Ph.D. Thesis

Macroeconomic interactions between firms' market power and financial frictions

University of Sassari
(DISEA - Department of Economics and Business)



Ph.D. in Economics, Management and Quantitative Methods

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Introduction

An extensive body of theoretical and quantitative research indicates that financial frictions have a significant role in shaping the macroeconomic dynamics in the short and the long run. More recently, a growing empirical and theoretical literature has developed about the macroeconomic consequences of firms' market power. The broad aim of this thesis is to study the interaction between these two structural phenomena based on the idea that financial frictions can be a determinant of firms' market power, while the macroeconomic effects of market power may vary depending on the severity of financial frictions within an economy.

The recent literature on corporate market power is driven by the observed upward trend in firms' market power since the 1980s. Using listed firm-level data, De Loecker et al. (2020) document the evolution of aggregate markups from 1955 to 2016. Their findings indicate that while aggregate markups remained relatively stable between 1955 and 1980, a significant increase occurred from 1980 onwards, rising from 21% of the marginal cost in 1980 to 61% in 2016[1]. Diez et al. (2018) obtained similar results, applying the same methodological approach to both publicly and privately listed firms. Importantly, the persistent surge of market power is not a phenomenon confined to the US market but represents a global trend. Studies by De Loecker and Eeckhout (2018) and Díez et al. (2021) have analyzed the evolution of market power across a range of developed and developing countries, concluding that the rise in market power is pervasive worldwide.

Such a significant structural increase in market power has put significant pressure on policymakers and researchers to understand its potential implications. The standard argument against market power is based on the idea that an increase in market power is generally associated with a reduction in quantities produced, an increase in prices, and a consequent reduction in consumer surplus and overall social welfare. Yet, temporary market power might also have positive effects. It may incentivize firms to invest more, increasing their technology or knowledge stock. In the long run, this positive effect contributes to economic growth, as investments in technology enhance the overall productivity of the economic system[2]. However, the

[1] It should be noticed that a higher markup level does not always unambiguously identify more market power. Higher mark-ups may also reflect higher fixed costs and not necessarily greater market power. The authors show, however, that in addition to the rise in aggregate markups, there has been a change in their distribution. To the extent that such an increase cannot be possibly justified solely by the rise in fixed costs, the evidence provided strongly supports the conclusion that market power has increased significantly over the years.

[2] Theoretical research often emphasizes that market power helps reward innovators. That idea has also been often used to justify patents. Without patents, imitation could prevent innovators from recovering their investment. However, some researchers, Boldrin et al. (2008), argue that imitation is not costless or immediate so innovators could still benefit from temporary market power even in the absence of patents.

recent rise in market power is mostly associated with negative effects. For instance, Autor et al. (2020) link the decline in labor share to the added value and the decline in competition. They argue that the rise in concentration is driven by the growing dominance of highly productive "superstar firms," which capture an increasingly large market share. Due to their advanced technology and efficiency, these firms tend to operate with lower labor intensity, contributing to the decline in the labor share. Similar results are found by Barkai (2020); Gutiérrez and Philippon (2017); Hall (2018); De Loecker et al. (2020) among the others. The rise of market power has also been closely associated with the decline in business dynamism, particularly the reduction in entry rates and job reallocation. Decker et al. (2016) documents a significant decline in startup rates and job reallocation in the US, suggesting that increased market concentration and dominance by large firms might be limiting the ability of new firms to enter the market. Of particular relevance to us is the significant role played by the ownership structure of the firms as one of the determinants of market power (Azar et al. (2018); Ederer and Pellegrino (2021, 2023); Antón et al. (2023); Schmalz (2018, 2021)).

Following the development of the economics of credit markets and, more generally, capital markets under asymmetric information, in the last 30 years, there has been a lot of economic research into the negative macroeconomic effects of financial frictions[3]. In a frictionless market, resources would naturally flow to the agents who can utilize them most efficiently and are willing to offer the highest price to acquire them. In the presence of friction, this is no longer necessarily true. More productive firms may be disadvantaged compared to less productive ones with easier access to funds, which creates inefficiencies in the economic system. In an economy with frictions, firms are not always able to invest or to produce as much as they would like, reducing opportunities for expansion and development(Midrigan and Xu (2014); Bai et al. (2018); Gilchrist et al. (2013); Buera et al. (2011)). This phenomenon limits overall economic growth, as investment is essential for innovation and productivity growth. In this case, more developed financial systems can reduce the effects of financial frictions, allowing for higher mobilization of savings, better risk diversification and liquidity management, and the production of information about valuable investment opportunities, thereby promoting economic growth. The idea is not new. Schumpeter (1911) argued that financial intermediaries play a crucial role in fostering economic growth by facilitating investment, thereby promoting long-term development. He emphasized the role of banks in channeling capital towards entrepreneurs who can use it most profitably. Based on that intuition, several theoretical and empirical papers have explored the link between financial and economic development. In their seminal paper, King and Levine (1993) show that countries with more developed financial systems tend to exhibit higher GDP per capita growth. Empirical studies have further substantiated this relationship. Levine and Zervos (1998) find that both stock market liquidity and banking sector development positively affect real per capita GDP growth, capital accumulation, and productivity growth. Several empirical studies, like Demirgüç-Kunt and Maksimovic (1998) highlight that firms have greater access to long-term external finance, facilitating firm growth in countries with better and more efficient legal systems.

[3] Tirole (2010) and Freixas and Rochet (2008) provide comprehensive surveys of the most relevant contributions on the microeconomics of financial transactions under asymmetric information. See Brunnermeier et al. (2012) a complete review

Throughout this literature, financial intermediaries are highlighted as key players. Their presence significantly reduces monitoring costs; without intermediaries, each investor would have to monitor potential borrowers, incurring substantial costs individually. By pooling investments, intermediaries ensure that monitoring costs are incurred only once, making the system more efficient. Furthermore, they facilitate efficient resource allocation among various agents, mobilize savings, and contribute to risk diversification.

Financial frictions might also have effects in economic fluctuations by generating endogenous economic cycles, and, perhaps even more importantly, by propagating shocks along the business cycle. In these types of models, temporary shocks impact the net worth of entrepreneurs and firms, which in turn leads to a gradual reduction in investment over time. For instance Benanke and Gertler (1989), in their seminal papers, presents a model showing how borrowers' net worth affects economic dynamics by amplifying business cycles. Higher net worth reduces financing costs, boosting investment during expansions and exacerbating downturns when net worth is low. There are several papers that analyze the effects of financial frictions on economic fluctuations studing the effect of financial frictions on firm's capital. For example, Bernanke (1999) find that a decrease in capital due to a negative shock reduces the firms' capital price, which in turn leads to a reduction in the future price and a decline in net worth. Similarly, Kiyotaki and Moore (1997) show how credit constraints can significantly impact the business cycle in the presence of temporary shocks, leading to persistent effects on the economy. Matsuyama (2007) show that credit market imperfections can lead to persistent effects such as credit traps, credit collapses and leapfrogging, where economies may either stagnate or experience rapid growth due to shifts in credit allocation between projects of varying productivity. The effects on the business cycle may also not be due to external shocks. For example, Martin (2008) demonstrates that changes in lending standards can generate endogenous economic cycles without the need for external shocks.

The above literature relies on different ways to justify financial frictions from a microeconomic point of view. A widely used approach relies on the costly state verification model proposed by Townsend (1979). According to this setup, lenders' inability to freely observe the realization of the investment leads to using standard debt contracts, such that firms are exposed to bankruptcy, which leads to welfare losses to the extent that verification and liquidation procedures are costly. Instead, other approaches are based on the idea that lenders cannot identify the type of borrower, which leads to the possibility of adverse selection. Such ex-ante asymmetry of information might prevent the financial exchange from taking place, leading to the possibility of credit rationing, so a borrower might not be financed even if they are willing to pay a higher interest rate. This is because a higher interest rate could attract only low-quality agents, thereby signaling poor quality (Stiglitz and Weiss (1981)). Alternatively, it might also generate excessive financing and, therefore, excessive investment (De Meza and Webb (1987)). Finally, financial frictions might also arise because lenders cannot perfectly observe borrowers' activities after the financing has been granted (Holmstrom and Tirole (1997)). Such an ex-post asymmetry of information might lead to moral hazard. Borrowers could divert their efforts to obtain private benefits, extract resources from the activity, and go away with part of the financial resource. Even in this case, equilibrium credit rationing might emerge as a result. Finally, financial frictions might arise when the financier

cannot force the borrower to fulfill the financing contract. Across all approaches, real guarantees emerge as a device that could ameliorate the potential conflict of interest between borrowers and lenders, thereby reducing the significance of information asymmetries and restoring the trade of financial resources. Still, firms without enough collateral might be rationed Kiyotaki and Moore (1997).

The existing macroeconomic literature typically examined market power and financial frictions separately. This thesis aims to contribute to such literature by focusing on the interplay between the two phenomena from two related perspectives. First, we study how market power, specifically due to firms' ownership structure, i.e., common ownership, affects macroeconomic outcomes such as the level of GDP, income distribution, and welfare in the presence of financial frictions due to costly state verification. Then, we analyze the two-way causality link between financial frictions that take the form of financing constraints and firms' market power. We shed light on how firms' market power might shape the financial constraints faced by firms and how the presence of such constraints, by affecting firms' ability to invest, affects the evolution of market power.

In the first part of the thesis, chapters 1 and 2 examine the macroeconomic effect of common ownership, which determines market power, in the presence of financial frictions leading to loan default and bankruptcy costs. In other words, we analyze how common ownership, which refers to a situation where a single investor or group of investors (often institutional) holds significant shares in multiple firms within the same industry that compete with each other, might influence aggregate economic outcomes in the presence of bankruptcy costs. Traditional economic theory assumes that managers make decisions to maximize firms' profits, fostering competition and encouraging innovation, which often results in lower consumer prices. However, when common ownership comes into play—where the same investors hold significant shares across multiple competing firms—this dynamic shifts. 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 (collusive) behavior that limits competition instead of competing to capture market shares[4]. By reducing competition, an increase in common ownership might adversely affect the macroeconomy. However, in the presence of financial frictions leading to inefficient bankruptcy, bankruptcy costs must be considered. Such costs include the resources used for state verification and liquidation of firms' assets and cash flows, as well as hidden costs associated with disrupting chains of production and job losses, which negatively affect economic activity and growth. In general, firms' market power increases the profitability of incumbent firms, making them less prone to loan default and bankruptcy. Accordingly, by increasing firms' market power, common ownership could serve as a mechanism to protect the economy against inefficient firm bankruptcy, potentially reducing the associated social costs. As a result, some degree of common ownership that reduces bankruptcy costs might be desirable despite the adverse effects that market power has on the output produced and consumers' welfare, and less-than-perfect competition could be optimal for the economy.

Specifically, in chapter 1 of the thesis, we build on the model proposed by Azar and Vives (2021) by introducing uncertainty as a shock to consumer preferences. Such a modification yields an original theoretical model that constitutes a tractable

[4]See Schmalz (2018, 2021) for a complete survey.

analytical framework suitable for analyzing the interplay between financial frictions due to costly state verification and common ownership, which we further develop in Chapter 2. However, such a theoretical framework is valuable in its own right, as it allows us to derive some interesting insights into the effects of common ownership in the presence of aggregate undiversifiable uncertainty due to demand shocks. Chapter 2 introduces financial frictions based on a costly state verification approach. The fact that lenders cannot observe firms' ex-post cash flows leads to the use of a standard debt contract that exposes firms to the possibility of loan default, which causes costly liquidation. We characterize the macroeconomic equilibrium of the model, showing the existence of an optimal degree of common ownership and of the firm's market power associated with it, and use our theory to evaluate some US-based evidence on common ownership

In the second part of the thesis, chapter 3 studies the two-way causality relationship between the financial frictions that firms are subject to and their level of market power. Empirical evidence suggests that a higher market power level correlates with increased fixed investments, particularly in intangible assets (De Loecker et al. (2020); Altomonte et al. (2021); De Ridder (2024)). At the same time, financially constrained firms tend to invest less in research and development or to acquire new assets(Brown et al. (2009); Hoberg and Maksimovic (2015)). In contrast, firms with higher levels of market power are generally more profitable, giving them greater profits to offer as collateral (Drechsel (2023); Lian and Ma (2021)). These empirical facts suggest that by relaxing financial constraints, market power might facilitate firms' ability to invest in developing new technology that will further strengthen their market power. We explore such theoretical argument in a static general equilibrium a la Melitz and Ottaviano (2008). Our analysis confirms the economic intuition that firms with greater market power can invest more, thereby reinforcing and accumulating additional market power in subsequent periods. However, that does not translate into straightforward general equilibrium effects as different mechanisms of opposing signs are at work. Specifically, when financial frictions are relaxed, firms can invest more, enabling them to produce at higher margins. This results in an increase in aggregate average market power. On the other hand, a reduction in financial frictions could also facilitate the entry of new firms into the market, thereby increasing competitive pressure. Our results indicate that an increase in investment, driven by reduced financial frictions, does not necessarily enhance competition unless the entry of new firms accompanies it. Through empirical analysis, using data from publicly listed U.S. firms, we test that firms with more market power are subjected to less financial frictions pressures in the subsequential periods. Empirical evidence also suggests higher levels of market power in the earlier period are correlated with less financial constraints in later periods.

The thesis is organized as follows. Part I, chapters 1 and 2, analyzes the effect of common ownership and market power in the presence of financial frictions, chapters. Part II, chapter 3, discusses the two-way causality relationship between financing constraints and market power.

Part I

Chapter 1

Common ownership uncertainty

1.1 Introduction

Following the growing body of empirical evidence documenting the persistent rise in market power, 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 et al. (2018); Ederer and Pellegrino (2021, 2023); Antón et al. (2023)). Traditional economic theory assumes 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 et al. (2018) investigate the anticompetitive 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 et al. (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[1]. Atkeson and Burstein (2008) and De Loecker et al. (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 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[2]. 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[3] 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 chapter, we extend the Azar and Vives (2021) model by introducing uncertainty due to demand shocks, which we model in a similar way as Casares et al. (2023). Such a modification, serves two purposes. The main one is to provide a tractable analyitical framework to assess the macroeconomic effects of common ownership in the presence of financial frictions, an analysis that we will carry out in chapter two. 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

[1] De Loecker et al. (2020) among the others shows that the rise of market power is driven mostly by firms in the last 75% of markups distribution.

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

[3] Note that the term diversification in these two chapters indicates the level of common ownership and thus the level of market power.

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 chapter is structured as follows: In Section 1.2, we present the basic model with only one sector to establish the core dynamics. Section 1.3 extends the model to include uncertainty in the multiple sector model and, in Section 1.4, we simulate the model with multiple sectors and compare the results with the original Azar and Vives (2021) model.

1.2 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:

$$U^w(C_i^w, L_i) = e\ C_i^w - \chi \frac{L_i^{1+\frac{1}{\eta}}}{1+\frac{1}{\eta}}, \tag{1.1}$$

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

$$U^o(C_i^o) = e\ C_i^o, \tag{1.2}$$

where C_i^o is the level of consumption of consumer good of owner i. 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

$$f(e) = \frac{1}{\overline{e} - \underline{e}}, \tag{1.3}$$

$$\mathbb{E}(e) = \int_{\underline{e}}^{\overline{e}} e \frac{1}{\overline{e} - \underline{e}} de = \frac{\overline{e} + \underline{e}}{2}. \tag{1.4}$$

1.2.0.1 Ownership structure

As in the Azar and Vives (2021) 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 $(1-\phi)+\phi/J$ shares of firm j and, ϕ/J shares 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 all 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 through the group they own. 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 the aggregate market power. The objective function of the manager of firm j is

$$\frac{\Pi_j}{P} + \lambda \sum_{k \neq j} \frac{\Pi_k}{P}, \tag{1.5}$$

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[4] and it is equal to

$$\lambda = \frac{(2 - \phi)}{(1 - \phi)^2 J + (2 - \phi)\phi}. \tag{1.6}$$

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 chooses 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.

1.2.1 Agents Behavior

1.2.1.1 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

[4] Notice that the common ownership structure in this model is the same as the one proposed by Azar and Vives (2021). The introduction of uncertainty has no effect on the common ownership structure. See Azar and Vives (2021) for an analytical derivation of λ.

determine how much to work by considering the optimal choice they make in the second period. Therefore, the problem is solved using backward induction.

1.2.1.2 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

$$\max_{C_i^w} U^w(C_i^w, L_i) = eC_i^w - \chi\frac{L_i^{1+\frac{1}{\eta}}}{1+\xi} \tag{1.7}$$

$$s.to.$$

$$wL_i \geq PC_i, \tag{1.8}$$

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

$$C_i^w = \omega L_i, \tag{1.9}$$

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

1.2.1.3 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,

$$\max_{C_i^w, L_i} \mathbb{E}\left[U^w\left(C_i^w, L_i\right)\right] = \int_{\underline{e}}^{\overline{e}} \left(C_i^w e - \chi\frac{L_i^{1+\frac{1}{\eta}}}{1+\frac{1}{\eta}}\right)\frac{1}{\overline{e}-\underline{e}}de \tag{1.10}$$

$$s.to.$$

$$C_i^w = \omega L_i. \tag{1.11}$$

By substituting the constraint (1.11) into objective function (1.10) and solving the integral, we can rewrite the previous problem as

$$\max_{L_i} \mathbb{E}\left[U^w\left(L_i\right)\right] = \omega L_i \mathbb{E}(e) - \chi\frac{L_i^{1+\frac{1}{\eta}}}{1+\frac{1}{\eta}}. \tag{1.12}$$

The solution of this problem yields the individual inverse labor supply

$$\omega = \left(\frac{\chi}{\mathbb{E}(e)}\right) L_i^{\frac{1}{\eta}}. \tag{1.13}$$

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

$$\omega = \left(\frac{\chi}{\mathbb{E}(e)}\right) L^{\frac{1}{\eta}}. \tag{1.14}$$

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

$$\max_{L_j} g(L_j) = F(L_j) - \omega(L)L_j + \sum_{k \neq j}^{J} \lambda[F(L_k) - \omega(L)L_k]. \tag{1.15}$$

The first rder condition (FOC) associated with the above problem is

$$\frac{\partial g(L_j)}{\partial L_j} = F^{'}(L_j) - \omega(L) - \omega'(L)\left(L_j + \sum_{k \neq j}^{J} \lambda L_k\right) = 0. \tag{1.16}$$

Solving the FOC we obtain the inverse labor demand

$$\omega(L) = \frac{F^{'}(L^d/J)}{1+\mu}. \tag{1.17}$$

1.2.1.4 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

$$L^* = \left[\left(\frac{\mathbb{E}(e)}{\chi}\right) J^{1-\alpha} \frac{\alpha A}{1+\frac{H}{\eta}}\right]^{\frac{1}{1-\alpha+\frac{1}{\eta}}}; \tag{1.18}$$

(b) the real wage is

$$\omega^* = \left[\left(\frac{\chi}{\mathbb{E}(e)}\right)^{\eta} \left(\frac{1}{\alpha A}\right)^{\frac{1}{\alpha-1}} J^{\eta}\right]^{\frac{1}{\eta+\alpha-1}}; \tag{1.19}$$

(c) the markdown of real wage is given by

$$\mu = \frac{F'(L^*/J) - \omega(L^*)}{\omega(L*)} = \frac{H}{\eta(L^*)}; \tag{1.20}$$

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 that people get from consumption is zero, and in this case, the entire economy might collapse because no value is placed on consumption.

1.3 Multiple sector model

1.3.0.1 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

[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

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[6]. The utility function of worker i is:

$$U^w(C_i^w, L_i) = C_i^w - \chi \frac{L_i^{1+\frac{1}{\eta}}}{1+\frac{1}{\eta}}, \tag{1.21}$$

where

$$C_i^w = \left[\sum_{n=1}^{N} \left(\frac{1}{N}\right)^{\frac{1}{\theta}} (e_n)^{\frac{1}{\theta}} \left(c_{ni}^w\right)^{\frac{\theta-1}{\theta}}\right]^{\frac{\theta}{\theta-1}}, \tag{1.22}$$

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$[\underline{e}, \overline{e}]$. All individuals share the same consumption preferences. In other words, both workers and owners decide on consumption in an identical way, even after shocks occur. As we observed in the single-sector model, this common preference leads to uncertainty about the value of future consumption.[7]

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

$$\Pi_{nj} = p_n F(L_{nj}) - wL_{nj}, \tag{1.23}$$

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

$$P = \left[\sum_{n=1}^{N} \frac{1}{N} e_n \left(p_n\right)^{1-\theta}\right]^{\frac{1}{1-\theta}}. \tag{1.24}$$

1.3.0.2 Ownership structure

In this section, 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 built such that each group nj directly owns a share $(1 - \widetilde{\phi} - \phi)$ of firm nj, 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 the same sector, respectively. It is obvious that the sum of the two indices can

[6] This assumption is the same of Azar and Vives (2021).

[7] If we had assumed that each shock was specific to individuals, agents would have been able to completely diversify risk among themselves.

never be greater than 1.

As in the single sector model, the manager of firm nj maximize the real wealth of all shareholders that at time 1 is equal to

$$\frac{\Pi_{nj}}{P} + \lambda_{intra} \sum_{k \neq j}^{J} \frac{\Pi_{nk}}{P} + \lambda_{inter} \sum_{m \neq n}^{N} \sum_{k=1}^{J} \frac{\Pi_{mk}}{P}, \tag{1.25}$$

where λ_{intra} and λ_{inter}[8] represent the weights that capture the common ownership across and intra sectors and are equal to

$$\lambda_{\text{intra}} = \frac{(2-\phi)\phi + [2(1-\phi) - \tilde{\phi}]\tilde{\phi}N}{(1-\phi)^2 JN + (2-\phi)\phi - [2(1-\phi) - \tilde{\phi}]\tilde{\phi}N(J-1)}, \tag{1.26}$$

$$\lambda_{\text{inter}} = \frac{(2-\phi)\phi}{(1-\phi)^2 JN + (2-\phi)\phi - [2(1-\phi) - \tilde{\phi}]\tilde{\phi}N(J-1)}. \tag{1.27}$$

1.3.0.3 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.

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

$$\max_{c_{ni}^w} C_i^w = \left[\sum_{n=1}^{N} \left(\frac{1}{N} \right)^{\frac{1}{\theta}} (e_n)^{\frac{1}{\theta}} \left(c_{ni}^w \right)^{\frac{\theta-1}{\theta}} \right]^{\frac{\theta}{\theta-1}} \tag{1.28}$$

s.to.

$$wL_i = \sum_{n=1}^{N} p_n c_{ni}^w. \tag{1.29}$$

[8] Notice that, as in the single sector model, uncertainty does not affect ownership structure and the structure is the same as Azar and Vives (2021) model. See Azar and Vives (2021) for technical derivation.

The FOC (First Order Condition) associated with problem (1.28) yields the optimal level of consumption of variety n conditional to shocks realization and aggregate level of consumption,

$$c_{ni}^{w} = \frac{1}{N} e_n \left(\frac{p_n}{P}\right)^{-\theta} C_i^{w}. \tag{1.30}$$

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

$$PC_i^{w} = wL_i. \tag{1.31}$$

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.

$$\underbrace{\int_{I_w \bigcup I_o} c_{ni} di}_{c_n} = \frac{1}{N} e_n \left(\frac{p_n}{P}\right)^{-\theta} \underbrace{\int_{I_w \bigcup I_o} C_i di}_{C}. \tag{1.32}$$

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

$$\frac{p_n}{P} = \left(\frac{1}{N}\right)^{\frac{1}{\theta}} e_n^{\frac{1}{\theta}} \left(\frac{c_n}{C}\right)^{-\frac{1}{\theta}}. \tag{1.33}$$

In a competitive equilibrium total production is equal to total consumption

$$c_n = \sum_{j=1}^{J} F(L_{nj}). \tag{1.34}$$

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

$$\frac{p_n}{P} = \left(\frac{1}{N}\right)^{\frac{1}{\theta}} e_n^{\frac{1}{\theta}} \left(\frac{\sum_{j=1}^{J} F(L_{nj})}{\left[\sum_{m=1}^{N} \left(\frac{1}{N}\right)^{\frac{1}{\theta}} (e_m)^{\frac{1}{\theta}} \left(\sum_{j=1}^{J} F(L_{mj})\right)^{\frac{\theta-1}{\theta}}\right]^{\frac{\theta}{\theta-1}}} \right)^{-\frac{1}{\theta}}. \tag{1.35}$$

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 $\theta \to \infty$ 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.

