\frac{1}{N}\right)^{\frac{1}{\theta}} e_n^{\frac{1}{\theta}}\left(\frac{c_n}{C}\right)^{-\frac{1}{\theta}} \\
&\quad + \frac{1}{\theta(\theta-1)}\left(\frac{1}{N}\right)^{\frac{1}{\theta}} e_n^{\frac{1}{\theta}}\left(\frac{c_n}{C}\right)^{-\frac{1}{\theta}}\left(\frac{1}{N}\right)^{\frac{1}{\theta}} e_n^{-1}\left(\frac{c_n}{C}\right) \\
&= \frac{1}{\theta}\left(\frac{p_n}{P}\right)\frac{1}{e_n} + \frac{1}{\theta(\theta-1)}\left(\frac{p_n}{P}\right)^2\left(\frac{c_n}{C}\right)\frac{1}{e_n} \\
&= \frac{1}{\theta}\left(\frac{p_n}{P}\right)\frac{1}{e_n}\left(1+\frac{1}{\theta-1}\left(\frac{p_n}{P}\right)\left(\frac{c_n}{C}\right)\right) > 0.
\end{aligned} \tag{81}
$$

$$
\begin{aligned}
\frac{d\left(\frac{p_n}{P}\right)}{de_m} &= -\frac{1}{\theta}\left(\frac{1}{N}\right)^{\frac{1}{\theta}} e_n^{\frac{1}{\theta}} \left(\frac{c_n}{C}\right)^{-\frac{1}{\theta}-1} \\
&\quad \times \left(\frac{-\frac{1}{\theta} c_m^{\frac{\theta-1}{\theta}} \left(\frac{1}{N}\right)^{\frac{1}{\theta}} e_m^{\frac{1}{\theta}-1} \frac{\theta}{\theta-1} \frac{C}{C^{\frac{\theta-1}{\theta}}} c_n}{C^2} \right) \\
&= \frac{1}{\theta(\theta-1)} \left(\frac{1}{N}\right)^{\frac{1}{\theta}} e_n^{\frac{1}{\theta}} \left(\frac{c_n}{C}\right)^{-\frac{1}{\theta}} \left(\frac{1}{N}\right)^{\frac{1}{\theta}} e_m^{-\frac{1}{\theta}} \left(\frac{c_m}{C}\right)^{-\frac{1}{\theta}} \left(\frac{c_m}{C}\right) \\
&= \frac{1}{\theta(\theta-1)} \left(\frac{p_n}{P}\right) \left(\frac{p_m}{P}\right) \left(\frac{c_m}{C}\right) \left(\frac{1}{e_m}\right) > 0.
\end{aligned} \tag{82}
$$

E General Equilibrium

We have obtained the following equations that define the general equilibrium:

$$
\mathbb{E}(\mu) = \frac{\frac{1}{\eta} H_{\text{labor}} + \tau \frac{H_{\text{product}}}{\mathbb{E}\left(\frac{p_n}{P}\right)}}{1 - \tau \frac{H_{\text{product}}}{\mathbb{E}\left(\frac{p_n}{P}\right)}}. \tag{83}
$$

Using this equation, we can determine the aggregate supply and total employment in equilibrium.

$$
\mathbb{E}\left(\omega\right) = \frac{\mathbb{E}\left(\frac{p_n}{P}\right) F'\left(\frac{L^d}{JN}\right)}{1 + \mathbb{E}(\mu)}. \tag{84}
$$

$$
L^* = \left[\chi J^{1-\alpha} \frac{\mathbb{E}\left(\frac{p_n}{P}\right) \alpha A}{1 + \mathbb{E}(\mu)} \right]^{\frac{1}{\frac{1}{\eta}+1-\alpha}} N. \tag{85}
$$

E.1 Equilibrium expected values

$$
\begin{aligned}
\mathbb{E}\left(\frac{c_n}{C}\right) &= \mathbb{E}\left(\frac{\sum_{j=1}^{J} F\left(\frac{L^*}{NJ}\right)}{\left[\sum_{n=1}^{N}\left(\frac{1}{N}\right)^{\frac{1}{\theta}} e_n^{\frac{1}{\theta}}\left(\sum_{j=1}^{J} F\left(\frac{L^*}{NJ}\right)\right)^{\frac{\theta-1}{\theta}}\right]^{\frac{\theta}{\theta-1}}}\right) \\
&= \mathbb{E}\left(\frac{JF\left(\frac{L^*}{NJ}\right)}{JF\left(\frac{L^*}{NJ}\right)\left[\sum_{n=1}^{N}\left(\frac{1}{N}\right)^{\frac{1}{\theta}} e_n^{\frac{1}{\theta}}\right]^{\frac{\theta}{\theta-1}}}\right) \qquad (86) \\
&= \mathbb{E}\left(\frac{1}{\left[\sum_{n=1}^{N}\left(\frac{1}{N}\right)^{\frac{1}{\theta}} e_n^{\frac{1}{\theta}}\right]^{\frac{\theta}{\theta-1}}}\right).
\end{aligned}
$$