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

$$\max_{C_i^w, L_i} \ \mathbb{E}(U^w) = \mathbb{E}\left(C_i^w - \chi \frac{{L_i}^{1+\frac{1}{\eta}}}{1+\frac{1}{\eta}}\right) \tag{1.36}$$

$$s.to.$$

$$PC_i^w = wL_i. \tag{1.37}$$

Dividing both side of equation (1.37) 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 labor supply as a function of expected real wage

$$\mathbb{E}(\omega) = \chi L_i^{\frac{1}{\eta}}. \tag{1.38}$$

Since workers are identical, the aggregate inverse labor supply is

$$\mathbb{E}(\omega) = \chi \left(\frac{L^s}{N}\right)^{\frac{1}{\eta}}. \tag{1.39}$$

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

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

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 (1.25), that is

$$\mathbb{E}\left(\frac{\Pi_{nj}}{P}\right) + \lambda_{intra}\mathbb{E}\left(\sum_{k\neq j}^{J}\frac{\Pi_{nk}}{P}\right) + \lambda_{inter}\mathbb{E}\left(\sum_{m\neq n}^{N}\sum_{k=1}^{J}\frac{\Pi_{mk}}{P}\right). \tag{1.40}$$

Using equation (1.23) and substituting it into equation (1.40) the problem faced by the manager of firm nj is the following

$$\begin{aligned}\max_{L_{nj}} \ \mathbb{E}\left(\frac{p_n}{P}\right)F(L_{nj}) - \mathbb{E}(\omega)L_{nj} + \left[\lambda_{intra}\sum_{k\neq j}^{J}\mathbb{E}\left(\frac{p_n}{P}\right)F(L_{nk}) - \mathbb{E}(\omega)L_{nk}\right] \\ + \left[\lambda_{inter}\textstyle\sum_{m\neq n}^{N}\sum_{k=1}^{J}\mathbb{E}\left(\frac{p_n}{P}\right)F(L_{mk}) - \mathbb{E}(\omega)L_{mk}\right].\end{aligned} \tag{1.41}$$

The FOC of this problem is

$$\begin{aligned}&\mathbb{E}\left(\tfrac{p_n}{P}\right)F'(L_{nj}) - \mathbb{E}(\omega) - \tfrac{\partial\mathbb{E}(\omega)}{\partial L_{nj}}\left[L_{nj} + \lambda_{intra}\textstyle\sum_{k\neq j}^{J}L_{nk} + \lambda_{inter}\sum_{m\neq n}^{N}\sum_{k=1}^{J}L_{mk}\right] \\ &+\tfrac{\partial\mathbb{E}\left(\frac{p_n}{P}\right)}{\partial L_{nj}}\left[F(L_{nj}) + \lambda_{intra}\textstyle\sum_{k\neq j}^{J}F(L_{nk})\right] + \lambda_{inter}\textstyle\sum_{m\neq n}\tfrac{\partial\mathbb{E}\left(\frac{p_m}{P}\right)}{\partial L_{nj}}\left[\sum_{k=1}^{J}F(L_{mk})\right] = 0.\end{aligned} \tag{1.42}$$

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

$$\mathbb{E}(\omega) = \frac{\mathbb{E}\left(\frac{p_n}{P}\right) F'\left(\frac{L^d}{JN}\right)}{(1+\mathbb{E}(\mu))}. \tag{1.43}$$

1.3.1 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

$$L^* = \left[\frac{1}{\chi} J^{1-\alpha} \frac{\mathbb{E}\left(\frac{p_n}{P}\right)\alpha A}{(1+\mathbb{E}(\mu))}\right]^{\frac{1}{\frac{1}{\eta}+1-\alpha}} N; \tag{1.44}$$

b) the expected value of real wage is

$$\mathbb{E}^*(\omega) = \left[(\chi)^{\eta}\left(\frac{\mathbb{E}\left(\frac{p_n}{P}\right)\alpha A}{(1+\mathbb{E}(\mu))}\right)^{\frac{1}{1-\alpha}} J\right]^{\frac{1}{\eta+\frac{1}{1-\alpha}}}; \tag{1.45}$$

c) the expected markdown of real wage is

$$\mathbb{E}(\mu) = \frac{\frac{1}{\eta}H_{labor}+1}{1-\frac{\tau\left(H_{product}-\lambda_{inter}\right)}{\mathbb{E}\left(\frac{p_n}{P}\right)}} - 1. \tag{1.46}$$

Where $H_{product} = (1+\lambda_{intra}(J-1))/J$ and $H_{labor} = (1+\lambda_{intra}(J-1)+\lambda_{inter}(N-1)J)/NJ$ 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)[9]. An increase in common ownership structures within

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

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.

1.4 Numerical Simulation

In this section, we aim to numerically simulate both our model and the Azar and Vives (2021) general equilibrium model 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 equal 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.

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 1.1: Parameter Calibration

1.4.1 Uncertainty and equilibrium outcomes

In Figure (1.1), we observe how increasing common ownership in a single sector impacts key equilibrium outcomes in both models. As $\tilde{\phi}$ rises, total employment and real wages decline significantly, while markdown and profits increase. This inverse relationship can be explained by the fact that higher common ownership reduces competition within the industry, thereby enhancing firms' market power in the labor market. As a result, firms are able to exert greater markdowns on real wages. However, this change in competition does not notably alter the dynamics between the two models. The model with uncertainty consistently exhibits a downward shift compared to the model without uncertainty, indicating that uncertainty affects the equilibrium outcomes in both models similarly. In this context, greater common ownership does not alter the impact of uncertainty on the outcomes.

Instead Figure(1.2) shows 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 and sectors has a positive impact in both models (Figure(1.3)). 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.

1.4.2 Uncertainty and welfare

Figures (1.4 , 1.7) 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 similar effects 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. This represents the typical effect of market power through which firms are able to extrapolate consumer surplus. Interestingly, the relationship between diversification and welfare losses evolves as diversification increases. 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. For a value of θ between 1 and 1.3, relative prices tend to infinity, causing the welfare of both workers and owners to decrease as θ increases in this range. Beyond this point, greater substitutability reduces the rigidity of demand for each variety, leading to a decline in market power. Consequently, this reduction in market power produce an increase on workers' welfare, while owners' welfare decreases.

An increase in the number of sectors and the number of firms within each sector leads to a rise in welfare for all agents. As the number of sectors grows, the number of both owners and workers increases proportionally, expanding the overall market size. A larger number of sectors and firms reduces the aggregate market power due to common ownership, thereby improving workers' welfare. Owners also experience higher utility because the market expands, leading to increased profit margins.

1.5 Conclusion

The first chapter of this thesis explores 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 the one-sector model and in the 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 proves to be even 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 chapter highlights how uncertainty influences the real economy, both in a one-sector and a multi-sector model in presence of common ownership. 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.

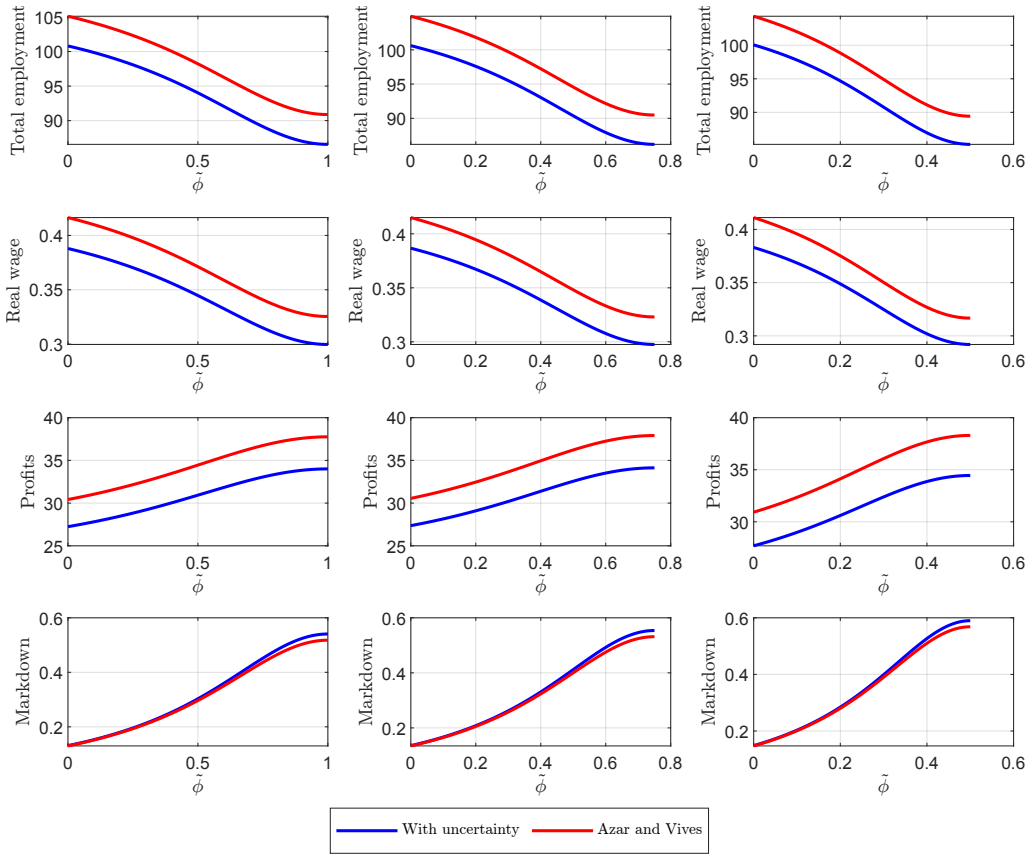


Figure 1.1: This figure illustrates the impact of increasing intra-sector diversification on equilibrium variables at different levels of diversification inter-sector. The first column represents $\phi = 0$, the second column shows $\phi = 0.25$, and the third column depicts $\phi = 0.5$.

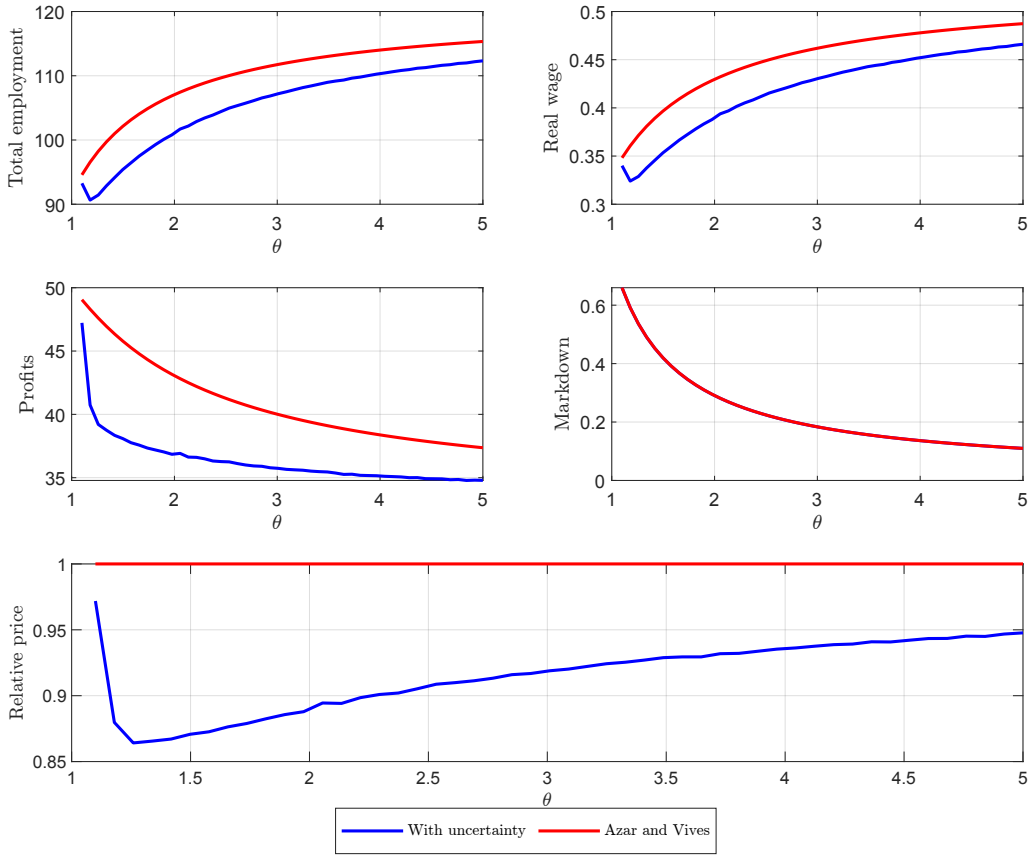


Figure 1.2: This figure shows the relationship between elasticity of substitution across variety and equilibrium outcome

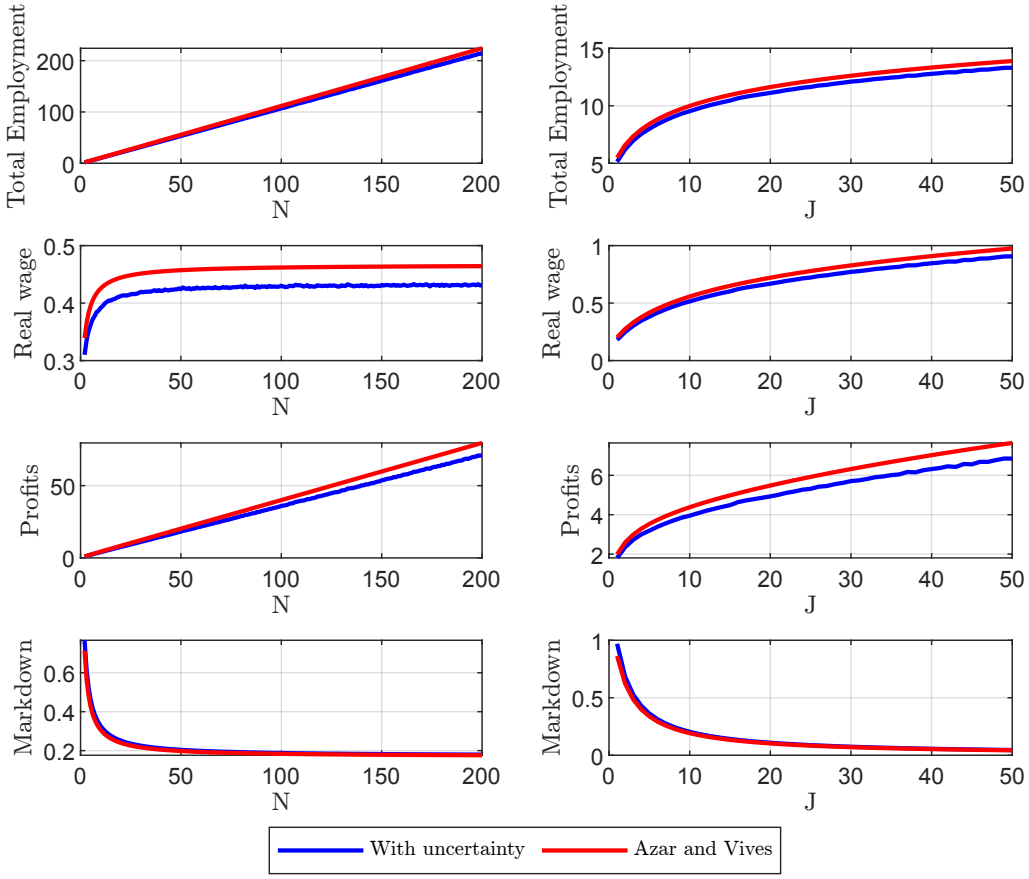


Figure 1.3: This figure shows the relationship between number of sector and firms within a sector and equilibrium outcomes

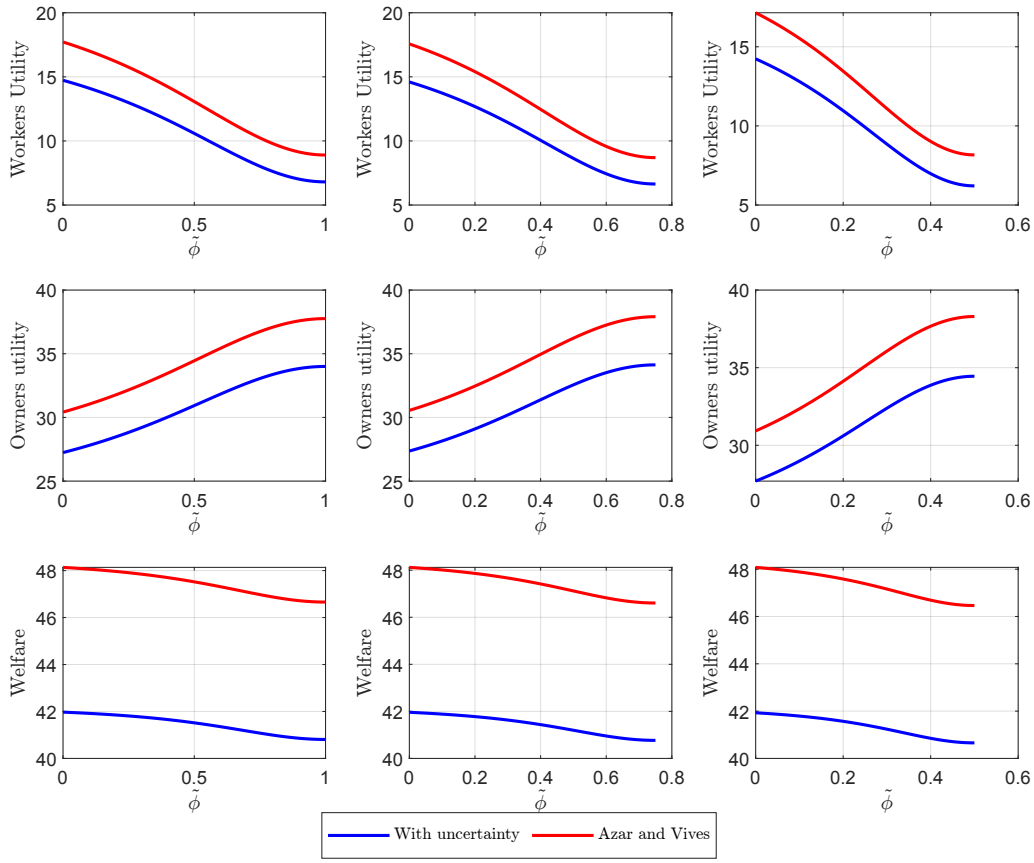


Figure 1.4: This figure illustrates the impact of increasing intra-sector diversification on welfare at different levels of diversification inter-sector. The first column represents $\phi = 0$, the second column shows $\phi = 0.25$, and the third column depicts $\phi = 0.5$.

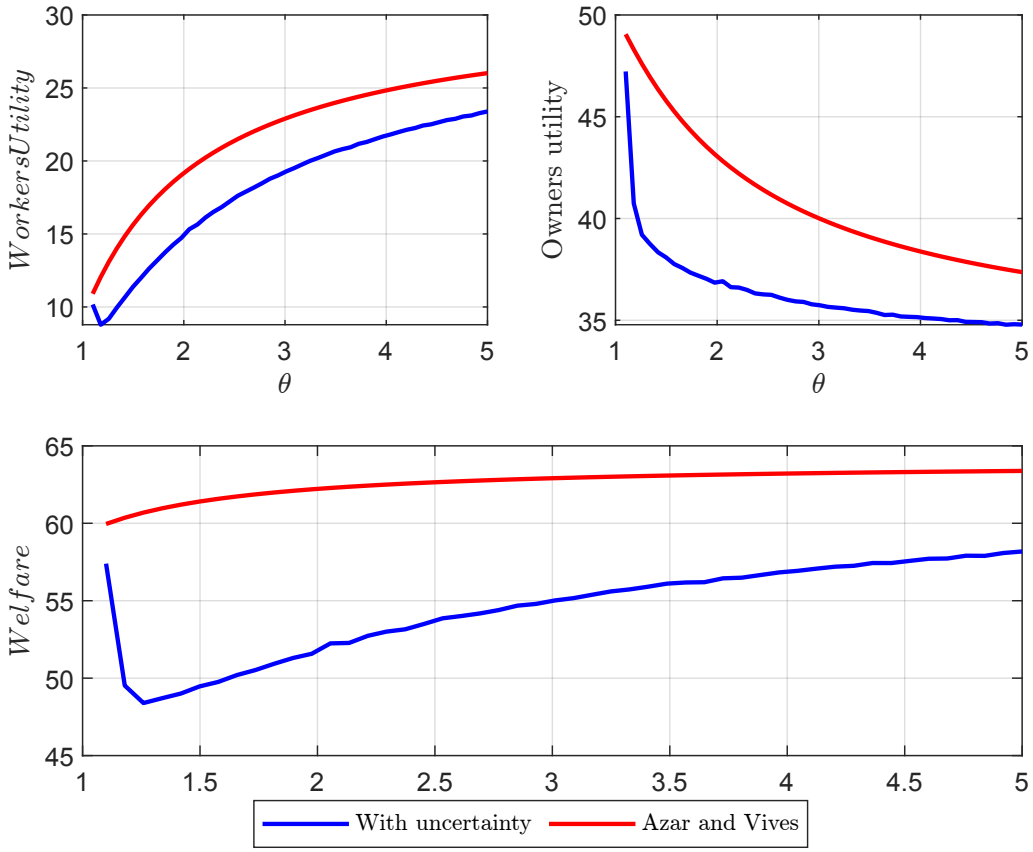


Figure 1.5: This figure shows the relationship between elasticity of substitution across variety and welfare

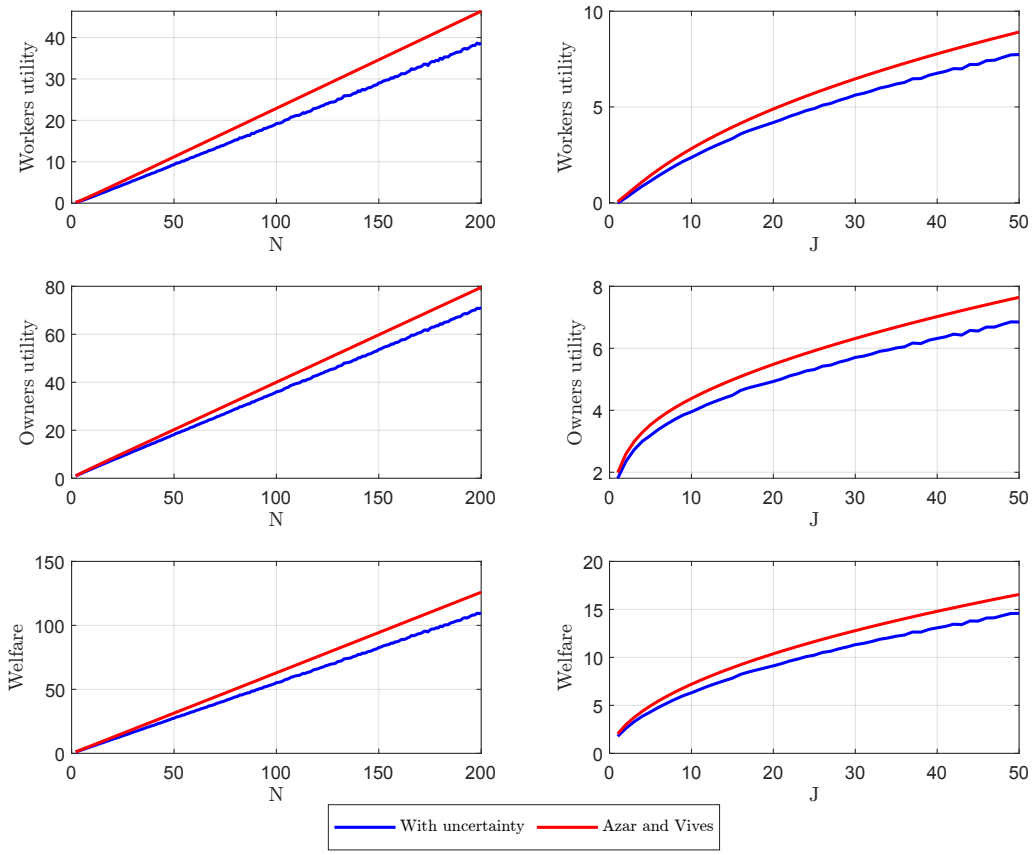


Figure 1.6: This figure shows the relationship between number of sector and firms within a sector and welfare

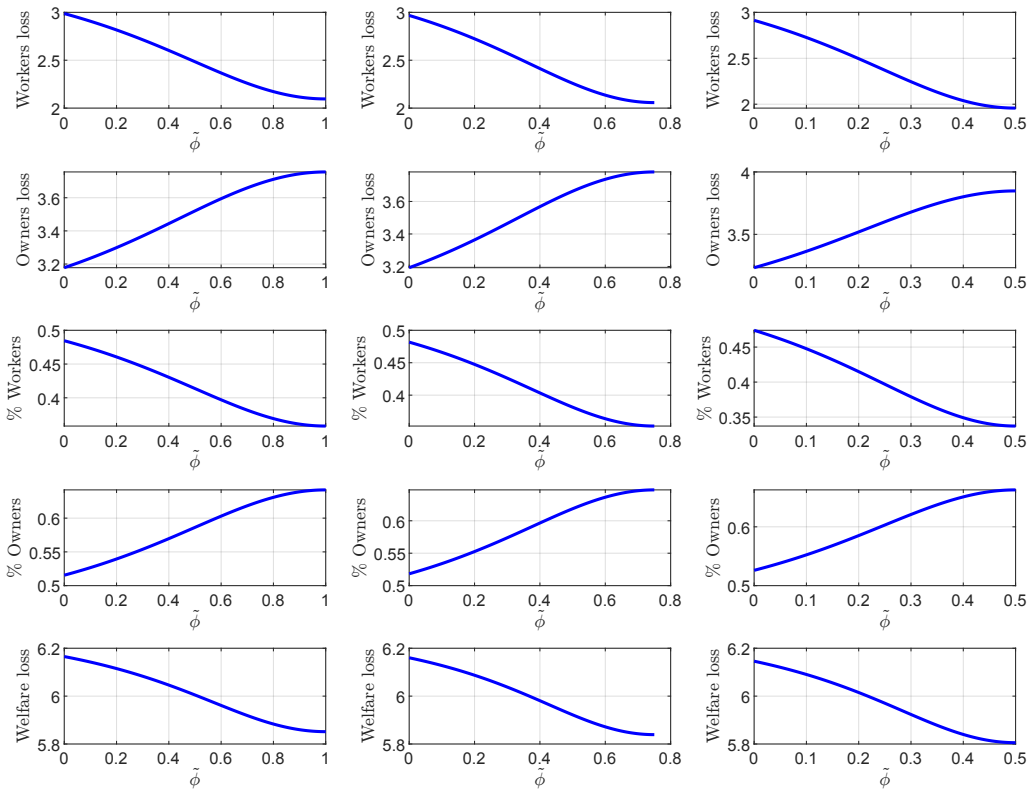


Figure 1.7: This figure illustrates the impact of increasing intra-sector diversification on welfare loss at different levels of diversification inter-sector. The first column represents $\phi = 0$, the second column shows $\phi = 0.25$, and the third column depicts $\phi = 0.5$.

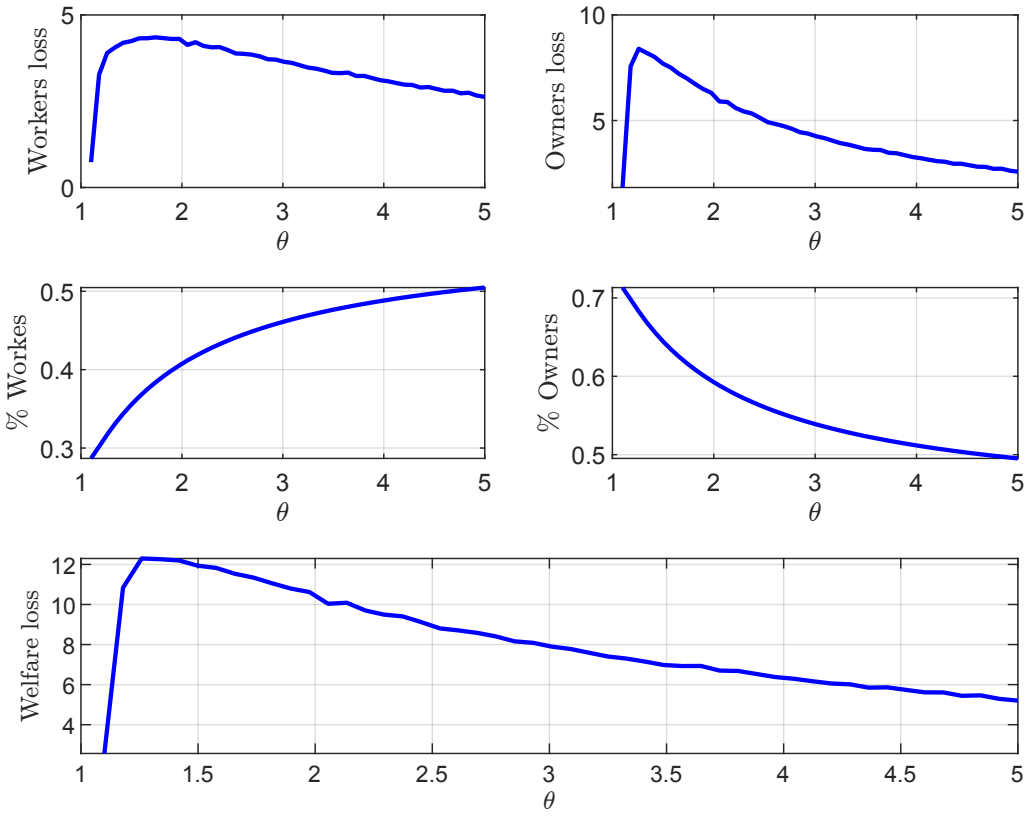


Figure 1.8: This figure shows the relationship between elasticity of substitution across variety and welfare loss

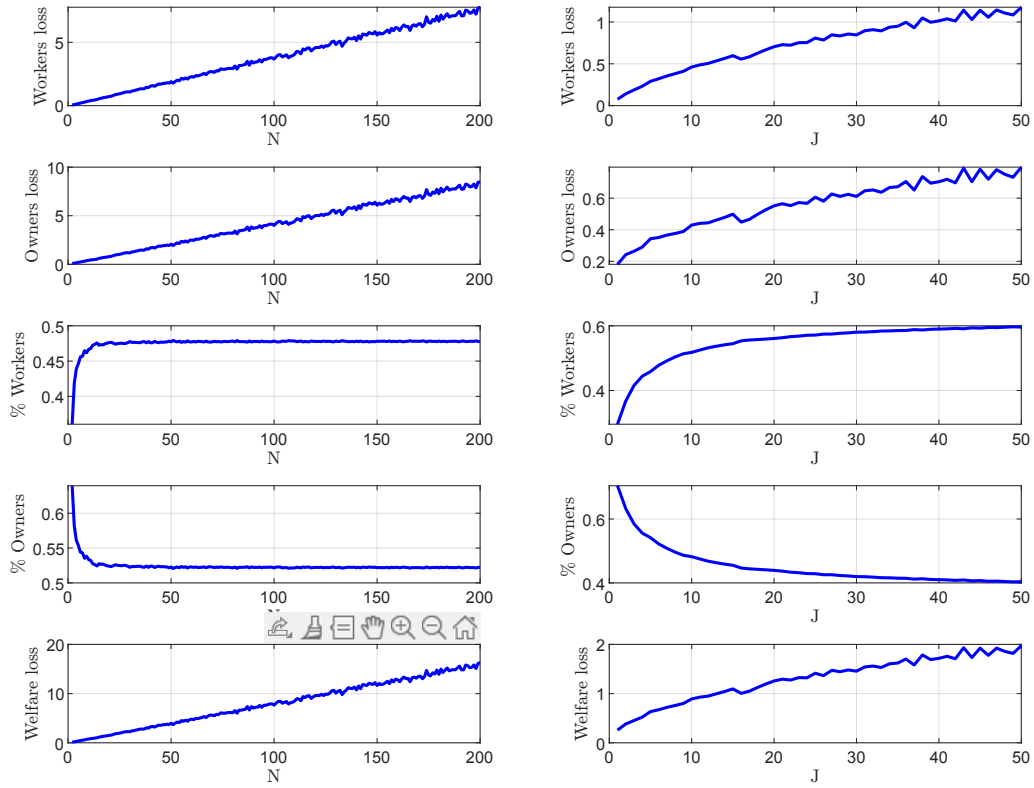


Figure 1.9: This figure shows the relationship between number of sector and firms within a sector and welfare loss

Chapter 2

Common ownership, market power and financial frictions due to costly state verification

2.1 Introduction

A substantial amount of research has investigated how financial frictions and firms' market power, when considered independently, might negatively impact macroeconomic performance. However, the existing literature has devoted much less attention to the interaction between these two phenomena and the consequences of such interaction. Firms with a higher level of market power are generally more profitable (De Loecker et al. (2020)) and, therefore, less likely to fail. This suggests that market power could serve as a protective mechanism against bankruptcies. In the context of inefficient bankruptcies—where firms fail despite having economic value—this implies that greater common ownership, by increasing market power, could potentially reduce the occurrence of such bankruptcies and generate positive welfare effects. The purpose of this chapter is to investigate whether a socially optimal level of market power exists in the presence of inefficient bankruptcy caused by an asymmetry information that forces financiers to adopt standard debt contracts, with the consequence of exposing firms to the event of costly bankruptcy.

In this model, the source of market power we have chosen is common ownership. As previously discussed, this might be considered a source of aggregate market power because a higher level of common ownership leads to decreased competition. The baseline setup used is the multisectoral model developed in Chapter 1, and we introduce financial frictions using the costly state verification framework as presented by Townsend (1979) and Bolton and Dewatripont (2004). According to this framework, lenders cannot observe the outcome of firms' investments, i.e. firm's profits, which by the way coincide with firms' net cash flows. They can only verify the result by incurring a verification cost. This costly verification incentivizes borrowers to report the lowest possible profit realization. Anticipating this behavior, lenders will be unwilling to provide funds in the form of equity, opting instead for a standard debt contract. Under this structure, firms are incentivized to declare the true outcome of the investment in case of success. If the borrower cannot meet the terms of the financing contract, the firm will be liquidated. However, the liquidation process is expensive, and these expenses represent a cost for the entire economy.

Our results reveal that, under certain conditions, sector-specific common ownership can have a net positive welfare effect. Specifically, when the percentage of credit recovered given default is low, a more concentrated common ownership structure reduces the social costs of bankruptcy, offsetting the surplus losses caused by market power and resulting in positive effects on welfare. In contrast, when the credit recovery rate in bankruptcy is high, increasing levels of common ownership reduce the likelihood of financial distress; however, this benefit is offset by a decrease in output and workers' wages, leading to an overall negative effect. To explore whether this optimal level of market power exists in reality, we calibrate the model using data from the U.S. market. Although the calibration is not perfectly precise due to data availability issues, the results still indicate that the level of market power in the U.S. exceeds its theoretical optimum. This finding suggests that, while an optimal level of market power does exist, the actual market power observed in the real world is higher than this optimal threshold. This discrepancy helps to explain the negative effects highlighted by the literature. For instance, Ederer and Pellegrino (2021) quantify the loss of welfare due by common ownership from 1995 to 2021 found that it has significantly increased welfare costs, with deadweight loss ranging from 3.5% to 13.2% of total surplus in 2021, and led to a substantial reallocation of surplus from consumers to producers.

Our study makes a significant contribution to the literature by exploring the interaction between financial frictions and market power (Jungherr and Strauss (2017); Galle (2020); Casares et al. (2023)), as well as examining the macroeconomic implications of common ownership. The most closely related work is by Casares et al. (2023), who also investigate the interaction between market power and financial frictions. In their study, using two types of financial frictions, such as moral hazard and costly state verification, they demonstrate the existence of an optimal social welfare level of market power. However, our approach differs both in the basic setup and in that we consider only one type of financial friction. In their analysis, Casares et al. (2023) use a monopolistic competition model as a base setup. In this case, as mentioned earlier, in monopolistic competition models, the only source of market power is demand rigidity, which is tied to consumer preferences. In our model, however, the presence of two sources of market power allows us to separate these two effects. In this thesis, we will focus exclusively on the effects of a common ownership structure. Although not addressed in this thesis, a future objective could be to explore further and replicate the results of the Casares et al. (2023) model to better understand how the two types of market power might interact with each other.

This chapter is structured as follows. In section 2.2 we present and solve the model while in section 2.3 we solve numerically the model and e then analyze how market power impacts economic variables, with a particular focus on agents' welfare.

2.2 Model setup

We consider an economy consisting of a continuum of islands, denoted by $\mathbb{I}$, where each island operates independently with no trade occurring between them. The economic structure of each island resembles the multisectoral model outlined in the previous chapter, with some differences. Specifically, we now assume only common ownership within each sector, and we introduce firms' financial needs, which are met

through banks[1]. Since labor is the only factor of production, we model financial need by assuming that firms must pay the entire wage bill upfront[2].

In this economy, there exists a mass of one bank, capable of operating on every island. The banks play a financial intermediation role by collecting deposits and then providing loans to firms. Due to the presence of financial frictions, banks engage in a standard debt contract with each firm. According to this contract, if a firm is unable to meet its debt obligations, the bank has the right to liquidate the firm and claim its cash flow. However, the liquidation process is imperfect, as the bank cannot fully recover all the firm's generated cash flow due to inefficiencies in the liquidation technology.

2.2.1 Ownership structure

In contrast to Azar and Vives (2021) and the multisectoral model developed in the previous chapter, we assume that common ownership exists only within each sector. This assumption serves two primary purposes. First, as we will explain later, solving the model under the assumption of a common corporate structure across different sectors is computationally intensive and does not yield additional insights for our analysis. Second, as demonstrated by Azar and Vives (2021, 2022), common ownership across multiple sectors may create a pro-competitive effect in the economy. Since our objective is to study the interplay between costly bankruptcy and the market power arising from common ownership, we restrict common ownership to within individual sectors. In doing so, we ensure that any increase in the intra-sector common ownership produce an increase on aggregated market power.

The ownership structure is built such that each group nj directly owns a share $(1-\phi) \geq 0$ of firm nj and, an industry index of all firms in the same sector sector (ϕ/J). In this case $\phi \in [0,1]$ [3] represents the level of portfolio diversification in the single sector.

As in the models discussed in the previous chapter, firm managers maximize the real value of shareholder wealth. Under the intra-sector common ownership assumption, the wealth of a generic group nj at time 1 is given by

$$\Pi_{nj} + \lambda \sum_{k \neq j}^{J} \Pi_{nk}, \tag{2.1}$$

where λ denotes the weight assigned to the profits of other firms in the same sector relative to the firm's own profit. Specifically, λ is defined as

$$\lambda = \frac{(2-\phi)\phi}{(1-\phi)^2 J + (2-\phi)\phi}. \tag{2.2}$$

A higher value of λ indicates a greater degree of common ownership within the industry and, consequently, a higher level of market power for the firms. In other

[1] In this economy, there are no economies of scale in the financial intermediate sector. This means that lenders could be other agents outside the economy, not necessarily banks.

[2] This assumption is similar to that made in Casares et al. (2023).

[3] This model is equivalent to Azar and Vives (2021) multisectoral model where ϕ=0. Notice that their model ϕ represents the level of diversification in the whole economy while in this model represents the level of diversification in the industry index. The corresponding of my ϕ in their model is $\widetilde{\phi}$

words, the larger the value of λ, the more weight each manager places on the profits of other firms relative to its own. Note that λ depends on both ϕ and the number of firms J. In particular, as the level of portfolio diversification ϕ approaches one, λ tends to one, and if the number of sectors tends to infinity, the outcome converges to the result described in Dixit and Stiglitz (1977).

2.2.2 Agents behavior

2.2.2.1 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 to finance consumption. Given production plans firms will borrow the financial resources needed to pay wages. The workers will receive the salaries and they will deposit them into the banks. Banks collect deposits and provide loans.
- at t=1, preference shocks occur and people decide, given the income obtained in the previous period, how much to consume of each variety. Banks receive the face value of the standard debt contract if firm repays the standard debt contract. If a firm is not able to fullfill the financing contract, it is audited by banks. The bank liquidation technology is impecfet so this proces involve a loss for the entire economy.

The function that aggregates consumption across all sectors is homothetic, so, as in the previous chapter the problem is solved using backward induction.

2.2.2.2 Workers problem at time 1

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

$$\max_{c_{ni}^w} \quad C_i^w = \left[\sum_{n=1}^{N} \left(\frac{1}{N}\right)^{\frac{1}{\theta}} (e_n)^{\frac{1}{\theta}} (c_{ni}^w)^{\frac{\theta-1}{\theta}}\right]^{\frac{\theta}{\theta-1}} \tag{2.3}$$

s.to.

$$(1+r_d)(wL_i) = \sum_{n=1}^{N} p_n c_{ni}^w. \tag{2.4}$$

Solving the above problem we get the optimal level of consumption of variety n conditional to shock realization and aggregate level of consumption

$$c_{ni}^w = \frac{1}{N} e_n \left(\frac{p_n}{P}\right)^{-\theta} C_i^w. \tag{2.5}$$

From this equation arises also that total expenditure is equal to price index multiplied the total level of consumption

$$PC_i^w = (wL_i)(1+r_d). \tag{2.6}$$

The owners' demand conditional on their aggregate level of consumption is identical to those of workers. Integrating the individual demand for each agents we obtain the aggregate demand

$$\underbrace{\int_{I_w \bigcup I_o} c_{ni} di}_{c_n} = \frac{1}{N} e_n \left(\frac{p_n}{P}\right)^{-\theta} \underbrace{\int_{I_w \bigcup I_o} C_i di}_{C} . \tag{2.7}$$

Using this equation we can find the relative prices in a competitive equilibrium

$$\frac{p_n}{P} = \left(\frac{1}{N}\right)^{\frac{1}{\theta}} e_n^{\frac{1}{\theta}} \left(\frac{c_n}{C}\right)^{-\frac{1}{\theta}} . \tag{2.8}$$

In a competitive equilibrium, total production is equal to total consumption

$$c_n = \sum_{j=1}^{J} F(L_{nj}). \tag{2.9}$$

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

$$\frac{p_n}{P} = \left(\frac{1}{N}\right)^{\frac{1}{\theta}} e_n^{\frac{1}{\theta}} \left(\frac{\sum_{j=1}^{J} F(L_{nj})}{\left[\sum_{m=1}^{N} \left(\frac{1}{N}\right)^{\frac{1}{\theta}} (e_m)^{\frac{1}{\theta}} \left(\sum_{j=1}^{J} F(L_{mj})\right)^{\frac{\theta-1}{\theta}}\right]^{\frac{\theta}{\theta-1}}} \right)^{-\frac{1}{\theta}} . \tag{2.10}$$

As in the multisector model presented in the previous chapter, at time 1, production schedules are already fixed and relative prices are affected only by the realization of the shocks. The relative price of sector n depends on the realization of the shock associated with variety n and the realization of all $(N-1)$ shocks. 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. As we explained earlier, this effect depends on the elasticity of substitution among different varieties θ. A higher elasticity implies that the effect of the other shocks on the n variety is smaller.

2.2.2.3 Workers equilibrium at time 0

At time 0, workers decide how much to consume and how much labor to supply in order 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

$$\max_{C_i^w, L_i} \quad \mathbb{E}(U^w) = \mathbb{E}\left(C_i^w - \chi \frac{{L_i}^{1+\frac{1}{\eta}}}{1+\frac{1}{\eta}}\right) \tag{2.11}$$

$$s.to.$$

$$PC_i^w = (wL_i)(1+r_d). \tag{2.12}$$

By defining P as the numeraire good and normalizing it to one, we have that $C_i^w = (wL_i)(1 + r_d)$ and substituting it into $\mathbb{E}(U)$, we can rearrange the maximization problem such that it depends only on L_i. The solution of this problem gives us the individual inverse labor supply

$$w = \chi L_i^{\frac{1}{\eta}} \frac{1}{(1 + r_d)}. \tag{2.13}$$

Since workers are identical, the aggregate inverse labor supply is

$$w = \chi \left(\frac{L}{N}\right)^{\frac{1}{\eta}} \frac{1}{(1 + r_d)}. \tag{2.14}$$

2.2.3 Firms' problem

Firms require a period to produce consumer goods, so they establish their production schedule at time 0, prior to shocks' realization. Frims' nj profit are

$$\Pi_{nj} = p_n F(L_{nj}) - wL_{nj}(1 + r_l), \tag{2.15}$$

where $F(L_{nj}) = AL_{nj}^{\alpha}$ is the production function, A is the technology of production, w is the wage, p_n is the nominal price of variety n, $(1+r_l)$ is the unity cost of credit and $\alpha \in [0, 1]$ is the output elasticity respect to labor.

Since prices are affected by the realization of the shocks, the real profit of firm nj is a random variable so, the objective function that the manager of firm nj maximizes is the expected value of the equation (2.1) conditional on success[4]

$$ps \left(\mathbb{E}(\Pi_{nj}|succ) + \lambda \sum_{k \neq j}^{J} \mathbb{E}(\Pi_{nk}|succ) \right), \tag{2.16}$$

where ps represents the probability of success, and the expression in brackets represents the profit of firm nj and the other firms in sector j, conditional on success (conditional on positive profits).

[4]The objective function is written as follow. Consider a generic group nj that directly controls a generic firm in sector n. For simplicity, assume there is no common ownership. The group receives the firm's profits if the firm succeeds and receives nothing in the event of failure. Since all goods produced within the same sector are identical and firms share also the same production technology, if firm j in sector n earns positive profits, then any other firm k in the same sector will also earn positive profits. This implies that the probability of success is the same for every firm in the sector.

The managers' objective function for firm nj can be written as the weighted sum of the expected profits, considering both success and failure cases:

$$\text{Obj} = ps\, E[\pi_{nj} \mid \text{success}] + ps \sum_{k \neq j} \lambda\, E[\pi_{nk} \mid \text{success}] + pf\, E[\pi_{nj} \mid \text{failure}] + pf \sum_{k \neq j} \lambda\, E[\pi_{nk} \mid \text{failure}],$$

where ps and pf denote the probabilities of success and failure, respectively, $E[\pi_{nj} \mid \text{success}]$ represents the expected profit of firm j in the event of success, $E[\pi_{nk} \mid \text{success}]$ represents the expected profit of any other firm k in the event of success. Since the expected profit in the event of failure is zero for both firm j and any other firm k, the terms related to failure vanish and the objective function reduces to equation (2.16)

The problem faced by managers of firm nj is the following

$$\max_{L_{nj}} \; ps \left[\mathbb{E}(p_n|succ)F(L_{nj}) - wL_{nj}(1+r_l) + \lambda \left[\sum_{k \neq j}^{J} \mathbb{E}(p_n|succ)F(L_{nk}) - wL_{nk}(1+r_l) \right] \right]. \tag{2.17}$$

Solving the above problem we obtain the inverse of labor demand as a function of expected markdown and expected prices

$$w = \frac{\mathbb{E}\left(p_n|succ\right) F'(\frac{L^d}{JN})}{(1+\mathbb{E}(\mu|succ))}. \tag{2.18}$$

2.2.3.1 Banks' problem

Banks compete à la Bertrand to provide loans to firms at an interest rate denoted by r_l, while they collect deposits from workers at an interest rate denoted by r_d. In this economy, there is also a risk-free investment opportunity that guarantees a return rate of r_f. Because returns are not freely verifiable, the optimal financing contract is structured as a standard debt contract. Under this contract, banks receive r_l per unit of loan provided.

If a firm fails to meet its contractual obligations, banks have the right to audit the firm and claim the cash flow it has generated. To undertake an audit process, banks must incur a cost that is proportional to the size of the cash flow. Banks are equipped with a liquidation technology that allows them to recover a fraction k of the firm's generated cash flow, where $k \in [0,1]$.

When $k = 1$, the liquidation technology is perfect; banks can recover the entire cash flow in the event of a loan default. In this case, there are no costs associated with default, and there is no financial frictions. In contrast, when $k = 0$, banks are unable to recover any cash flow in case of default, representing the highest level of financial frictions.

The participation constraint for banks on a generic island i is given by:

$$\mathbb{E}(vl) \;\; \geq (1+r_f) w \frac{L}{JN} \tag{2.19}$$

where $(1+r_f)$ is the return of free risk investment and vl is the value of loan and it is equal to

$$vl = \begin{cases} p_n \; A \; \left(\frac{L}{JN}\right)^{\alpha} \; k & \text{if default} \\ w \; (1+r_l) \; \frac{L}{JN} & \text{if success} \end{cases} \tag{2.20}$$

Banks have the ability to invest across all islands, enabling them to fully diversify risk. Consequently, they set their participation constraints at a global level. By the law of large numbers, while the realization of the critical shock may differ across islands, it converges, on average, to its expected value. Let $\widehat{e}_n$ denote the realization of the critical shock at which firm n on a given island breaks even, earning zero profit. By the law of large numbers, the average ex-post value of this threshold equals its expected ex-ante value. As a result, the expected value of the loan, conditional on the probability of success or failure, will be equal to the value of the banks' portfolio, which is diversified across all islands. The aggregate conditional value of the loan is

$$\mathbb{E}\left[p_n\ A\ \left(\frac{L}{JN}\right)^{\alpha} k|\widehat{e}_w > e_n\right] F(\widehat{e}_w) + w\ (1+r_l)\ \frac{L}{JN}\left(1-F(\widehat{e}_w)\right). \tag{2.21}$$

Combining (2.21) and (2.19) with some rearrangement we obtain

$$(1+r_l) = \frac{(1+rf)}{ps} - \frac{pf}{ps}\frac{\mathbb{E}(p_n|fail)kA(JN)^{1-\alpha}}{w(L)^{1-\alpha}}, \tag{2.22}$$

where $\widehat{e}_w$ is the expected value of $\widehat{e}_n$, pf is the probability of default and it is equal to $F(\widehat{e}_w)$ and $\mathbb{E}(p_n|fail)$ is the expected value of price of variety n given default. The loss for the economy in this case is represented by:

$$loss = (1-k)\mathbb{E}(p_n|fail)A\left(\frac{L}{JN}\right)^{\alpha}. \tag{2.23}$$

2.2.4 General Equilibrium

The conditions of Azar and Vives (2021) hold and it guarantees the existence of unique, symmetric and local stable equilibrium where:

Definition 4. *A competitive equilibrium relative to* $(L_1, ..., L_J)$ *is a price system and allocation* $[w, p_n, r_l, r_d\}; \{C_i, L_i\}_{i\in I_w}, \{C_i\}_{i\in I_O}]$ *such that the following statements hold:*

(i) For $i \in I_W, (C_i, L_i)$ *maximizes* $\mathbb{E}[(C_i, wL_i)]$ *subject to* $pC_i \leq wL_i(1+r_d)$ *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: $\int_{i\in I_W\cup I_O} C_i di = \sum_{j=1}^{J} F(L_j)$.