$$
\begin{aligned}
\mathbb{E}\left(\frac{p_n}{P}\right) &= \mathbb{E}\left(\left(\frac{1}{N}\right)^{\frac{1}{\theta}} e_n^{\frac{1}{\theta}}\left(\frac{c_n}{C}\right)^{-\frac{1}{\theta}}\right) \\
&= \mathbb{E}\left(\left(\frac{1}{N}\right)^{\frac{1}{\theta}} e_n^{\frac{1}{\theta}}\left(\frac{1}{\left[\sum_{n=1}^{N}\left(\frac{1}{N}\right)^{\frac{1}{\theta}} e_n^{\frac{1}{\theta}}\right]^{\frac{\theta}{\theta-1}}}\right)^{-\frac{1}{\theta}}\right) \qquad (87) \\
&= \mathbb{E}\left(\left(\frac{1}{N}\right)^{\frac{1}{\theta}} e_n^{\frac{1}{\theta}}\left[\sum_{n=1}^{N}\left(\frac{1}{N}\right)^{\frac{1}{\theta}} e_n^{\frac{1}{\theta}}\right]^{\frac{1}{\theta-1}}\right).
\end{aligned}
$$

$$
\begin{aligned}
\tau &= \mathbb{E}\left(-\frac{1}{\theta}\frac{p_n}{P}\left(1-\frac{p_n}{P}\frac{c_n}{C}\right)\right) \\
&= \mathbb{E}\left(\frac{1}{\theta}\left(\frac{1}{N}\right)^{\frac{1}{\theta}} e_n^{\frac{1}{\theta}}\left[\sum_{n=1}^{N}\left(\frac{1}{N}\right)^{\frac{1}{\theta}} e_n^{\frac{1}{\theta}}\right]^{\frac{1}{\theta-1}}\frac{e_n^{\frac{1}{\theta}}}{\sum_{m\neq n} e_m^{\frac{1}{\theta}}}\right). \qquad (88)
\end{aligned}
$$

F Mathematical Proofs

We want to show that $\frac{d\left(\frac{p_n}{P}\right)}{de_n}$ and $\frac{d\left(\frac{p_n}{P}\right)}{de_m}$ are both greater than zero.

$$
\begin{aligned}
\frac{d\left(\frac{p_n}{P}\right)}{de_n} &= \frac{1}{\theta}\left(\frac{1}{N}\right)^{\frac{1}{\theta}} e_n^{\frac{1}{\theta}-1}\left(\frac{c_n}{C}\right)^{-\frac{1}{\theta}} \\
&\quad - \frac{1}{\theta}\left(\frac{1}{N}\right)^{\frac{1}{\theta}} e_n^{\frac{1}{\theta}}\left(\frac{c_n}{C}\right)^{-\frac{1}{\theta}-1}\left(\frac{-\frac{1}{\theta}c_n^{\frac{\theta-1}{\theta}}\left(\frac{1}{N}\right)^{\frac{1}{\theta}} e_n^{\frac{1}{\theta}-1}\frac{\theta}{\theta-1}\frac{C}{C^{\frac{\theta-1}{\theta}}}c_n}{C^2}\right) \\
&= \frac{1}{\theta}\left(\frac{1}{N}\right)^{\frac{1}{\theta}} e_n^{\frac{1}{\theta}}\left(\frac{c_n}{C}\right)^{-\frac{1}{\theta}} \\
&\quad + \frac{1}{\theta(\theta-1)}\left(\frac{1}{N}\right)^{\frac{1}{\theta}} e_n^{\frac{1}{\theta}}\left(\frac{c_n}{C}\right)^{-\frac{1}{\theta}}\left(\frac{1}{N}\right)^{\frac{1}{\theta}} e_n^{-1}\left(\frac{c_n}{C}\right) \\
&= \frac{1}{\theta}\left(\frac{p_n}{P}\right)\frac{1}{e_n} + \frac{1}{\theta(\theta-1)}\left(\frac{p_n}{P}\right)^2\left(\frac{c_n}{C}\right)\frac{1}{e_n} \\
&= \frac{1}{\theta}\left(\frac{p_n}{P}\right)\frac{1}{e_n}\left(1 + \frac{1}{\theta-1}\left(\frac{p_n}{P}\right)\left(\frac{c_n}{C}\right)\right) > 0.
\end{aligned} \tag{89}
$$

$$
\begin{aligned}
\frac{d\left(\frac{p_n}{P}\right)}{de_m} &= -\frac{1}{\theta}\left(\frac{1}{N}\right)^{\frac{1}{\theta}} e_n^{\frac{1}{\theta}}\left(\frac{c_n}{C}\right)^{-\frac{1}{\theta}-1} \\
&\quad \times \left(\frac{-\frac{1}{\theta}c_m^{\frac{\theta-1}{\theta}}\left(\frac{1}{N}\right)^{\frac{1}{\theta}} e_m^{\frac{1}{\theta}-1}\frac{\theta}{\theta-1}\frac{C}{C^{\frac{\theta-1}{\theta}}}c_n}{C^2}\right) \\
&= \frac{1}{\theta(\theta-1)}\left(\frac{1}{N}\right)^{\frac{1}{\theta}} e_n^{\frac{1}{\theta}}\left(\frac{c_n}{C}\right)^{-\frac{1}{\theta}}\left(\frac{1}{N}\right)^{\frac{1}{\theta}} e_m^{-\frac{1}{\theta}}\left(\frac{c_m}{C}\right)^{-\frac{1}{\theta}}\left(\frac{c_m}{C}\right) \\
&= \frac{1}{\theta(\theta-1)}\left(\frac{p_n}{P}\right)\left(\frac{p_m}{P}\right)\left(\frac{c_m}{C}\right)\left(\frac{1}{e_m}\right) > 0.
\end{aligned} \tag{90}
$$

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