(iv) Deposit rate is equal to free risk rate: $r_d = r_f$

The conditions of Azar and Vives (2021) hold and it guarantees the existence of unique, symmetric and local stable equilibrium where:

a) the total level of employment is

$$L^* = \left[\frac{1}{\chi}J^{1-\alpha}\frac{\mathbb{E}\left(p_n|succ\right)\alpha A}{\left(1+\mathbb{E}(\mu|succ)\right)}\frac{(1+r_d)}{(1+r_l)}\right]^{\frac{1}{\frac{1}{\eta}+1-\alpha}} N; \tag{2.24}$$

b) the value of expected real wage in equilibrium is

$$w = \left[\left(\chi\frac{1}{(1+r_f)}\right)^{\eta}\left(\frac{\mathbb{E}\left(p_n|succ\right)\alpha A}{\left(1+\mathbb{E}(\mu|succ)\right)(1+r_l)}\right)^{\frac{1}{1-\alpha}} J\right]^{\frac{1}{\eta+\frac{1}{1-\alpha}}}; \tag{2.25}$$

c) the expected markdown of real wage is

$$\mathbb{E}(\mu|succ) = \frac{\frac{1}{\eta}H_{labor}+1}{1-\frac{\tau\left(H_{product}\right)}{\mathbb{E}(p_n|succ)}} - 1; \tag{2.26}$$

d) the equilibrium cost of credit is

$$(1+r_l) = \frac{(1+rf)}{ps} \frac{1}{\left(1+\frac{pf}{ps}\frac{A\mathbb{E}(p_n|fail)k(JN)^{1-\alpha}}{w^{wf}(L^{wf})^{1-\alpha}}\right)}. \tag{2.27}$$

where L^{wf} and w^{wf} represent the level of total employment and the wage in the frictionless economy, $H_{product} = \left[\frac{1}{J} + \lambda\frac{(J-1)}{J}\right]$ and $H_{labor} = \left[\frac{1}{JN} + \lambda\frac{(J-1)}{J}\right]$ are respectively the modify HHI index of labor market and product market.

At time 1, the firms' zero profit condition under symmetric equilibrium can be represented by the following equation:

$$p_n\ A\ \left(\frac{L^*}{JN}\right)^{\alpha} = w^*\ \frac{L^*}{JN}.\ (1+r_l). \tag{2.28}$$

The left-hand side of the equation represents the income generated by a generic firm, while the right-hand side represents its cost of production. In a symmetric equilibrium, all firms are identical and thus employ the same amount of labor $\frac{L^*}{NJ}$ and produce the same quantity of output. To satisfy the zero-profit condition, the revenue generated from sales must equal the total costs, represented by the standard debt contract.

To ensure the zero-profit condition holds, we need to determine the critical value of the shock, denoted by $\widehat{e}_w$, at which the firm's expected revenue equals its cost. If the realized shock e_n falls below $\widehat{e}_w$, the firm's revenue will be insufficient to cover its standard debt contract. Solving the equation and taking expectations, we obtain:

$$\mathbb{E}\left[\widehat{e}_w^{\frac{1}{\theta}}\left(\left(\frac{1}{N}\right)^{\frac{1}{\theta}}\left(\sum_{m\neq n} e_m^{\frac{1}{\theta}} + \widehat{e}_w^{\frac{1}{\theta}}\right)\right)^{\frac{1}{\theta-1}}\right] = \frac{1}{A}\ \left(\frac{L^{wf}}{JN}\right)^{1-\alpha} w^{wf} N^{\frac{1}{\theta}}. \tag{2.29}$$

Due to the inherent complexity arising from the stochastic nature of the shocks, we cannot solve this equation analytically. Consequently, in the next section, we employ numerical methods to find a solution. Nevertheless, we can still derive valuable insights. By substituting the equilibrium conditions into the zero-profit condition, we find that the cost of capital term cancels out of equation (2.29). This result implies that, in equilibrium, the cost of credit does not influence the probability of a firm defaulting. This property of the solution will be particularly useful in the numerical analysis, as it allows for the resolution of the solution for $\widehat{e}_w$ to be separated from that of the cost of credit $(1+r_l)$.

However, this does not imply that a higher level of common ownership has no effect on the likelihood of default. As market power increases, firms reduce their total wage bill, causing the right-hand side of equation (2.29) to decrease. As the right-hand side decreases, the left-hand side must also decrease, which implies that the critical level $\widehat{e}_w$ must decline.

2.3 Numerical solution

In this section, we provide a numerical solution to the model presented, investigating how macroeconomic variables respond to varying levels of financial frictions

and market power. The model is solved using MATLAB, where we implement a Monte Carlo simulation involving 10,000 individual islands. Each island represents an independent economy, and shocks are drawn from a uniform distribution. For each variable, the expected values are computed as the average of these realizations among the islands.

The parameter calibration follows the values provided by Azar and Vives (2022) and it is set as follows: the number of sectors $N = 100$, the number of firms per sector $J = 5$, the technology parameter $A = 0.4976$, the output elasticity with respect to labor $\alpha = \frac{2}{3}$, the elasticity of substitution $\theta = 3$, the elasticity of labor supply $\eta = 0.59$, and the disutility of labor parameter $\chi = 0.3827$.

To ensure that the expected value of a single shock equals one, the lower and upper bounds of the uniform distribution are set to 0 and 2, respectively. Additionally, the risk-free interest rate is assumed to be zero. Furthermore, the weight of workers' utility in the welfare function is set at 0.89, reflecting the proportion of the U.S. population that are workers. The value of λ, representing the degree of common ownership, is set to 0.124, which is the estimate provided by Azar and Vives (2021) for the year 2017. To determine the value of ϕ, we solve equation (2.2), obtaining a value of 0.4144.

Table 2.1: Model Parameters

Parameter Symbol	**Description**	**Value**	**Source**
$\mathbb{I}$	Number of islands	10000	
N	Number of sectors	100	Azar and Vives (2021)
J	Number of firms within sector	5	Azar and Vives (2021)
A	Firm productivity	0.4976	Azar and Vives (2021)
α	Output elasticity	$\frac{2}{3}$	Azar and Vives (2021)
θ	Elasticity of substitution across varieties	3	Azar and Vives (2021)
λ	Edgeworth sympathy coefficients	0.124	Azar and Vives (2021)
η	Labour elasticity	0.59	Azar and Vives (2021)
χ	Disutility of labor	0.3827	Azar and Vives (2021)
$\underline{e}$	Shock lower bound	0	
$\overline{e}$	Shock upper bound	2	
r_f	Risk-free interest rate	0.01	
τ	Weight of workers' utility in the welfare function	0.89	

2.3.1 Optimal degree of market power and financial frictions

In this section, we analyze the interaction between financial frictions and market power stemming from common ownership. We use as a benchmark for our analysis the model without financial frictions (where $k = 1$). Figure (2.1) illustrates the

Table 2.2: Equilibrium values

Variable	**Value**	**Variable**	**Value**
ϕ	0.4144	pf	0.2888
$\mathbb{E}(pn\|succ)$	1.0457	ps	0.7112
$\mathbb{E}(pn\|fail)$	0.6052	$(1+r_l)$	1.0806
L^{wf}	114.7888	w	0.6214
w^{wf}	0.6630	L	110.4868
$Revenues$	0.1902	$Costs$	0.1484
$Profits$	14.5552	U^w	45.9622
U^o	14.5552	W	28.8645
$\mathbb{W}^w/\mathbb{W}^o$	3.1578	$loss$	90.2853
$Owners\ share$	0.1876	$Labor\ share$	0.8124

effects of increasing common ownership under different levels of liquidation technology.

When banks can fully recover a firm's generated cash flow ($k = 1$), increasing common ownership consistently has negative consequences for the economy. Specifically, as the degree of common ownership rises, competition in the market declines, leading to a decrease in all key equilibrium variables. With no bankruptcy costs, greater market power results in a lower cost of credit. However, this also leads to a reduction in wages and, consequently, a decrease in the optimal level of employment. This outcome aligns with the standard economic theory linking market power to adverse effects on economic efficiency.

As the efficiency of the liquidation technology decreases ($k < 1$), Figure (2.1) shows that higher levels of common ownership can have positive effects on economic outcomes. An increase in common ownership reduces the probability of bankruptcy, thereby lowering the credit cost faced by firms. This allows firms to increase production, which, in turn, results in higher wages for workers. In this scenario, a positive level of market power that maximizes aggregate welfare emerges, as market power helps to reduce the deadweight loss associated with bankruptcy. In Figure (2.1), we observe that this optimal level of market power increases with the intensity of financial frictions. This is because, as the intensity of financial frictions grows, the costs of bankruptcy become greater, making higher market power desirable to mitigate these costs. For instance, when liquidation technology allows only half of the generated cash flow to be recovered, the optimal level of λ is 0.08, whereas, in the scenario where no cash flow can be recovered, the optimal level rises to 0.46.

Since social welfare is also influenced by the weight assigned to different agents within the economy, Figure (2.2) shows the impact of increased market power on GDP. A similar trend is observed with aggregate welfare.

The rise in common ownership also has significant redistributive effects on income and resources. Specifically, an increase in market power results in a reduction of the labor share and an increase in the owners' share, effectively shifting resources from workers to owners. However, as illustrated in Figure (2.3), increased market power also reduces aggregate losses related to both welfare and GDP that are attributable to bankruptcy costs. Figure (2.3) further depicts how these losses are distributed between workers and owners, depending on the degree of financial frictions.

In the absence of common ownership, workers bear over 97.09% of the GDP loss and 99.49% of the welfare loss. As corporate concentration rises, this share decreases to 86.69% and 97.46%, respectively. Thus, as market power grows, the losses in terms of GDP and welfare shrink, and a larger share of the losses is absorbed by owners. Despite this shift, it is crucial to note that workers still bear the majority of the social costs, even in presence of perfect common ownership scenario. This observation suggests that workers in an oligopolistic corporate structure are disproportionately impacted by the adverse effects of bankruptcy.

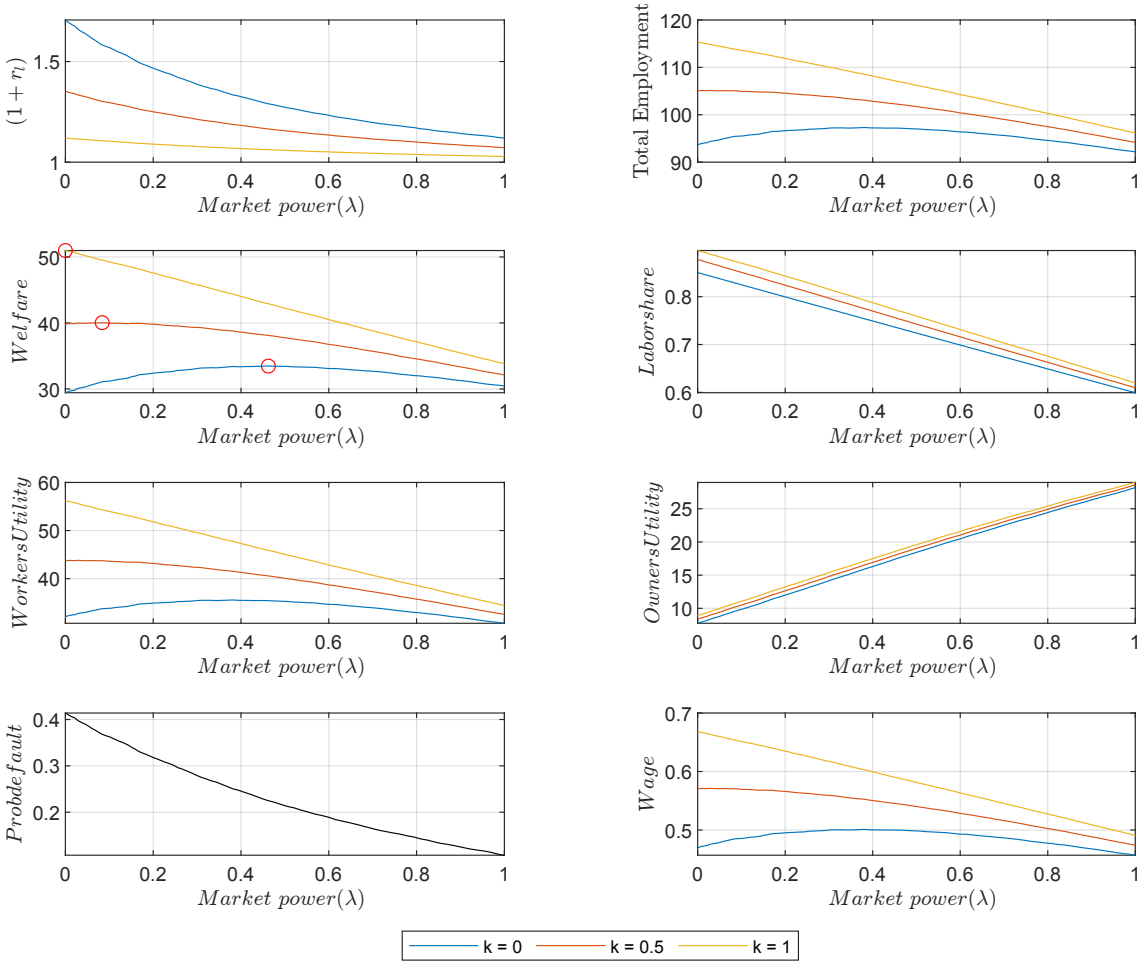


Figure 2.1: Equilibrium outcome under different levels of liquidation technology vs lambda.

2.3.2 Effects of Financial Frictions

In this section, we examine the relationship between economic outcomes and financial frictions. Figure (2.4) shows how equilibrium variables change with the efficiency of the liquidation technology.

As the efficiency of the liquidation technology (k) increases, we observe a reduction in the interest rate $(1+rl)$. This suggests that with better recovery technology, creditors demand a lower risk premium, reflecting a decreased likelihood of loan losses. Consequently, total employment rises as reducing financial frictions stimulates economic activity, allowing firms to expand production and hire more workers.

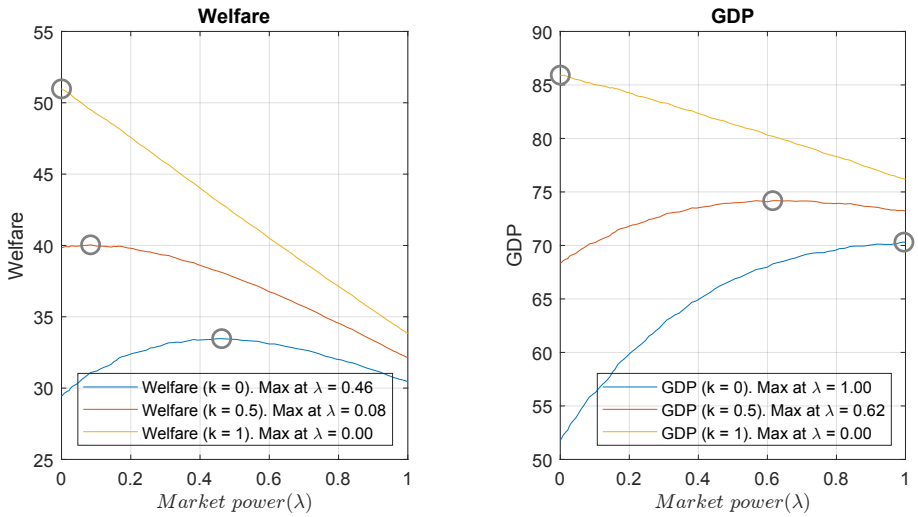


Figure 2.2: GDP vs. Welfare

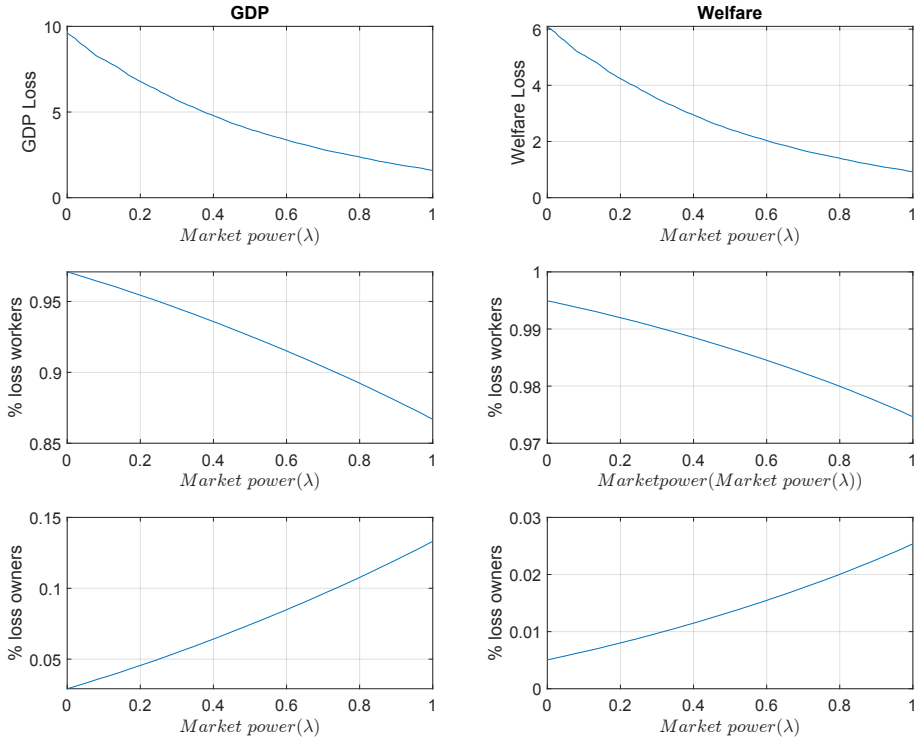


Figure 2.3: Loss due financial frictions on welfare and GDP vs market power due by common ownership

Social welfare also improves with the efficiency of the liquidation technology. Better liquidation technology implies low bankruptcy cost reducing the negative effects of financial frictions. Additionally, labor share shows a slight increase, indicating that a greater portion of the value added produced by firms is distributed to workers.

Workers' utility increases as well, with higher employment and wages contributing positively to their well-being. Owners' utility also rises, suggesting that both workers and owners benefit from better recovery technology, although to different extents. Aggregate income increases with the efficiency of the liquidation technology, as a more efficient financial environment allows for a more productive use of capital and labor, boosting the total income of the economy.

As the efficiency of liquidation technology by banks increases, there is a shift in the allocation of resources within the economy, leading to an increase in the labor share and a corresponding decrease in the owner share. The Figure(2.5) illustrates how bankruptcy losses vary with the intensity of financial frictions. Higher liquidation efficiency results in a reduction of costs, both in terms of welfare and GDP, approaching zero when efficiency is at its maximum. Even in this scenario, the burden of financial frictions predominantly falls on workers. However, the percentage they bear increased with reduced financial frictions, shifting from 86.49% (82.36 % in terms of welfare) when financial frictions are at their highest to 86.98% (82.97% in terms of welfare) when there are no financial frictions.

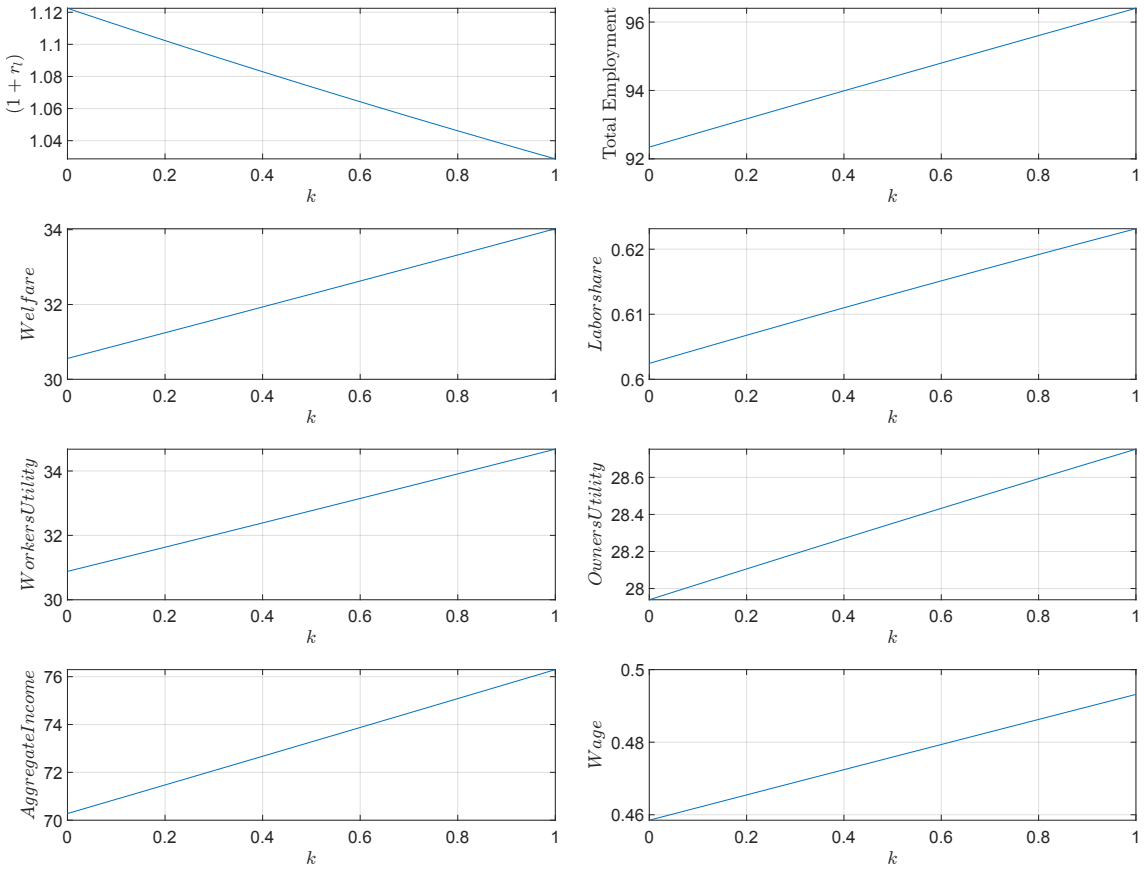


Figure 2.4: Equilibrium outcomes vs. efficiency of liquidation technology

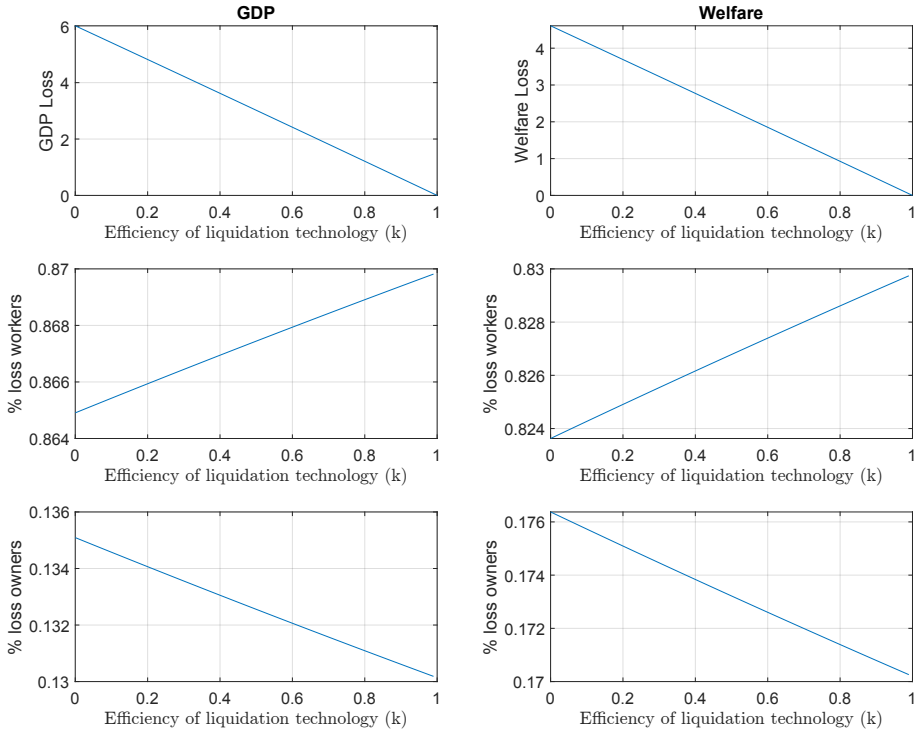


Figure 2.5: GDP and welfare loss vs efficiency of liquidation technology

2.3.3 A discussion on common ownership in the US

The goal of this section is to determine whether, based on our model, the U.S. economy has ever achieved an optimal level of market power. Due to the lack of detailed data for a precise estimation of common ownership levels in the U.S. market, we use the estimation conducted by Azar and Vives (2021). In their paper, the authors estimate the evolution of λ in the U.S. market. They find that for large firms, intra-group λ values increased from 0.41 in 1985 to 0.72 in 2017. Assuming that other firms were not subject to a common ownership structure, they estimate a global evolution of λ from 0.07 to 0.124 over the same period.

For data on the efficiency of the liquidation technology, we rely on the report of loan recovery rate given default published by S&P Global on their website[5]. They reports that the average loan recovery rate given default between 1990 and 2023 was 0.73.

Figure (2.6) illustrates how the optimal λ varies with the efficiency of the liquidation technology under our model. As liquidation efficiency increases, the level of market power that maximizes aggregate welfare decreases, approaching zero when efficiency is about 0.68. Considering the average loan recovery value of 73 percent, optimal level of market power provide by our model is zero that it is lower than all possible value realized in the US market (green area).

To improve our analysis, we examine a range of recovery rate values derived from S&P Global data. Note that the source does not provide exact annual data but rather offers a graph representing the annual trend of this measure. According to the provided chart, the loan recovery rate after default ranges from approximately

[5]https://www.spglobal.com/ratings/en/research/articles/231215-default-transition-and-recovery-u-s-recovery-study-loan-recoveries-persist-below-their-trend-12947167

0.65 to 0.9. In Figure (2.6), the yellow area represents all possible recovery rate values given default, while the green area shows the corresponding market power values realized in the US economy. The overlapping points between these areas indicate potential combinations of market power and financial friction levels that may have occurred in the U.S. economy.

The results show that the level of realized market power has consistently been above the optimal level, which is zero in most of the selected range. When the recovery rate is between approximately 0.65 and 0.68, a positive level of market power that maximizes aggregate welfare emerges but remains lower than any value realized in the U.S. economy from 1985 to 2017. For market power to be optimal for the economy, the recovery rate would need to be between 45 percent and 55 percent—10 to 15 percentage points lower than the rates observed in the U.S. economy.

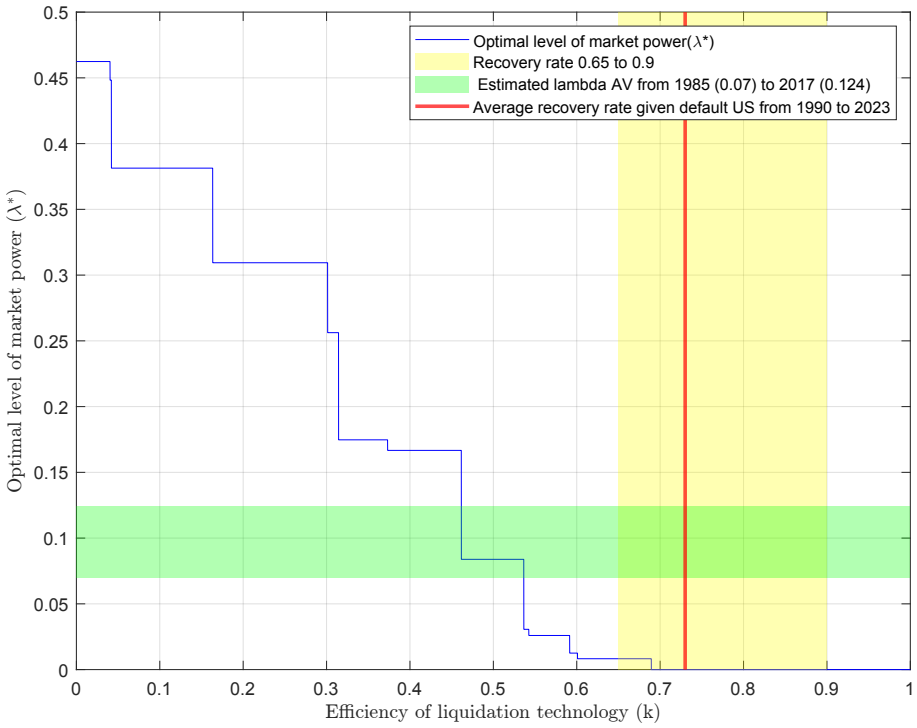


Figure 2.6: Optimal Lambda Intra vs. Recovery Rate (US Welfare)

2.3.4 Conclusion

In conclusion, by employing the framework developed in the previous chapter and incorporating financial frictions such as costly state verification, this chapter has demonstrated that increased market power resulting from a more concentrated corporate structure can have a positive impact on welfare and aggregate income—particularly in the presence of high bankruptcy costs. The analysis reveals that when the costs associated with bankruptcy are substantial, a higher level of market power can help to mitigate financial distress and improve overall welfare by reducing inefficiencies liquidation.

However, as bankruptcy costs decrease, the optimal level of market power correspondingly diminishes, ultimately approaching zero when bankruptcy costs become sufficiently low. This suggests that in scenarios where financial frictions are min-

imal, maintaining competitive market dynamics is more beneficial for maximizing social welfare.

A comparison of these theoretical findings with empirical data from the U.S. market indicates, based on our model, that the actual market power level has likely exceeded its optimal value. Specifically, our results imply that, given the relatively low bankruptcy costs in the American market, the optimal level of market power should ideally be zero. These findings highlight the potential welfare losses associated with excessive common ownership and provide support for policies aimed at reducing corporate concentration and enhancing market competition.

Part II

Chapter 3

Financial frictions and market power accumulation.

The recent years witnessed a significant growth of literature on firms' market power, which is motivated by the increasing trend in market power since the 1980s, as documented by De Loecker et al. (2020) and Diez et al. (2018). The growing body of evidence about the increase in firms' market power has attracted the attention of policymakers and researchers, who are now interested in analyzing the potential effects and risks associated with the rise in market power. The literature has come up with several negative effects associated to the increase in market power, including a negative impact on business dynamics, a decline in the labor share, and wage stagnation[1].

While the exact causes of the rise in market power are still under debate, there is substantial agreement among researchers that higher levels of market power are correlated with greater investments, particularly in intangible productive factors, such as technology and R&D (De Loecker et al. (2020); De Ridder (2024); Ayyagari et al. (2024)). According to De Ridder (2024), the increase in firms' use of intangible assets has led to greater market power for those capable of acquiring and using such assets. This correlation suggests that companies investing more in intangible resources, such as software, tend to achieve more dominant market positions compared to others[2]. Altomonte et al. (2021) using a difference-in-differences approach on French firms demonstrates that an increase in corporate liquid resources leads to higher investments in intangible assets and enhances the firms' market power.

Several papers, such as Hoberg and Maksimovic (2015) and Brown et al. (2009), show a negative relationship between firms' financial constraints and R&D expenditures. They show that constrained firms tend to reduce these costs before cutting production. Firms with higher levels of market power typically achieve higher profits and greater capitalized value (De Loecker et al. (2020); Cho et al. (2024)). Consequently, they are less likely to face financial frictions, which can facilitate increased investment. This enhanced investment capability might further augment these firms' market power. In subsequent periods, increased market power might result in lower marginal costs or heightened demand, creating a feedback loop that enhances profits and market power. Hence, it is evident that market power and financial frictions

[1] see De Loecker et al. (2021); Autor et al. (2020, 2017); Edmond et al. (2023); Peters (2020)

[2] This is in line with Bao and Eeckhout (2023); Liu et al. (2022) that show that leaders might overinvest to acquire more market power

might be interconnected through an amplification mechanism. This mechanism can potentially lead to increased aggregate concentration and reduce competition in the market. This brings us to our research question. What is the interplay between financial frictions and market power? Can market power ameliorate financial frictions that affect a specific firm? Could financial frictions have played a role in the accumulation of market power?

Over the past decades, we've observed a rise in firms' market power alongside a process of financial development, as evidenced by the growing ratio of private credit to GDP and other measures of financial development, such as the level of stock market capitalization (Demirgüç-Kunt and Levine (2018)). Such trends suggest over the period in which market power has been increasing, credit availability for firms has been improving, too, on average. Theoretically, if all firms had equal access to credit, we would expect to see more entry and investment, leading to greater competition and higher productivity. However, that is not necessarily the case if firms are heterogeneous and such heterogeneity affects their capability to access external financial resources, i.e., the magnitude of the financial friction they are effectively subject to. Indeed, the empirical evidence from the literature contradicts this theoretical expectation, documenting a decline in competition and productivity growth rates. Such evidence can be reconciled with financial development that results in more external financial resources available on average to firms, if one recognizes that different firms have different market power. In practice, firms with greater market power tend to face fewer financial frictions. As a result, if constrained firms—those with less market power—are unable to enter into the market and compete, or forced to exit, a higher availability of financial resources can be associated with more market power. In other words, the development of the financial system might be largely driven by the presence of firms with more market power, which, in turn, face fewer financial constraints.

The purpose of this chapter is to identify and analyze the interplay, i.e. the two-way causality relationship between market power and financial frictions. We develop a theoretical model, introducing firm's investment in technology that leads to the production of better quality consumption goods in a model a la Melitz and Ottaviano (2008). In our model, firms are randomly endowed with a level of technology that determines the quality of the consumption good they are initially able to produce, thereby determining their initial market power. Then, firms, based on their capacity to get externally financed, will invest to improve their technology, which results in the production of higher quality goods, with a positive effect on future market power. The modeling approach of interpreting quality of consumption goods as the outcome of technology shares similarities with the so called "quality ladder" model widely used growth theory, following the seminal contribution by Aghion and Howitt (1992); Grossman and Helpman (1991). In these models, the quality of developed goods depends on the technology through which they are made, which, in turn, depends on the outcome of the research and development sector.

In our model, the outcome of firms' investment in technology is certain, but it is subject to financial frictions. Firms can only borrow a fraction of the cash flow they have generated (Drechsel (2023)), which limits their ability to finance investments. This mechanism allows firms with greater market power to borrow larger amounts of financial resources and invest more. The results of the theoretical model demonstrate that firms with higher market power, having the ability to borrow

a greater proportion of financial resources, can invest more, which enables them to achieve higher markups in the subsequent period.

While this effect is evident in a partial equilibrium context, the impact of a reduction in financial frictions in general equilibrium is less clear and closely dependent on the number of firms within the economy. Reducing financial frictions allows firms previously constrained to invest more, thus gaining a higher level of market power. This effect contributes positively to market power accumulation, as previously constrained firms can now increase their market power. On the other hand, a reduction in financial frictions could also allow new firms to overcome the entry barriers represented by fixed costs and enter into the market. This, in turn, leads to increased competition and a subsequent reduction in individual firm markups. The dual nature of these effects highlights the complexity of reducing financial frictions in an economy, and the net effect depends on the balance between these forces. If new entrants succeed in establishing themselves, the increase in competition can offset the increase in markups made by existing firms, leading to a more balanced market structure. Conversely, incumbent firms may continue to strengthen their dominance if entry barriers remain high despite reduced frictions. These two channels are the same as those highlighted by De Loecker et al. (2021) as causes of market power. Through a quantitative model, they document that the increase in market power is due to an increase in the firms' technology adoption that implies an increase in the fixed costs of entry and a change in the number of potential competitors. This aligns with the results of our model, as higher investments enhance the technology available to firms, and if a reduction in financial frictions it is not followed by an increase in entrants, they may lead to an increase in aggregate market power.

We further test this empirically by using data from publicly listed U.S. firms to examine whether firms with greater market power face fewer financial frictions. Although we cannot make definitive causal claims, the empirical findings indicate that firms with higher levels of market power are associated with fewer financial constraints in subsequent periods, which confirms our theoretical prediction.

The chapter is organized as follow in section 3.1 we present our model, in section 3.2 we solve numerically the theoretical model, in section 3.3 we discuss the interplay between financial frictions and market power while, in section 3.4 we discuss a possible dynamic development of our theoretical model. At the end in section 3.5 we test one mechanism of our theoretical model.

3.1 Model

We consider a two-period economy populated by consumers, firms, and banks living for two period. There is a mass L of consumers, each offering a unit of labor. For simplicity we assume no savings, and in each period, consumers choose how to allocate their income between the homogeneous good and the differentiated goods. There is a continuum of varieties of differentiated goods offered by firms that compete through monopolistic competition[3] while homogeneous good is produce by perfect competition. The marginal cost is constant for all firms, but they are heterogeneous

[3]Despite the critique we previously made of monopolistic competition models in analyzing the implications of market power, as you will see later, the markup of our firms will be endogenously determined by the technology endowment they receive at inception and by their level of investment.

in terms of the quality of the goods they sell. Firms receive a technology endowment determined by a random draw from a generic distribution[4]. Based on this technology endowment, firms produce a variety of consumption goods with certain quality. The quality of the goods they produce depends on the technology they are endowed with, implying that in this model, the concepts of consumption good quality and technology are equivalent. This modeling approach draws from the literature on endogenous growth, particularly the idea of quality ladder (Grossman and Helpman (1991)). Once they have entered, firms decide how much to produce and whether to invest in technology in order to increase the quality of their goods in the following period. This investment is costly and subject to financial frictions.

3.1.1 Consumers

Consumers derive utility consuming two types of goods: a homogeneous one and a differentiated one, both supplied by firms. Consumers are homogeneous in their preferences, and their utility is determined by

$$U = q_0 + \int_{i\in\Omega} A_{it} q_{it}\, di - \frac{1}{2}\gamma \int_{i\in\Omega} (q_{it})^2\, di - \frac{1}{2}\eta \left(\int_{i\in\Omega} q_{it}\, di \right)^2, \tag{3.1}$$

where $q_{0,t}$ represents the consumption of the homogeneous good, $q_{i,t}$ and $A_{i,t}$ represent respectively the quantity consumed and the quality of each differentiated good i at time t. In this specification of quadratic utility function parameter $\eta > 0$ denote the sustainability between different varieties, while $\gamma \geq 0$ represents the degree of product differentiation among the varieties. The set Ω encompasses all varieties. Since consumers do not have the option to save part of their income to finance future consumption, they must choose how to allocate their income between the homogeneous good and the consumption goods, following the constraint below

$$q_{0t} + \int_{i\in\Omega} q_{it} p_{it} di \leq I^c_{it}. \tag{3.2}$$

Following Melitz and Ottaviano (2008), upon solving the consumers' problem conditional on a positive demand for the homogeneous good, we obtain the inverse demand for each variety i al time t:

$$p_{it} = A_{it} - \gamma q_{it} - \eta Q_t, \quad \forall i \in \Omega^*, \tag{3.3}$$

where $\Omega^* \subset \Omega$ is the subset of varieties for which the demand is positive and $Q_t = \int_{i\in\Omega} q_{it}\, di$. Solving equation 3.3 for q_{it} we get

$$q^d_{it} = \frac{L}{\gamma} \left(A_{it} - p_{it} - \eta \frac{N(\overline{A}_t - \overline{p}_t)}{\gamma + \eta N} \right). \tag{3.4}$$

In this equation, N represents the consumed varieties and the number of firms operating in the market, while $\bar{p}_t = \frac{1}{N}\int_{i\in\Omega^*} p_{it}\, di$ and $\bar{A}_t = \frac{1}{N}\int_{i\in\Omega^*} A_{it}\, di$ denote respectively the average price charged by firms and the average good quality in the differentiated sector at time t. Following Melitz and Ottaviano (2008), by setting $q_{it} = 0$ in equation 3.4, we derive the maximum price at which variety $i \in \Omega^*$ can be sold in each time that is

[4] In the theoretical model we do not need to assume a specific functional form.

$$p_{max_t} = A_{it} - \eta \frac{N(\overline{A}_t - \overline{p}_t)}{\gamma + \eta N}. \tag{3.5}$$

The maximum price depends on the size of market, average level of price and average level of quality. Since the company's investment in quality is negligible, the aggregate quality level is not affected by the firm's investment decision . This means that higher quality leads to an increase in demand for the single variety. An increase in A_{it} results in a perpendicular shift of the demand curve upward. This is because, in the model, firms' invest in technology by affecting the quality of specific variety affects the vertical product differentiation and not horizontal product differentiation[5]. Higher investment leads to an increase in product quality, but does not affect differentiation between varieties. An increase in quality not only stimulates an increase in demand for a particular product variety, but also results in an increase in the maximum price a consumer is willing to pay for that specific variety[6]. Rewriting equation (3.5) we have that

$$p_{max_t} = \frac{\gamma A_{it} + \eta N(A_{it} - \overline{A}_t) + \eta N \overline{p}_t}{\gamma + \eta N} \tag{3.6}$$

In this case we can see that for a quality sufficient low respect to its average, the maximum price that consumers are willing to pay tend toward zero resulting in a negative demand of its specific variety. In this case firms with no sufficient quality does not face positive demand and ,as a consequence, they do not produce. In the limit case when a specific firm has exactly the average quality ($A_{it} = \overline{A}_t$) the maximum price is the same of Melitz and Ottaviano (2008)[7].

In this case the price elasticity of demand is not only a function of differentiation, market size and average price, but is also a function of firm's specific quality and average quality $\epsilon_i = |(\partial q_i/\partial p_i)(p_i/q_i)| = [(p_{max}/p_i) - 1]^{-1}$. An increase of A_{it} produces an increase of the maximum price that firm i can charge resulting in a decrease of price elasticity of demand for any level of price. On the contrary, higher level of aggregate quality induce a decrease on maximum price lending a lower elasticity.

3.1.2 Firms

We have a market with N firms that produce differentiated good, each producing a single variety under monopolistic competition. Labor is the sole production input and as Melitz and Ottaviano (2008), the numeraire good is produced under constant return to scale at unit cost in a perfectly competitive market. It implies a unit wage. To enter into the market, firms must cover a sunk fixed cost f_E. All firms share the same marginal cost of production. Each firm produces a distinct variety using a technology that determines its quality level A_{it}. Firms are randomly endowed with a production technology that allows them to produce at a certain initial quality A_0. Following Grossman and Helpman (1991) the level of quality in this model might be seen as technological adoption. After entering into the market, they have the

[5] Differently form Di Comite et al. (2014) where authors have both horizontal and vertical differentiation.

[6] This is in line with the definition of quality and vertical differentiation provide in the literature. See Di Comite et al. (2014)among the other

[7] This is because in their quadratic utility function all variety share the same quality that is represented by the parameter *alpha*

opportunity to invest in a technology that increases the quality of the good they produce in the subsequent period (a_{it}). Since firms lack internal financial resources, they must secure loans to finance investment, with the amount they can borrow limited to a fraction of their cash flows:

$$i_i(a_i) \leq \lambda \, cf_{it}, \tag{3.7}$$

where $i_i(a_i)$ represent the investment made by firm i at time t to improve its quality of a_i at time $t+1$, while cf_{it} denotes the cash flow generated by firm i at time t. A higher cash flow increases a firm's borrowing capacity, thus enabling greater potential investment. In contrast, low cash flow reduces firms' ability to provide sufficient collateral, thereby limiting its borrowing capacity and, consequently, its potential investment. As in Drechsel (2023), the parameter $\lambda > 1$ represents the maximum allowable ratio of debt to cash flow that a company can maintain. This ratio effectively defines the borrowing capacity of a firm, constraining the extent to which a firm can use its cash flow to secure debt. If the ratio of debt to cash flow exceeds this threshold, firms will face borrowing restrictions, meaning that they will be not able to invest optimally. For simplicity, we assume that the maximum level of λ is common across all firms and it is influenced only by external factors that determine the overall value.

3.1.2.1 Timing

The timing of the economy is as follows:

- **Time 1:** Each firm is randomly assigned a technology level. Firms then decide whether to enter into the market by paying the fixed cost f_E or choose not to enter, in which case they do not produce. If they enter into the market, they decide both how much to produce and how much to invest in technology to improve the quality of their products.
- **Time 2:** Firms determine whether to produce and decide on the production quantity. The investment made at Time 1 yields its benefits in this period, resulting in an improvement in technology and quality.

Since firms can perfectly anticipate the optimal decisions in each period after the realization of the shock, the problem can be solved using backward induction.

3.1.2.2 Firms' problem at time 2

The problem faced by firm i at time 2 is

$$\max_{q_i 2} \quad q_{i2} p_{i2} - c q_{i2} - i_i(a_i)(1 + r_l), \tag{3.8}$$

where $(1 + rl)$ is the gross interest rate. Solving the maximization problem, we obtain the following supply function

$$q_{i2}^s = \frac{L}{\gamma} \left(p_{i2} - c \right). \tag{3.9}$$

As in Melitz and Ottaviano (2008) if the profit-maximizing price p_{i2} charged by a firm exceeds the maximum price $p_{\max_2}$ that consumers are willing to pay, the firm

will exit the market. The critical cost level $A_0 - \frac{\eta N(\overline{a}_2 - \overline{p}_2)}{\gamma + \eta N}$ represents the cost at which a firm is indifferent about staying in the industry or exit if $i_i(a_i) = 0$. By equating supply and demand we obtain the following equilibrium variables

$$q_{i2} = \frac{1}{2}\frac{L}{\gamma}\left(A_0 + a_i - \frac{\eta N(\overline{A}_2 - \overline{p}_2)}{\gamma + \eta N} - c\right); \tag{3.10}$$

$$p_{i2} = \frac{1}{2}\left(A_0 + a_i - \frac{\eta N(\overline{A}_2 - \overline{p}_2)}{\gamma + \eta N} + c\right); \tag{3.11}$$

$$\mu_{i2} = \frac{1}{2}\left(A_0 + a_i - \frac{\eta N(\overline{A}_2 - \overline{p}_2)}{\gamma + \eta N} - c\right); \tag{3.12}$$

$$\pi_{i2} = \frac{1}{4}\frac{L}{\gamma}\left(A_{i0} + a_i - \frac{\eta N(\overline{A}_2 - \overline{p}_2)}{\gamma + \eta N} - c\right)^2 - i_i(a_i)(1 + r_l). \tag{3.13}$$

An increase in technology that allows firms to produce higher good quality leads to a rise in the quantity sold that increases the prices that each firm can set and it leads to the rise of associated markups. This occurs because higher quality increases consumers' wiliness to pay shifting demand upward, thereby increasing equilibrium price and quantity sold. Increased equilibrium price, without incurring at higher marginal cost allow firms to charge higher markups. However, profits do not always increase monotonically with technology. While profits benefit from the ability to charge a higher price, enhancing technology incurs additional costs. Consequently, the fixed costs of technological investment may offset the potential gains from higher pricing, thus influencing overall profitability. The average level of technology negatively influences equilibrium variables. A firm producing with a technology level that is below the average faces lower demand, which in turn reduces the maximum price consumers are willing to pay for its product. This dynamic implies that firms with lower quality sell less good and a lower price compared to the others with a quality higher than the average.

3.1.2.3 Firms' problem at time 1

At time 1, firms choose the produced quantities that maximizes their profits and the level of investment that maximize the profit at time 2. Firms can only borrow a fraction of generated cash flow at time 1. The problem faced by firms at time 1 is

$$\max_{q_{i1}, i_i} \quad q_{i1}p_{i1} - cq_{i1} + \pi_{i2} \tag{3.14}$$

$$\text{s. to}$$

$$i_i \leq \lambda\, cf_{i1} \tag{3.15}$$

$$a_i = \frac{1}{b} i_i^{\theta} \tag{3.16}$$

$$\pi_{i2} = \frac{1}{4}\frac{L}{\gamma}\left(A_0 + a_i - \frac{\eta N(\overline{A}_2 - \overline{p}_2)}{\gamma + \eta N} - c\right)^2 - i_i(1 + r_l). \tag{3.17}$$

where $\theta \in (0, 1)$ represent the elasticity of technology with respect to investment and b is a weight parameter. By substituting equations (3.16) (3.17) into the objective function, the maximization problem can be reformulated as:

$$\max_{q_{i1},i_i} \quad q_{i1}p_{i1} - cq_{i1} + \frac{1}{4}\frac{L}{\gamma}\left(A_0 + \frac{1}{b}i_i^{\theta} - \frac{\eta N(\overline{A}_2 - \overline{p}_2)}{\gamma + \eta N} - c\right)^2 - i_i(1 + r_l) \tag{3.18}$$

$$\text{s. to}$$

$$i_i \leq \lambda\,(p_{i1}q_{i1} - cq_{i1}). \tag{3.19}$$

The Lagrangian associated with the previous problem is

$$\mathcal{L} = p_{i1}q_{i1} - cq_{i1} + \frac{1}{4}\frac{L}{\gamma}\left(A_0 + \frac{1}{b}i_i^{\theta} - \frac{\eta N(\overline{A}_2 - \overline{p}_2)}{\gamma + \eta N} - c\right)^2 - i_i(1+r_l) + \psi_i\left(i_i - \lambda p_{i1}q_{i1} + \lambda c q_{i1}\right). \tag{3.20}$$

The FOCs are

$$\frac{\partial \mathcal{L}}{\partial q_{i1}} = \frac{\partial p_{i1}}{\partial q_{i1}}q_{i1} + p_{i1} - c - \lambda\psi_i\left(\frac{\partial p_{i1}}{\partial q_{i1}}q_{i1} + p_{i1} - c\right) = 0 \tag{3.21}$$

$$\frac{\partial \mathcal{L}}{\partial i_i} = \frac{1}{2}\frac{L}{\gamma}\left(A_0 + \frac{1}{b}i_i^{\theta} - \frac{\eta N(\overline{A}_2 - \overline{p}_2)}{\gamma + \eta N} - c\right)\frac{\theta}{b}i_i^{\theta-1} - (1 + r_l) + \psi_i = 0 \tag{3.22}$$

$$\psi_i\left(i_i - \lambda p_{i1}q_{i1} + \lambda c q_{i1}\right) = 0. \tag{3.23}$$

where ψ_i is the Lagrange multiplier associated with the problem. Since equation (3.21), the decision of how much to produce and the resulting profits are independent of the firm's investment choice. The quantity supplied depends only on the quality assigned to each firm. By using the demand in period one and solving the problem, we obtain the following results

$$q_{i1} = \frac{1}{2}\frac{L}{\gamma}\left(A_0 - \frac{\eta N(\overline{A}_1 - \overline{p}_1)}{\gamma + \eta N} - c\right); \tag{3.24}$$

$$p_{i1} = \frac{1}{2}\left(A_0 - \frac{\eta N(\overline{A}_1 - \overline{p}_1)}{\gamma + \eta N} + c\right); \tag{3.25}$$

$$\mu_{i1} = \frac{1}{2}\left(A_0 - \frac{\eta N(\overline{A}_1 - \overline{p}_1)}{\gamma + \eta N} - c\right); \tag{3.26}$$

$$\pi_{i1} = \frac{1}{4}\frac{L}{\gamma}\left(A_0 - \frac{\eta N(\overline{A}_1 - \overline{p}_1)}{\gamma + \eta N} - c\right)^2. \tag{3.27}$$

In this context, higher endowed technology has only a positive effect on the equilibrium variables. An increase in quality at time one enhances consumers' willingness to pay for a given good, allowing firms to set a higher price and leading to a greater quantity produced and sold. This results in a positive effect on both profits and markups. By solving the investment problem in technology, we find that for the constrained firms, equation (3.15) is satisfied as an equality. Substituting the equilibrium value of profit at time 1 into the equation (3.15), we obtain that the level of investment for a constrained firm

$$i_i^c = \frac{\lambda L}{4\gamma}(A_0 - \frac{\eta N(\overline{A}_1 - \overline{p}_1)}{\gamma + \eta N} - c)^2. \tag{3.28}$$

For constrained firms, the optimal level of investment is directly linked to the technology used in the production. This is because a constrained firm is unable to invest

optimally; it will invest only up to the point where its budget constraint becomes binding. Higher technology leads to an outward shift in the demand curve, which, in turn, increases equilibrium profits. This results in a reduction in the pressure of the budget constraint, thereby enhancing the firm's capacity to invest further. Firms that are not constrained will invest until the first derivative of their profits equals zero. Due to the nonlinear nature of the equation, an analytical solution is not possible in this case, and the problem must be solved numerically. The optimal investment condition for an unconstrained firm is given by

$$\frac{1}{2}\frac{L}{\gamma}\left(A_0 + \frac{1}{b}i_i^{u^\theta} - \frac{\eta N(\overline{A}_2 - \overline{p}_2)}{\gamma + \eta N} - c\right)\frac{\theta}{b}i_i^{u^{\theta-1}} = (1 + r_l). \tag{3.29}$$

The left-hand side of this expression represents the marginal return of one unit of investment on profits, while the right-hand side represents the cost of credit. For a financially constrained firm, the right-hand side is lower than the left-hand side, indicating that the firm is unable to invest optimally.

Unlike Melitz and Ottaviano (2008) , in our model firm first see the technology they have and then decide to enter by paying the cost of entry. Consequently we assume that firms enter in order of productivity until the last entrant has zero profits.

3.1.3 Theoretical mechanism

After observing their quality shock, firms must decide whether or not to enter the market. The decision to enter into the market is intrinsically tied to each firm's product quality level. Only high-quality firms—those capable of covering the fixed costs of entry—will choose to enter and produce. Firms that experience more favorable shocks, those borne with a higher technological endowment, can produce higher-quality goods and sell at higher prices. Consequently, high technology acts as a strategic asset, providing significant competitive advantages that allow firms to charge higher markups and invest more at time 1, in order to have even better technology at time 2.

This dynamic creates a virtuous cycle: firms that are able to produce higher quality goods, because they are endowed with better technology, can further invest and are able to produce even better quality in the future. Greater investment enhances consumer willingness to pay, ultimately increasing markups[8]. Figure (3.1) illustrates the dynamics between investments and market power, emphasizing how these variables interact in this economic framework. The relationship between firm-level investment and market power highlights the influence of financial mechanisms on competitive dynamics in the market.

[8]The first derivative of markups at time 1 is positive with respect to investment.

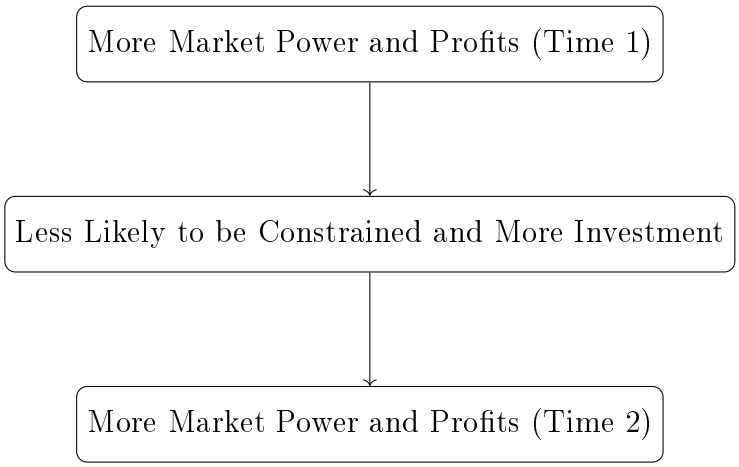


Figure 3.1: This figure illustrates the theoretical interaction between financial frictions and market power.

Although the relationship between investment and market power is perfectly clear, the relationship between financial frictions and market power is not. On one hand, the reduction of financial constraints allows individual firms to optimize their investment levels, which, in theory, should lead to an increase in aggregate market power by enhancing the capabilities of existing firms. On the other hand, there are complex general equilibrium effects that must be considered, which may mitigate or even reverse these outcomes. The fist derivative or markup of firm i at time 2 is

$$\frac{\partial \mu_{i2}}{\partial \lambda} = \frac{1}{2}\left(\frac{\partial A_{i2}}{\partial \lambda} - \eta \frac{\gamma \frac{\partial N}{\partial \lambda}(\overline{A_2} - \overline{p}_2) + N(\gamma + \eta N)\frac{\partial(\overline{A_2} - \overline{p}_2)}{\partial \lambda}}{(\gamma + \eta N)^2}\right). \tag{3.30}$$

From this equation, it becomes evident that there three primary channels through which financial frictions interact with market power. First, a decrease in financial frictions increases investments, as it allows firms to access funds more easily, thereby optimizing their endowed technology and enhancing quality. This increased level of investment, in turn, have a positive effect on firm's markups. However, this effect could be moderated or offset by other general equilibrium responses that a reduction in financial frictions might generate.

The two main general equilibrium channels are: (1) the entry of new firms into the market and (2) changes in the difference between average quality and price. A reduction in financial frictions could lower barriers to entry, allowing new competitors to enter the market. These new entrants introduce competitive pressures, which may drive down the average markup, thereby reducing the market power of existing firms. This increase in market competition, through the entry of new firms, could be beneficial for consumers, leading to lower prices and increased product quality.

At the same time, the interaction between technology levels and prices might play a crucial role. Specifically, the key measure here is the difference between the average technology stock and the average price. The effect of this channel is difficult to identify since a reduction in financial frictions results in both an increase in the stock of technology and, on the other hand, an increase in prices making it problematic to understand, at least theoretically, the direction of this effect.

In summary, the model tells us that, if the reduction in financial frictions is accompanied by an increase in the number of firms entering the market, this generally

might have positive effects on the economy, as it diminishes the overall market power held by incumbent firms. The resulting competition might encourage firms to adopt newer technologies and increase the quality of their good, ultimately benefiting consumers through lower prices and better products.

Conversely, if a reduction in financial frictions leads to an increase in market power without a corresponding rise in new firm entry, then the benefits are likely concentrated among the incumbent firms. In such a scenario, reduced financial frictions allow these firms to invest more and increase their market power. This concentration of market power could potentially lead to higher prices for consumers, reduced incentives for innovation, and a less competitive market overall.

To better understand the interaction of these mechanisms and assess their net effects, we will solve the model numerically in the next section. By using numerical methods, we aim to capture the complex interplay between reduced financial frictions, investment levels, firm entry, and market power, providing a more nuanced perspective on how financial policies impact economic outcomes at both the micro and macro levels.

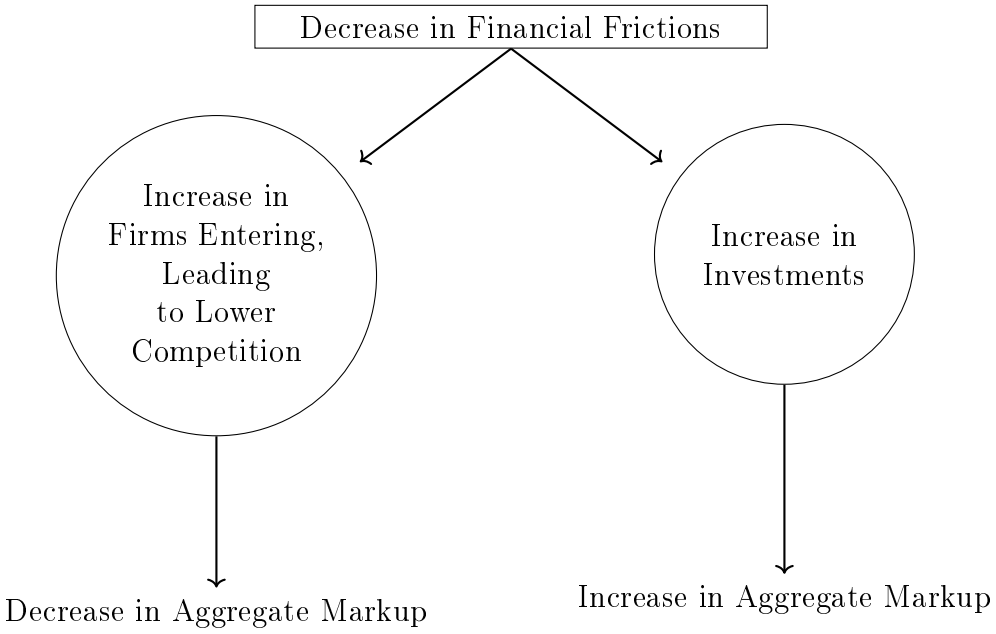


Figure 3.2: Effects of Decreasing Financial Frictions

3.2 Numerical solution

Given the model's complexity, a complete analytical characterization is infeasible. Therefore, in this section, we present a numerical solution to the proposed model. The numerical solution is based on the following strategy.

Each firm receives a productivity shock at time 1, which determines its production technology and quality level. To simplify, we assume these shocks are drawn from a uniform distribution with bounds $[\underline{a}, \overline{a}]$. Following the realization of these shocks, firms sequentially enter the market until the profit of the marginal entrant is driven to zero.

During market entry, we hypothesize initial values for average aggregate quality and average prices. These values are then iteratively updated until convergence is achieved.

Regarding parameter calibration, we follow the strategy described below. In our model, the parameters γ and η represent, respectively, the love of variety and the elasticity of substitution across varieties. Concerning the elasticity of substitution, several studies estimate it. For example, Hobijn and Nechio (2019) estimate a value between 1 and 3, so it seems reasonable to set this elasticity equal to 2.

While many studies estimate the elasticity of substitution, to the best of our knowledge no paper has directly estimated the value of the love-of-variety parameter. Estimation from the literature are derived from a CES framework that links this parameter to the elasticity of substitution. For example, Corsetti et al. (2007) hypothesize a value for the love of variety ranging between 1.01 and 3. In the CES function of Dixit and Stiglitz (1977), the love-of-variety parameter is given by $\frac{\eta}{\eta-1}$. Thus, calibrating η to 2 implies a value of $\gamma = 2$. However, in our case, we want a different elasticity and we set a lower value for the love-of-variety parameter by choosing $\gamma = 1.5$.

For the calibration of λ, we use the value provided by Drechsel (2023) and set it equal to 4.58. For the parameters θ and b, we set $\theta = 0.03$ and $b = 1.5$. The goal of this calibration is to create a pool of firms that includes both constrained and unconstrained firms. Note that the purpose of this calibration is not to match any aggregate data but to illustrate the properties of the model. In future versions of the model, it will be implemented to match aggregate data.

Parameter	Description	Value
γ	Differentiation	1.5
η	Sustainability across varieties	2
λ	Max ratio of debt to cash flow	4.58
R_L	Interest rate on loans	1.1
θ	Elasticity of investment	0.03
L	Total labor force	100
c	Marginal cost	1
a_{low}	Lower bound of technological shock	0
a_{up}	Upper bound of technological shock	4
f_E	Fixed entry cost	2
b	Investment weight parameter	1.5
max_{firms}	Potential entrants	1000

Table 3.1: Parameter Calibration for Model

3.2.1 Equilibrium: Market power, Investment and Technology

Once they have entered, firms decide how much to invest. A larger quality shock leads to a higher level of aggregate production and increased profits. As a result, firms with superior technology can achieve higher profits and greater margins while also facing a lower probability of being financially constrained.

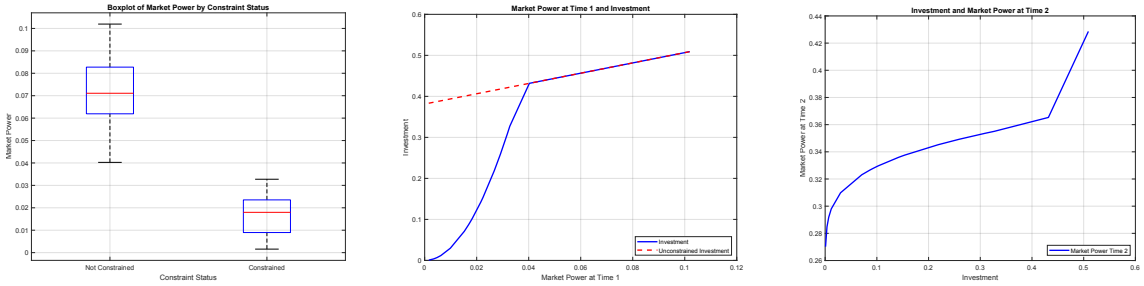
Figure (3.3a) shows the relationship between constrained and unconstrained classes and their respective market power. Firms facing constraints tend to have lower market power, which is closely linked to their initial technological endowment. Firms with greater technological endowment have higher profits in the first period and, consequently, tend to be less constrained.

A higher level of market power affects a firm's investment level by influencing its financial constraints. Figure (3.3b) illustrates the relationship between market power in the first period and the corresponding level of investment. The solid line represents the change in investment as market power increases, while the dashed line represents the investment each firm would have made if it were not constrained[9]. Constrained firms show a more than proportional increase in investments as market power grows. In contrast, for unconstrained firms, the relationship between market power and investment is linear.

The dashed line in the figure represents the optimal level of investment that would be made if the firm were not constrained. For constrained firms, this line consistently lies above the actual investment level, indicating an aggregate loss in investment due to financial frictions. The inability of these firms to invest optimally has significant implications for the second period, as it reduces their ability to produce at higher quality and subsequently diminishes their market power.

As shown in Figure (3.3c), there is a positive relationship between market power in the second period and investments. Firms with a lower level of technology face weaker individual demand, which reduces their profits and markups. This numerical resolution confirms the partial equilibrium results that emerged from the model: a higher level of market power enables firms to invest more, which subsequently grants them greater market power in the following period.

Investment also has an impact on the distribution of markups. From the first period to the second, both the mean and variance of market power increase. While the increase in mean is due to a static effect of firms having better technology, this also results in increased dispersion. Financial frictions and investments, therefore, produce a dispersion in market power that tends to shift towards the tails. Constrained firms are firms that underinvest, resulting in an inability to gain market power over time. In contrast, firms that can invest without constraints do so optimally, allowing them to allocate more resources and gain more market power.



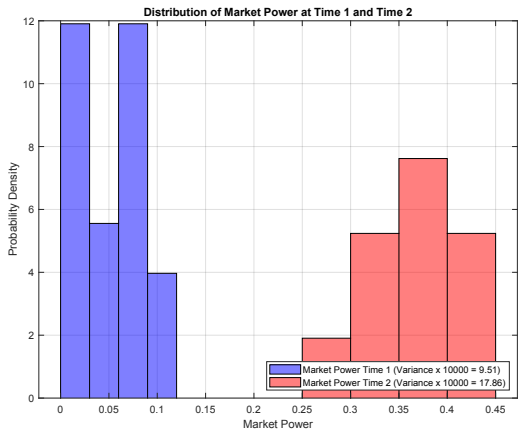
(a) Market Power and Constraint Status.

(b) Market Power at Time 1 and Investment.

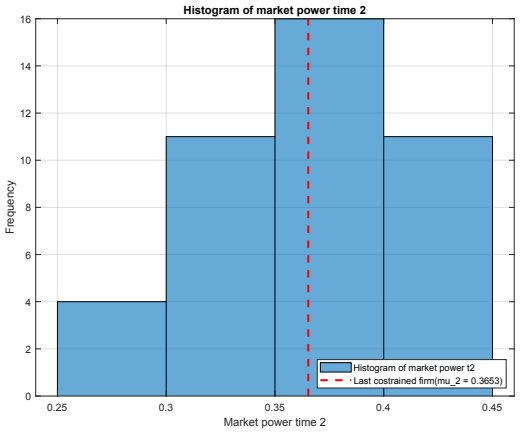
(c) Investment and Market Power at Time 2.

Figure 3.3: Combined Graphs Showing Market Power Analysis and Investment Relations.

[9]We did the same analysis by keeping the number of firms in the market fixed without financial frictions, and the qualitative results remained the same.



(a) Distribution of Market Power at Time 1 and Time 2.



(b) Histogram of μ_2 with Vertical Line at Last Unconstrained Firm.

Figure 3.4: Analysis of Market Power Distribution and Unconstrained Firms.

3.3 Interaction between market power and financial frictions

In this section, we explore the impact of financial frictions on market power. Relaxing financial frictions, as previously discussed, leads to a decrease in financial pressure on firms, which allows them to make more investments. This increase in investment capacity translates directly into a rise in average investment.

From Figure (3.6), we observe that as financial frictions—represented by λ—are reduced, there is a steady increase in average investments. As λ increases from 1 to 10, average investments rise from approximately 0.2 to over 0.4. This indicates that lower levels of financial friction allow firms to allocate more resources to investment, suggesting that access to capital and reduced financial constraints allow firms to improve their market position, which in aggregate result in an increase in average market power. Furthermore, when examining Figure (3.6), specifically the number of constrained firms as a function of λ, we see a clear decline in the number of constrained firms as financial frictions decrease. Initially, at higher λ values, around 40 firms are financially constrained. However, as λ is reduced, the number of financially constrained firms falls to below 20.

However, despite these positive outcomes in terms of investment and number of costrained firms, Figure (3.6) also shows that reducing financial frictions does not lead to a significant increase in market entry by new firms. Throughout the different λ values, the number of new entrants remains constant at 49 firms. This suggests that while established firms benefit from the reduction in financial frictions through increased investments, these conditions do not significantly impact the decision of new firms to enter the market.

The impact of relaxing financial frictions is also evident in the evolution of markup statistics, which provides insights into the distribution of market power among firms. From Figure (3.7), it is evident that as financial frictions decrease, both the average and median markups increase. For instance, in Period 2, the mean markup gradually increases with lower λ values, indicating that firms are gaining more market power. Similarly, the median markup shows a consistent rise, reflecting that, on average, firms across the market are benefiting from reduction of financial

frictions.

Another important observation comes from the variance plots in Figure (3.7). In Period 2, the variance in markups declines as financial frictions decrease. This reduction in variance suggests a convergence in the level of market power among firms, meaning that firms become more homogeneous in terms of market power. Reduced financial frictions lead to a leveling effect, where previously constrained firms can catch up to their more financially robust counterparts, resulting in a more even distribution of market power. Although there is a reduction in the average dispersion of market power, all firms are homogeneous but with greater market power .

The Figure (3.5) further reinforces these findings. The distribution of markups in the first period remains constant, regardless of changes in financial frictions. However, in the second period, the markup distribution shifts to the right as λ decreases, signifying increased market power for most firms. This rightward shift, combined with the decreasing variance, implies that firms are benefiting from reduced financial frictions by increasing their market power, but also they become more similar in terms of their pricing power.

Obviously, the results also indicate that the first period is unaffected by the intensity of financial frictions, with average, median, and variance values remaining constant across different levels of λ.

3.3.1 Entry Channel and Financial Frictions

In this subsection, we introduce a new parametrization to facilitate the entry of new firms into the market[10], enabling us to examine the entry channel more effectively. Specifically, we increase the elasticity of investment returns by setting $\theta = 0.33$ and expand the number of potential entrants to 1,000. Under these conditions, investment returns become sufficiently high and, consequently, as financial frictions diminish, the market environment becomes more profitable, encouraging new firms to enter.

To evaluate the impact of these new entrants on the market, we conduct two types of simulations. The first simulation follows the analysis previously conducted, while the second keeps the number of firms fixed, allowing to enter only at those firms that entered in the prior iteration with a lower λ level. This approach enables us to compare the overall and partial effects of firm entry on market outcomes and isolates the economic effects generated by new market participants.

The figures (3.8) and (3.9) illustrate the effects observed, now showing both the total and partial effects of reduced financial frictions. The red line represents the fixed-firm model, excluding the entry channel. In the first period, reducing financial frictions has an immediate effect: fewer frictions combined with increased elasticity of returns make it more profitable for firms to produce and invest. Consequently, this higher profitability attracts more firms to enter the market, driving down first-period profits. As a result, both average and median markups decline, while the variance among markups increases due to greater competition among firms.

In the second period, however, the reduction in financial frictions leads to an increase in both average and median markup power. Notably, this positive effect is

[10]Using the previous parametrization we do not have entry into the model.

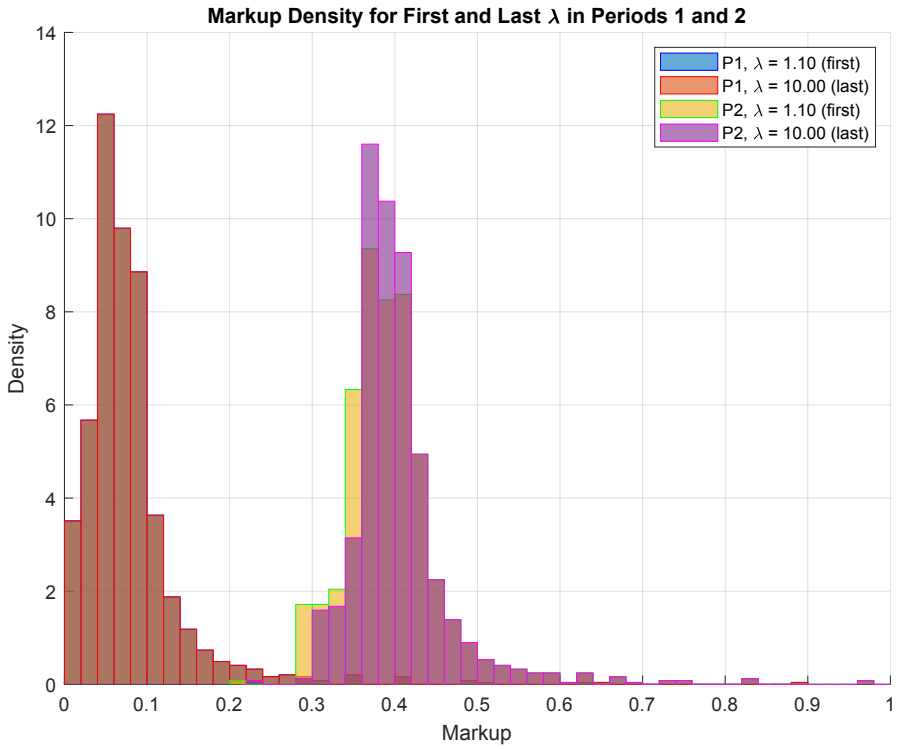


Figure 3.5: Markup Density for First and Last λ in Periods 1 and 2. This figure shows the density distributions for both periods, for the first and last values of λ.

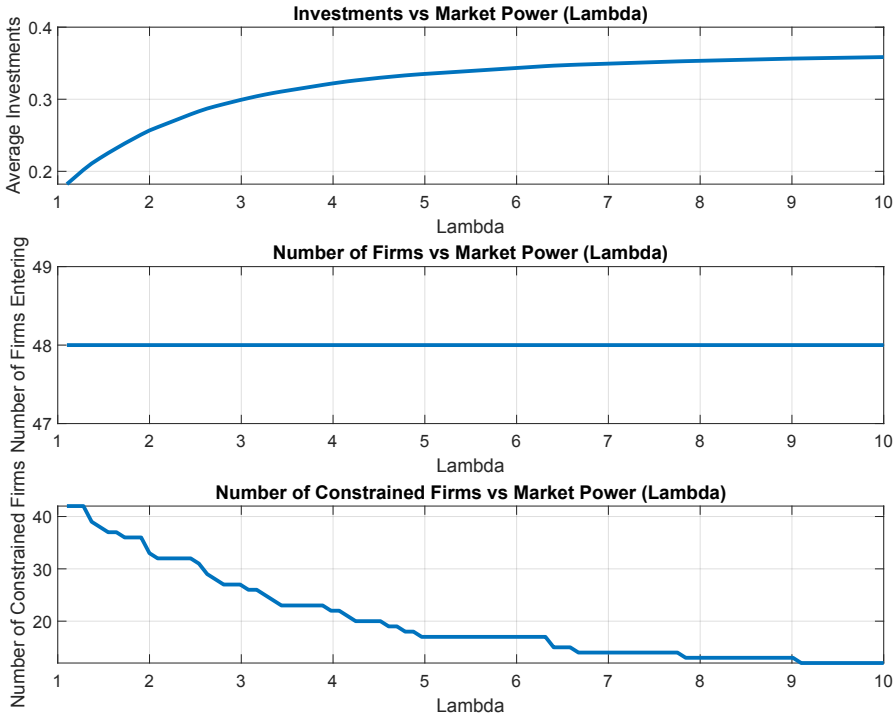


Figure 3.6: Investments vs Market Power. The plots show average investments, the number of firms entering, and the number of constrained firms as a function of λ.

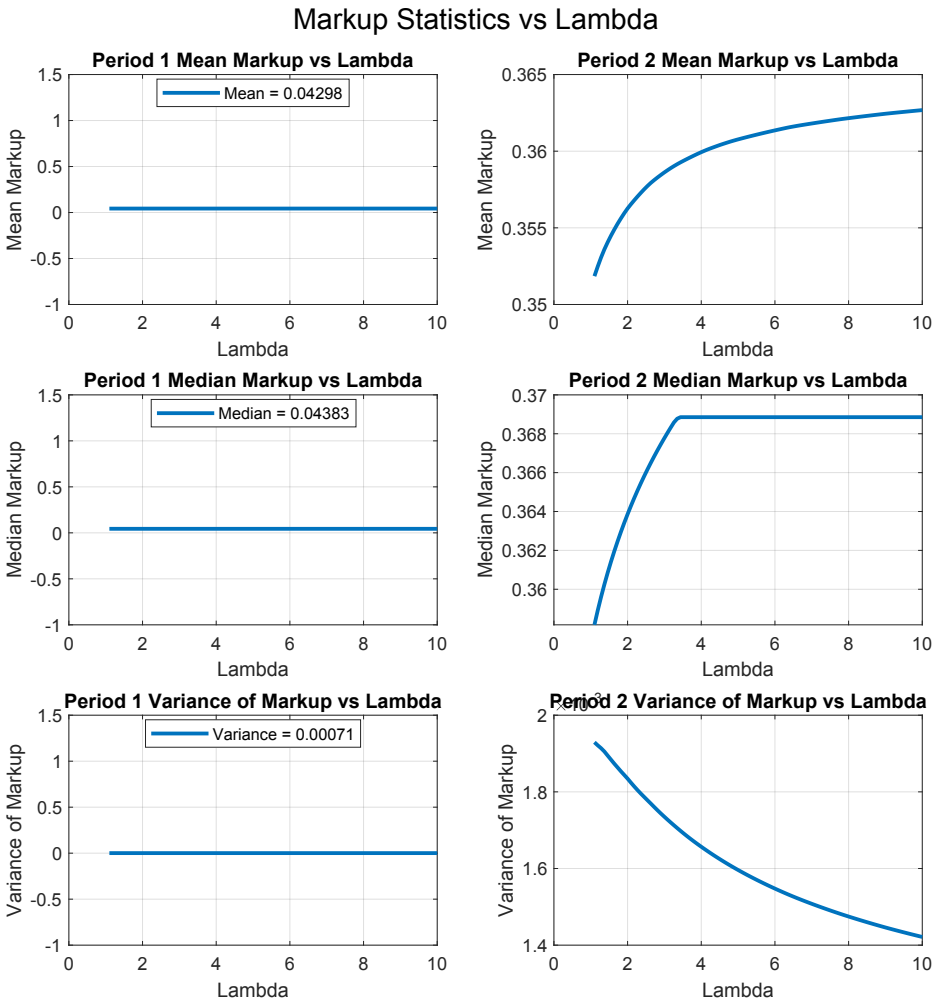


Figure 3.7: Subplots display the mean, median, and variance of markups as a function of λ for both periods.

largely driven by partial equilibrium effect, since markups levels is higher in the fixed-firm scenario. Although reduced financial frictions increase the number of competing firms in the standard model, this effect is offset by higher investment, which enables firms to raise their markups. In both models, investment levels increase with λ; however, the investment levels in the fixed-firm scenario remain consistently higher, indicating that entry negative impact on aggregate markup.

3.4 A Tentative dynamic quantitative model

In this section, we aim to outline how our model might be extended into a dynamic framework that, opportunely enriched, could be used to assess the quantitative relevance of the link between financial frictions and market power in determining the observed evolution of markups. We want to be very clear that, at present, the model is not rich enough to be applied in that sense, and what follows is only a tentative methodological description of the baseline logic one could use to extend the static model into a dynamic framework.

Assume that the economy is a sequence of two-period economies, each being the same as the one analyzed in the static model we presented. Agents, i.e., firms, consumers, and banks, live for only two periods before being replaced by a new generation[11]. This new generation inherits the stock of technology from the previous generation. Specifically, we assume that the distribution from which economic shocks are drawn is the stock resulting from past investment activity by previous generations of firms. In other words, the economy starts with an exogenous distribution of technology shocks at time zero, and then, in every two periods, there will be a new distribution of shocks resulting from the combination of the initial distribution and the investment undertaken by each firm. Specifically, if firm i inherits a technology $A_{i,t}$, after it dies, it will leave a technology $A_{i,t+2} = A_{i,t} + a_{i,t}$ to future generations, where $a_{i,t}$ is the result of the investment in technology undertaken by that firm. Each new generation inherits a distribution of technology for free, as a public good, exactly as suggested by the growth literature. This approach simplifies the complexity of the economic problem, effectively making each period independent of future periods and allowing us to analyze each generation independently.

To give an idea of how the model behaves over time, we present a graph illustrating the evolution of the model across 50 consecutive time steps (Figure 3.10). The results show that market power tends to increase over time, reflecting a potential cumulative effect. However, this increase could be misleading due to the static assumptions regarding marginal and fixed costs, which are kept constant in our current formulation.

In the present model, firms face neither decreasing marginal costs nor changes in fixed costs relative to technology advancements. Once firms enter the market, their only incentive is to continue investing since marginal costs do not decline with technological improvements. This static structure could potentially result in an unrealistic accumulation of market power over time, as technological advantages do not translate into decreasing costs.

To overcome this limitation, one possible modification could be to link the fixed

[11]Notice that we do not have overlapping generations. Each generation of agents lives for two periods, and when such a generation dies, a new generation is born

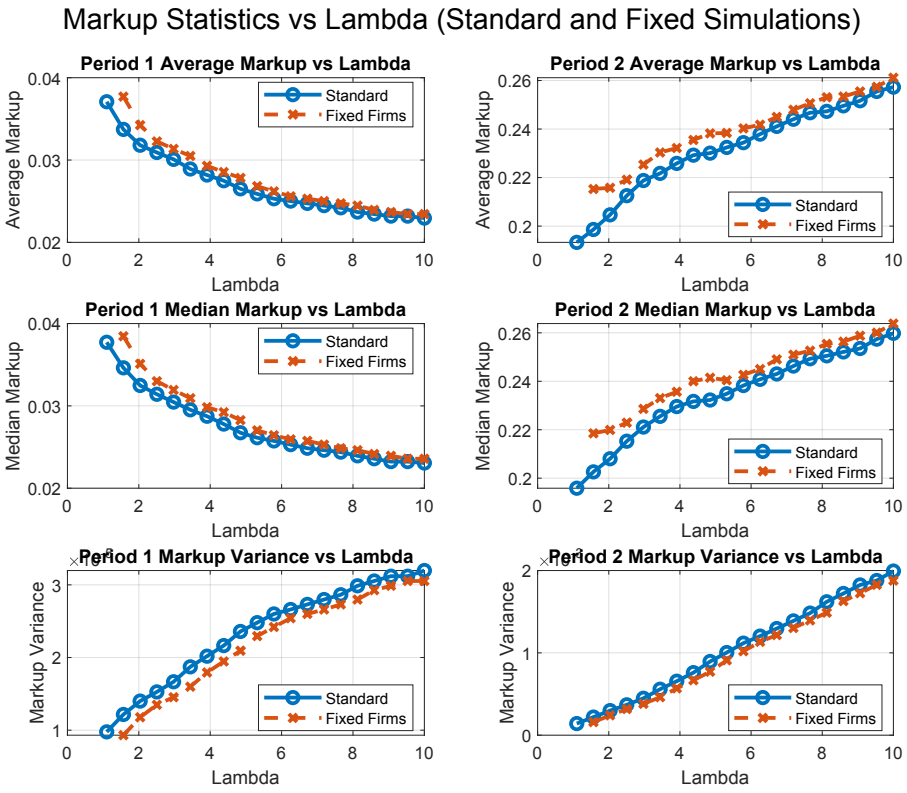


Figure 3.8: Relationship between average, median, and variance of markup and λ. The red line represents the model without the entry channel, highlighting the effect of reduced financial frictions in the first period, where increased profitability leads to greater market entry and competitive pressure.

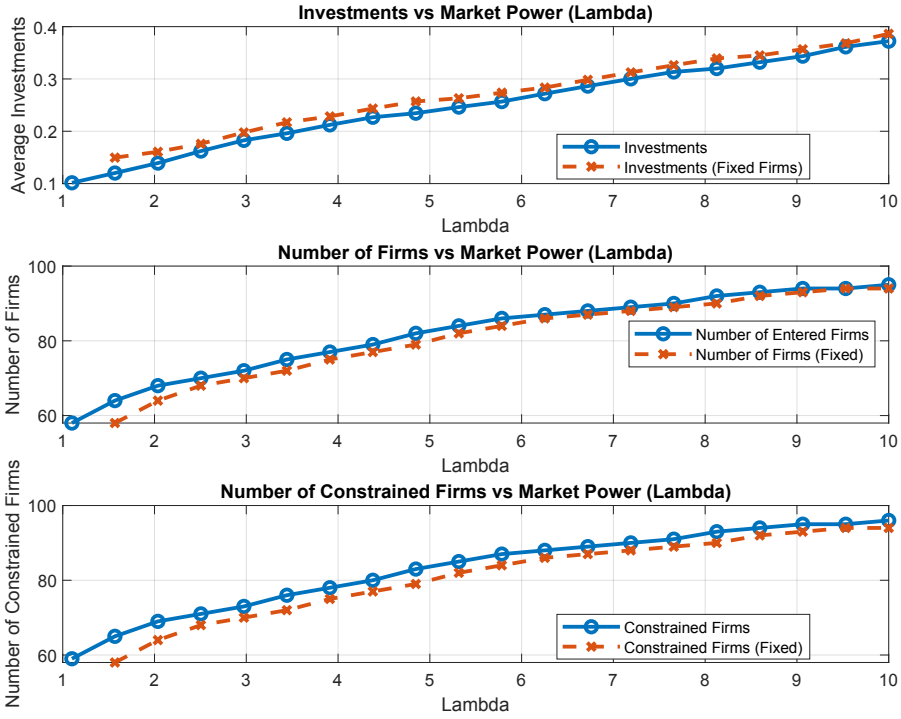


Figure 3.9: Investments and number of firms as a function of λ. Reduced financial frictions lead to an increase in the number of entering firms, which reduces first-period profits, while increased investment levels are sustained in the fixed-firm scenario.

entry costs to the inherited level of technology. Economically, this means that although technology is inherited, acquiring and implementing it would still have an associated cost, and this cost would be directly proportional to the level of technology itself. Such an adjustment could reflect the realistic expense of adopting advanced technology, thereby introducing a meaningful dynamic component to the model that discourages the unrestrained accumulation of market power through inherited advantages.

Additionally, this extended version of the model could be used to analyze the relationship between economic growth, financial frictions, and market power. It could provide insights into how changes in financial accessibility over time influence the market structure. For instance, a reduction in financial frictions, without adequate entry of new firms, could increase market power concentration, ultimately resulting in greater inequality and potentially causing an overall welfare loss for society.

Incorporating these dynamic elements could improve the model's realism, allowing us to simulate long-term effects and better understand the interaction between technological evolution, market power, financial constraints and economic welfare.

3.5 Empirical evidence

In this section we aim to test empirically the correlations between financial frictions and market power. In particular we want to test the partial equilibrium channel. In order to so we need both a financial friction indicator and a market power indicator.

Identifying a firm's financial frictions indicator is very challenging [12]. In the literature, as far as I know, there are two different ways to identify firms' specific financial frictions indicator. The first is the so-called theoretical method, in which constrained firms are identified using a structural model(Kaplan and Zingales (1997); Whited and Wu (2006); Caggese and Mesters (2023)). The problem with this approach is that it is difficult to identify a financial variable that is uniquely related to the all types of financial constraints to which a firm may be subjected[13]. Consider leverage, for example. Highly leveraged firms could be constrained or unconstrained, depending on the interpretation of financial frictions. High leverage could mean that firms are close to the debt limit or that firms have that amount of leverage because they can borrow so much, since they are not constrained. Using this approach it is difficult to identify an indicator that unequivocally identifies financially constrained firms for a broadly sample.

Another way to identify firms' financial frictions is to use a narrative indicator (Hadlock and Pierce (2010); Hoberg and Maksimovic (2015); Buehlmaier and Whited (2018)). In most countries it is also mandatory to provide a narrative document that provides information on the financial health of enterprises. This approach makes it possible to identify, through text analysis, keywords that may signal the presence and degree of financial frictions. The challenge with this approach is that comparing firms from different countries is complicated, and regulations on the information firms are required to disclose can change over time.

[12] See Farre-Mensa and Ljungqvist (2016)

[13] A firm may be constraint on its assets or on its profits or it may not be constraint but have to pay a higher interest rate. See Brunnermeier et al. (2012) for a complete survey.

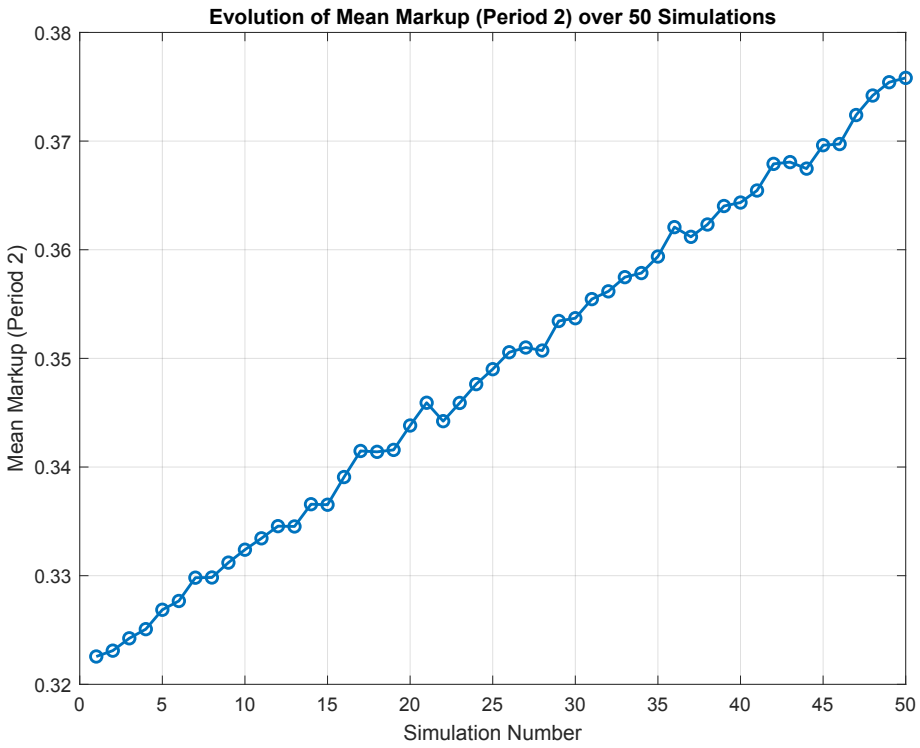


Figure 3.10: Evolution of Mean Markup (Period 2). The plot illustrates the progression of the mean markup in period 2 across multiple simulations.

For our research we use the narrative indicators provided by Hoberg and Maksimovic (2015). Using automatic textual analysis, they analyze the 10-K reports of public companies in the "Liquidity and Capital Resources" section. They investigate whether firms delay investment due to liquidity problems and try to understand how firms intend to solve these liquidity problems. Then, using cosine-like similarity, they develop four cardinal indicators that indicate the probability for a specific firm to be constrained. They provide four indicators:

- **delaycon**: A higher level of this indicator indicates a higher probability that firms will postpone an investment due to liquidity issues.
- **debtdelaycon**: Similar to the previous indicator, but it also indicates the probability that firms will address these liquidity issues by issuing debt.
- **equitydelaycon**: Similar to the previous one, but firms will issue equity to resolve liquidity problems.
- **privdelaycon**: Similar to the previous one, but firms will opt for private placements to address liquidity problems.

The most appropriate indicator for our analysis would be **equitydelaycon**. Caggese and Mesters (2023) argue that this indicator likely identifies financially constrained firms, as equity issuance is generally more costly than debt (pecking order theory). Additionally, interest on debt is usually tax-deductible, so firms with liquidity issues that can still issue debt may not be financially constrained, given their ability to access debt financing.

In order to estimate firms' markup we use the same approach proposed by Loecker and Warzynski (2012). The firms' markups is

$$\mu_{it} = \theta_{it}^{v} \frac{p_{it} Q_{it}}{p_{it}^{V} V_{it}} \tag{3.31}$$

where θ_{it}^{v} is the output elasticity of input variables for firm i at time t, $p_{it}Q_{it}$ represents the revenues and $p_{it}^{V}V_{it}$ is the cost of input variables. One of the most challenging problems in markup estimation is determining the correct output elasticity. We use three different measure of it. One is constant and following De Loecker et al. (2020) we set its value equal to 0.85, the second one comes from the so-called production function estimation and we use the values provide in De Loecker et al. (2020), and the last one is the so-called cost-share approach. This approach is less time-consuming, and De Loecker et al. (2020) have shown that it produces results similar to those obtained through parametric estimation of the production function. Using this approach we obtain the output elasticity in the following way. Let

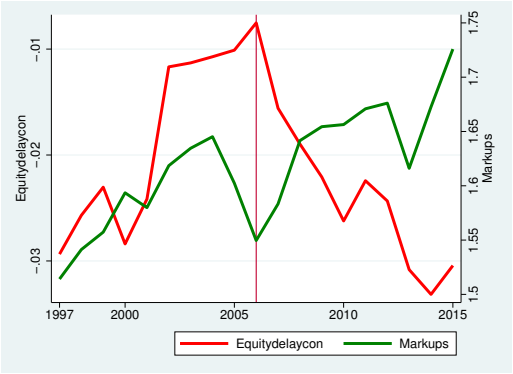
$$\alpha_{vt} = \frac{p^{V} V}{p^{V} V + rK + p^{X} X} \tag{3.32}$$

where V represents the variable input, K represents capital, X represents other inputs (such as overhead costs in our model), and p^{v}, r, and p^{X} represent the respective costs of all inputs. For each sector, we define θ_{it}^{v} as the median of $\theta_{it}^{v} = \textbf{median}\ \{\alpha_{vt}\}$.

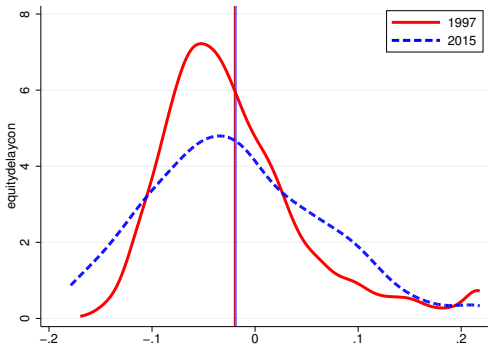
3.5.1 Data collecting

We collect firms' fundamental data from Compustat. For data on financial frictions, we use the database of Hoberg and Maksimovic (2015), available on his website[14]. The dataset provides the narrative indicators of financial frictions ranging from 1997 to 2015. With this dataset, it is possible to align these indicators with the fundamental data collected in Compustat. To estimate markups, we use the following cost components: for the cost of variable inputs (p^V), we use the cost of goods sold ($COGS$); for the cost of capital (rK), we use data provided by De Loecker et al. (2020); and for the cost of other fixed inputs (p^X), we use $SG\&A$. Notice that in the model $SG\&A$ represents the overhead fixed cost.

We conducted our data cleaning following the same procedure as De Loecker et al. (2020). After completing the cleaning process, we obtained a dataset with 115,531 observations. It's worth noting that only 65,361 observations were present in the dataset provided by Hoberg and Maksimovic (2015), which accounts for approximately 56% of our sample. For our analysis, we drop those observations for which we do have the index constraint observation and we consider only manufactory sector (Naics:31-33). In addition, following Caggese and Mesters (2023), we exclude all firms that are not present in our database for at least three periods and those with fewer than 20 employees.



(a) Time series of US aggregate markup and equitydelaycon



(b) Distribution of equitydelaycon

Figure (3.11a) shows a graphical representation of the estimated aggregate markups together with the time series of the aggregate financial constraint index. To generate this aggregate view, we use sales as the weighting factor for both the markups and the financial constraint index. The graph reveals an interesting pattern: until 2004-2007, there appears to be a positive correlation between aggregate markups and the aggregate equitydelaycon index. However, after that date, there is a noticeable decline in equitydelaycon, despite aggregate markups continue to rise, signaling a possible negative correlation.

A possible economic interpretation could be that, during the first part of the time series (1997-2004), firms faced similar level of financial condition. This allowed firms with the ability to invest to enhance their market power at the expense of those that were unable to invest due to these financial constraints. As a result, the

[14] http://faculty.marshall.usc.edu/Gerard-Hoberg/MaxDataSite/index.html

market power of unconstrained firms increased, while that of constrained firms decreased, exacerbating the financial frictions faced by the latter. This dynamic may explain the observed rise in markups and the aggregate financial frictions index. This trend persisted until the financial crisis of 2007. After the crisis, firms that had been constrained for a long time were forced out of the market. The remaining firms were able to increase their profit margins due to reduced competition. As constrained firms exited, the firms that remained in the market were those with more market power and therefore subject to fewer financial constraints. These firms may have been able to invest more and increase their market power due to a reduction in competition and financial frictions. This might explain the fact that we observe that after this date the aggregate indicator of financial frictions decreases while aggregate markups increase.

Another noteworthy observation, which supports our hypothesis, concerns the evolution of the distribution of our financial constraint index over time. As shown in Figure (3.11b), we compare the distribution at the beginning of our sample period to that at the end. The distribution undergoes significant changes, flattening and shifting to the right, with the mean value increasing from -0.2 in 1997 to -0.18 in 2015, and the median value moving from -0.34 to -0.25. This shift suggests that, although the average value has remained relatively stable, a larger proportion of firms were less constrained in 1997 compared to 2015[15] as suggested by the increases of median value.

This result is consistent with our hypothesis. We observe that more firms are less constrained, but at the same time these are firms with greater market power. The result is an equilibrium driven by high market power firms.

To validate our hypothesis that firms exiting from the market after the 2007 crisis were those facing greater financial constraints, we developed an indicator to capture the history of a firm's financial constraints. First, we build an indicator, named "Constraint," defined as a binary variable that takes the value of one if a firm's financial constraints, measured by the *equitydelaycon* variable, are above the 75th percentile in a given year. This indicator effectively identifies whether a firm was constrained in year t. Next, we developed a second indicator, "Constraint History," designed to reflect the cumulative financial constraints experienced by a firm over time. This measure is constructed by summing the years in which the firm was classified as constrained according to the first indicator. "Constraint History" thus provides a historical perspective on a firm's financial condition, capturing persistent constraints throughout its operational history.

We then conducted a regression analysis using the "Constraint History" indicator to assess its relationship with firm exit from the market after financial crisis , where the dependent variable indicates whether a firm exited from the dataset. The results, presented in Table (3.2), reveal a strong and statistically significant correlation between a firm's history of financial constraints and its likelihood of exit, across various model specifications.

[15]It is important to recall that our financial friction index increases with the level of financial constraint: lower values indicate lower financial friction, while higher values correspond to higher financial frictions.

VARIABLES	**(1)**	**(2)**	**(3)**
Constraint history	0.0327***	0.0382***	0.0344***
	(0.0113)	(0.0110)	(0.0122)
Constant	-2.522***	-2.439***	-2.012***
	(0.200)	(0.170)	(0.129)
Year fixed effects	YES	NO	NO
Industry fixed effects	YES	YES	NO
Cluster id	YES	YES	YES
Observations	6,897	6,897	4,748

Robust standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Table 3.2: In this regression, the dependent variable is the firm's exit, while the independent variable is our indicator of financial frictions over time. As controls, we have used (current assets - short-term liabilities) / total assets, dividends / total assets, market value / total debt, sales / total assets, and operating income / total assets.

3.5.2 Market power and financial frictions

In this subsection, our purpose is to test one of the key results of our model. Specifically, we aim to test the hypothesis that firms with greater market power have a lower probability of being financially constrained. The baseline specification of the model is

$$equitydelaycon = \beta_1 + \beta_2 \mu_{it-1} + \beta_3 \mu_{it-1}^2 + \mathbf{fi}_x X_{it-1} + \epsilon_{it}, \tag{3.33}$$

where *equitydelaycon* represents the indicator of financial frictions for firm i at time t, μ_{it-1} is the logarithm of markup for firm i at time $t-1$ and X is a set of control variables, and ϵ_{it} is the error term. As control variables, we use the logarithm of fixed assets, leverage calculated as the ratio of short-term plus long-term debt to fixed assets, and labor productivity, measured as sales divided by the number of employees. Additionally, we include three dummy variables: one that takes value of 1 if a firm is in the bottom 25th percentile of the labor productivity distribution in period $t-1$, another that takes value of 1 if the firm is in the bottom 25th percentile of the fixed assets distribution at time t, and a final dummy that takes value of 1 if the firm is in the top quartile of the leverage distribution in period $t-1$. In order to mitigate the presence of possible outliers, we winsorize the 1st and 99th percentiles of their distribution for all variables. In all regression, we accounted for firm and industry year fixed effects and adjusted for standard errors clustered at firm's level to ensure the robustness of our results.

In Caggese and Mesters (2023), the authors highlight that, given the way that the financial frictions indicator that we have choosen is constructed, it primarily captures constraints on investments in physical capital. Following their approach, we conduct two types of analyses: one that includes all firms in our sample, and another that excludes firms that reduce their physical capital in a given year. For each of these two samples, we conduct three regressions using three different methods to

estimate markups. The difference among these methods lies in how we estimate output elasticity. Specifically, we use the cost-share approach, the production function estimation approach, and, finally, we keep elasticity constant at 0.85.

The tables (3.3) and (3.4) present the results of our regressions. We observe that a higher level of markup in the preceding period is correlated with a lower likelihood of being financially constrained across all three specifications of market power. These results remain significant even when we consider only firms that did not reduce their physical capital in a given year. These results align also with our theoretical model, which shows a positive relationship between market power and probability of being constrained. Our analysis also reveals a consistent negative correlation between leverage and financial constraints, suggesting that firms with lower financial frictions tend to have more capacity to take on debt compared to their more constrained counterparts. Additionally, higher levels of labor productivity are associated with a lower likelihood of being financially constrained, indicating that more productive firms are better equipped to avoid financial difficulties. These results are align with our model since we have that, firms with greater market power, resulting from a favorable technological draw, are able to incur more debt and invest more heavily. This implies that firms with superior technology are less subject to financial frictions and, at the same time, have higher levels of debt.

Moreover, when we tested the robustness of this effect across different sectoral definitions, we found that the relationship between market power and reduced financial constraints is significant in all sectoral specification if we consider the full sample and, it is significant under 2-digit classification if we consider only the reduced sample. In all cases, leverage and labor productivity are always significant.

In conclusion, while our findings suggest a significant correlation between higher market power and reduced financial frictions in subsequent periods, it is important to note that these results might not be interpreted as evidence of causality. The relationship between market power and financial frictions is likely influenced by reverse causality. Specifically, while greater market power is associated with fewer financial frictions in the future, as we have observed, it is also plausible that lower financial frictions allow firms to invest more, which in turn could lead to increased market power and further reductions in financial frictions.

VARIABLES	(1) cost-share equitydelaycon	(2) production function equitydelaycon	(3) constant equitydelaycon
log(markup)	-0.0111***	-0.0138**	-0.0134**
	(0.00422)	(0.00564)	(0.00586)
log(markup)^2	0.00333	0.00371	0.00321
	(0.00322)	(0.00334)	(0.00335)
log(Fix asset)	-0.00381**	-0.00382**	-0.00383**
	(0.00170)	(0.00170)	(0.00170)
leverage	-0.0115**	-0.0116**	-0.0116**
	(0.00477)	(0.00477)	(0.00477)
lab productivity	-1.39e-08***	-1.39e-08***	-1.39e-08***
	(4.85e-09)	(4.85e-09)	(4.86e-09)
low prod	0.00507	0.00506	0.00513*
	(0.00309)	(0.00310)	(0.00310)
high lev	-0.000139	-0.000122	-0.000130
	(0.00187)	(0.00187)	(0.00187)
low size	0.00966**	0.00966**	0.00964**
	(0.00422)	(0.00422)	(0.00422)
Constant	0.0180	0.0219	0.0221
	(0.0194)	(0.0195)	(0.0195)
Observations	23,541	23,541	23,541
R-squared	0.631	0.631	0.631

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table 3.3: Regressions using the full sample with different specifications of output elasticity. Specifically, to estimate the dependent variable markup, we use the cost-share approach in column 1, the production function approach in column 2, and a fixed output elasticity of 0.85 in column 3.

VARIABLES	(1) cost-share equitydelaycon	(2) production function equitydelaycon	(3) constant equitydelaycon
log(markup)	-0.0169**	-0.0239**	-0.0230**
	(0.00832)	(0.0113)	(0.0117)
log(markup^2	0.0112*	0.0109*	0.00994*
	(0.00614)	(0.00605)	(0.00597)
log(Fix asset)	-0.00394	-0.00394	-0.00398
	(0.00245)	(0.00245)	(0.00245)
leverage	-0.0171***	-0.0172***	-0.0172***
	(0.00594)	(0.00594)	(0.00594)
lab productivity	-1.41e-08**	-1.43e-08**	-1.44e-08**
	(6.64e-09)	(6.61e-09)	(6.62e-09)
low prod	-0.000682	-0.000523	-0.000379
	(0.00429)	(0.00429)	(0.00430)
high lev	-0.000545	-0.000468	-0.000496
	(0.00282)	(0.00282)	(0.00282)
low size	0.00730	0.00731	0.00729
	(0.00605)	(0.00604)	(0.00604)
Constant	0.0191	0.0254	0.0260
	(0.0286)	(0.0287)	(0.0287)
Observations	9,909	9,909	9,909
R-squared	0.665	0.665	0.664

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table 3.4: Regressions focusing only on firms that did not reduce their physical capital in a given year. Specifically, to estimate the dependent variable markup, we use the cost-share approach in column 1, the production function approach in column 2, and a fixed output elasticity of 0.85 in column 3.

VARIABLES	(1) 2 digit equitydelaycon	(2) 3 digit equitydelaycon	(3) 4 digit equitydelaycon
log(markup)	-0.0111***	-0.0103***	-0.00747*
	(0.00422)	(0.00397)	(0.00392)
log(markup)^2	0.00333	0.00275	0.00264
	(0.00322)	(0.00338)	(0.00341)
log(Fix asset)	-0.00381**	-0.00355**	-0.00336*
	(0.00170)	(0.00174)	(0.00173)
leverage	-0.0115**	-0.0121**	-0.0129**
	(0.00477)	(0.00478)	(0.00505)
lab productivity	-1.39e-08***	-1.37e-08***	-1.13e-08**
	(4.85e-09)	(5.06e-09)	(5.07e-09)
low prod	0.00507	0.00539*	0.00546*
	(0.00309)	(0.00313)	(0.00322)
high lev	-0.000139	0.0000381	-0.000164
	(0.00187)	(0.00185)	(0.00190)
low size	0.00966**	0.00968**	0.00960**
	(0.00422)	(0.00426)	(0.00444)
Constant	0.0180	0.0147	0.0118
	(0.0194)	(0.0198)	(0.0197)
Fixed effects (Firm Sector*Year)	YES	YES	YES
Cluster (Firms Year)	YES	YES	YES
Observations	23,541	23,537	23,367
R-squared	0.631	0.636	0.656

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table 3.5: Regressions using the full sample with different market definitions. Each column represents a different level of market aggregation, respectively. In these regressions, markups were estimated using an output elasticity derived from the cost-share approach.

VARIABLES	(1) 2 digit equitydelaycon	(2) 3 digit equitydelaycon	(3) 4 digit equitydelaycon
log(markup)	-0.0169**	-0.0115	-0.00649
	(0.00832)	(0.00785)	(0.00756)
log(markup)^2	0.0112*	0.00850	0.00506
	(0.00614)	(0.00679)	(0.00685)
log(Fix asset)	-0.00394	-0.00365	-0.00335
	(0.00245)	(0.00256)	(0.00260)
leverage	-0.0171***	-0.0176***	-0.0193***
	(0.00594)	(0.00597)	(0.00674)
lab productivity	-1.41e-08**	-1.39e-08**	-1.53e-08**
	(6.64e-09)	(6.90e-09)	(7.42e-09)
low prod	-0.000682	-0.00135	-0.000817
	(0.00429)	(0.00448)	(0.00493)
high lev	-0.000545	-0.000341	-0.000597
	(0.00282)	(0.00285)	(0.00310)
low size	0.00730	0.00654	0.00616
	(0.00605)	(0.00620)	(0.00702)
Constant	0.0191	0.0156	0.0127
	(0.0286)	(0.0299)	(0.0301)
Fixed effects (Firm Sector*Year)	YES	YES	YES
Cluster (Firms Year)	YES	YES	YES
Observations	9,909	9,894	9,629
R-squared	0.665	0.676	0.710

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table 3.6: Regressions using the reduced sample with different market definitions. Each column represents a different level of market aggregation, respectively. In these regressions, markups were estimated using an output elasticity derived from the cost-share approach.

3.6 Conclusion

In this chapter, we examined the interplay between corporate market power and financial frictions, shedding light on the intricate relationship between access to finance and competitive dynamics. Our theoretical model allowed us to identify two primary channels through which financial frictions influence market power, each producing distinct effects.

On one hand, in a partial equilibrium analysis, firms with greater market power enjoy easier access to financial resources. This enhanced capital availability enables them to invest more in technology, thereby further consolidating their competitive position.

On the other hand, the general equilibrium effects of reducing financial frictions do not yield uniform outcomes across the economy, as they depend on the interaction between the partial and general equilibrium channels. Generally, a reduction in financial frictions allows firms to expand their investments, which can lead to increased market power and greater market concentration. Conversely, easing financial constraints also encourages new firms to enter the market by lowering the barriers to accessing credit. This implies intensified competition, ultimately reducing average markups.

In summary, the overall impact of financial frictions on market power results from the combined effect of these contrasting channels. Future iterations of this model should aim to parameterize it using empirical data to provide a more concrete and evidence-based perspective. Integrating real-world data will enhance our understanding of the complex interactions between these channels and help identify the conditions under which each effect becomes dominant.

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Appendix A

Appendix Chapter 1

A.1 Multiple sectors model: workers' problem at time 1

At time 1 worker i solves the following problem:

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

The Lagrangian is:

$$\mathcal{L} = \left(\sum_{n=1}^{N} \left(\frac{1}{N}\right)^{\frac{1}{\theta}} (e_n)^{\frac{1}{\theta}} \left(c_{ni}^w\right)^{\frac{\theta-1}{\theta}}\right)^{\frac{\theta}{\theta-1}} - \lambda \left(\sum_{n=1}^{N} p_n c_{ni}^w - wL_i\right) \tag{A.2}$$

The first-order conditions (FOC) are:

$$\frac{\partial \mathcal{L}}{\partial c_{ni}^w} = \left(\frac{1}{N}\right)^{\frac{1}{\theta}} (e_n)^{\frac{1}{\theta}} \left(c_{ni}^w\right)^{\frac{\theta-1}{\theta}-1} \left(\sum_{n=1}^{N} \left(\frac{1}{N}\right)^{\frac{1}{\theta}} (e_n)^{\frac{1}{\theta}} \left(c_{ni}^w\right)^{\frac{\theta-1}{\theta}}\right)^{\frac{\theta}{\theta-1}-1} - \lambda p_n = 0 \tag{A.3}$$

$$\frac{\partial \mathcal{L}}{\partial \lambda} = \sum_{n=1}^{N} p_n c_{ni}^w - wL_i = 0 \tag{A.4}$$

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

$$\frac{p_n}{p_m} = \left(\frac{e_n}{e_m}\right)^{\frac{1}{\theta}} \left(\frac{c_{ni}^w}{c_{mi}^w}\right)^{-\frac{1}{\theta}} \tag{A.5}$$

We solve for c_{ni}^w:

$$c_{ni}^w = \left(\frac{e_n}{e_m}\right) \left(\frac{p_n}{p_m}\right)^{-\theta} c_{mi}^w \tag{A.6}$$

Multiplying by p_n and summing over n:

$$\sum_{n=1}^{N} p_n c_{ni}^w = p_m^\theta c_{mi}^w \frac{1}{e_m} \sum_{n=1}^{N} p_n^{1-\theta} e_n \tag{A.7}$$

We know that the price index is given by:

$$P = \left(\sum_{n=1}^{N} \frac{1}{N} e_n \left(p_n\right)^{1-\theta} \right)^{\frac{1}{1-\theta}} \tag{A.8}$$

Thus, we can rewrite the equation as:

$$c_{mi}^w = \frac{1}{N} \left(\frac{p_m}{P} \right)^{-\theta} e_m \frac{1}{P} \sum_{n=1}^{N} p_n c_{ni}^w \tag{A.9}$$

Using this result, we find that:

$$\sum_{n=1}^{N} p_n c_{ni}^w = P C_i^w \tag{A.10}$$

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

$$c_{ni}^w = \frac{1}{N} e_n \left(\frac{p_n}{P} \right)^{-\theta} C_i^w \tag{A.11}$$

A.2 Multiple sectors model: workers' problem at time 0

The problem faced by each worker is:

$$\max_{C_i^w, L_i} \quad \mathbb{E}(U) = \mathbb{E}\left(C_i^w - \chi \frac{L_i^{1+\frac{1}{\eta}}}{1+\frac{1}{\eta}} \right) \tag{A.12}$$

$$\text{s.t.} \quad P C_i^w = w L_i \tag{A.13}$$

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

$$\max_{L_i} \quad \mathbb{E}(U^w) = \mathbb{E}(w) L_i - \chi \frac{L_i^{1+\frac{1}{\eta}}}{1+\frac{1}{\eta}} \tag{A.14}$$

The FOC is:

$$\frac{\partial \mathbb{E}(U^w)}{\partial L_i} = \mathbb{E}(w) - \chi L_i^{\frac{1}{\eta}} = 0 \tag{A.15}$$

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

$$\mathbb{E}(w) = \chi L_i^{\frac{1}{\eta}} \tag{A.16}$$

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

$$\mathbb{E}(w) = \chi \left(\frac{L}{N} \right)^{\frac{1}{\eta}} \tag{A.17}$$

A.3 Multiple sector model: firms' problem

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

$$\begin{aligned} \max_{L_{nj}} \quad & \mathbb{E}\left(\frac{p_n}{P}\right) F(L_{nj}) - \mathbb{E}(\omega) L_{nj} \\ & + \lambda_{\text{intra}} \sum_{k \neq j}^{J} \left(\mathbb{E}\left(\frac{p_n}{P}\right) F(L_{nk}) - \mathbb{E}(\omega) L_{nk} \right) \\ & + \lambda_{\text{inter}} \sum_{m \neq n}^{N} \sum_{k=1}^{J} \left(\mathbb{E}\left(\frac{p_m}{P}\right) F(L_{mk}) - \mathbb{E}(\omega) L_{mk} \right) \end{aligned} \tag{A.18}$$

The FOC of this problem is:

$$\begin{aligned} & \mathbb{E}\left(\frac{p_n}{P}\right) F'(L_{nj}) - \mathbb{E}(\omega) - \frac{\partial \mathbb{E}(\omega)}{\partial L_{nj}} \left(L_{nj} + \lambda_{\text{intra}} \sum_{k \neq j}^{J} L_{nk} + \lambda_{\text{inter}} \sum_{m \neq n}^{N} \sum_{k=1}^{J} L_{mk} \right) \\ & + \frac{\partial \mathbb{E}\left(\frac{p_n}{P}\right)}{\partial L_{nj}} \left(F(L_{nj}) + \lambda_{\text{intra}} \sum_{k \neq j}^{J} F(L_{nk}) \right) + \lambda_{\text{inter}} \sum_{m \neq n}^{N} \sum_{k=1}^{J} F(L_{mk}) = 0 \end{aligned} \tag{A.19}$$

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

$$\mathbb{E}\left(\frac{p_n}{P}\right) = \mathbb{E}\left(\left(\frac{1}{N}\right)^{\frac{1}{\theta}} e_n^{\frac{1}{\theta}} \left(\frac{c_n}{C}\right)^{-\frac{1}{\theta}} \right). \tag{A.20}$$

Using Leibniz's rule, we can see that

$$\frac{\partial}{\partial L_{nj}} \mathbb{E}\left(\frac{p_n}{P}\right) = \mathbb{E}\left(\frac{\partial}{\partial L_{nj}} \frac{p_n}{P} \right). \tag{A.21}$$

Hence,

$$\begin{aligned}\frac{\partial \mathbb{E}\left(\frac{p_n}{P}\right)}{\partial L_{nj}} &= \mathbb{E}\left(-\frac{1}{\theta}\left(\frac{1}{N}\right)^{\frac{1}{\theta}} e_n^{\frac{1}{\theta}}\left(\frac{c_n}{C}\right)^{-\frac{1}{\theta}-1}\right. \\ &\quad \left.\times\left(\frac{F'(L_{nj})C - \frac{\theta-1}{\theta}c_n^{\frac{\theta-1}{\theta}-1}\left(\frac{1}{N}\right)^{\frac{1}{\theta}} e_n^{\frac{1}{\theta}}\frac{\theta}{\theta-1}\frac{C}{C^{\frac{\theta-1}{\theta}}}F'(L_{nj})c_n}{C^2}\right)\right) \\ &= \mathbb{E}\left(-\frac{1}{\theta}\left(\frac{1}{N}\right)^{\frac{1}{\theta}} e_n^{\frac{1}{\theta}}\left(\frac{c_n}{C}\right)^{-\frac{1}{\theta}}\right. \\ &\quad \left.\times\left(1-\left(\frac{1}{N}\right)^{\frac{1}{\theta}} e_n^{\frac{1}{\theta}}\left(\frac{c_n}{C}\right)^{-\frac{1}{\theta}}\frac{c_n}{C}\right)\frac{F'(L_{nj})}{c_n}\right) \\ &= \mathbb{E}\left(-\frac{1}{\theta}\frac{p_n}{P}\left(1-\frac{p_n}{P}\frac{c_n}{C}\right)\frac{F'(L_{nj})}{c_n}\right).\end{aligned} \tag{A.22}$$

Similarly,

$$\begin{aligned}\frac{\partial \mathbb{E}\left(\frac{p_m}{P}\right)}{\partial L_{nj}} &= \mathbb{E}\left(-\frac{1}{\theta}\left(\frac{1}{N}\right)^{\frac{1}{\theta}} e_m^{\frac{1}{\theta}}\left(\frac{c_m}{C}\right)^{-\frac{1}{\theta}-1}\right. \\ &\quad \left.\times\left(\frac{0 - \frac{\theta-1}{\theta}c_n^{\frac{\theta-1}{\theta}-1}\left(\frac{1}{N}\right)^{\frac{1}{\theta}} e_m^{\frac{1}{\theta}}\frac{\theta}{\theta-1}\frac{C}{C^{\frac{\theta-1}{\theta}}}F'(L_{nj})c_m}{C^2}\right)\right) \\ &= \mathbb{E}\left(\frac{1}{\theta}\left(\frac{1}{N}\right)^{\frac{1}{\theta}} e_m^{\frac{1}{\theta}}\left(\frac{c_m}{C}\right)^{-\frac{1}{\theta}}\times\frac{C}{c_m}\times\left(\frac{1}{N}\right)^{\frac{1}{\theta}} e_n^{\frac{1}{\theta}}\left(\frac{c_n}{C}\right)^{-\frac{1}{\theta}}\frac{F'(L_{nj})}{c_m}\right) \\ &= \mathbb{E}\left(\frac{1}{\theta}\frac{p_n}{P}\left(\frac{p_m}{P}\frac{c_m}{C}\right)\frac{F'(L_{nj})}{c_m}\right).\end{aligned} \tag{A.23}$$

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

$$\frac{\partial \mathbb{E}\left(\frac{p_m}{P}\right)}{\partial L_{nj}}c_n = -\sum_{m\neq n}\frac{\partial \mathbb{E}\left(\frac{p_m}{P}\right)}{\partial L_{nj}}c_m. \tag{A.24}$$

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:

$$\frac{p_n c_n}{PC} + \sum_{m\neq n}\frac{p_m c_m}{PC} = 1. \tag{A.25}$$

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

$$\begin{aligned}\mathbb{E}\left(\frac{p_n}{P}\right)F'(L_{nj}) - \mathbb{E}\left(\frac{w}{P}\right) - \frac{\partial \mathbb{E}\left(\frac{w}{P}\right)}{\partial L_{nj}}L\left[s_{nj}^L + \lambda_{\text{intra}}s_{n-j}^L + \lambda_{\text{inter}}\left(1 - s_{nj}^L - s_{n-j}^L\right)\right] \\ + \frac{\partial \mathbb{E}\left(\frac{p_n}{P}\right)}{\partial L_{nj}}c_n\left[s_j + \lambda_{\text{intra}}(1-s_j) - \lambda_{\text{inter}}\right] = 0.\end{aligned} \tag{A.26}$$

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

$$\begin{aligned}\mathbb{E}(\mu) = \frac{1}{\eta}\left[s_{nj}^L + \lambda_{\text{intra}} s_{n-j}^L + \lambda_{\text{inter}}\left(1 - s_{nj}^L - s_{n-j}^L\right)\right] \\ + \frac{1}{\mathbb{E}\left(\frac{w}{P}\right)}\frac{d\mathbb{E}\left(\frac{p_n}{P}\right)}{dL_{nj}} c_n \left[s_j + \lambda_{\text{intra}}(1 - s_j) - \lambda_{\text{inter}}\right],\end{aligned} \tag{A.27}$$

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

$$\mathbb{E}(\mu) = \frac{1}{\eta}\left[\frac{1}{JN} + \lambda_{\text{intra}}\frac{(J-1)}{J} + \lambda_{\text{inter}}\frac{(N-1)}{N}\right] + \frac{1}{\mathbb{E}\left(\frac{w}{P}\right)}\frac{d\mathbb{E}\left(\frac{p_n}{P}\right)}{dL_{nj}} c_n \left[\frac{1}{J} + \lambda_{\text{intra}}\frac{(J-1)}{J} - \lambda_{\text{inter}}\right] = 0. \tag{A.28}$$

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

$$\mathbb{E}(\mu) = \frac{1}{\eta} H_{\text{labor}} + \frac{1}{\mathbb{E}\left(\frac{w}{P}\right)}\frac{d\mathbb{E}\left(\frac{p_n}{P}\right)}{dL_{nj}} c_n H_{\text{product}}. \tag{A.29}$$

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

$$\frac{\partial \mathbb{E}\left(\frac{p_n}{P}\right)}{\partial L_{nj}} c_n = \mathbb{E}\left(-\frac{1}{\theta}\frac{p_n}{P}\left(1 - \frac{p_n}{P}\frac{c_n}{C}\right)F'(L_{nj})\right) = \tau F'(L_{nj}), \tag{A.30}$$

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

$$\mathbb{E}(\mu) = \frac{1}{\eta} H_{\text{labor}} + \frac{\mathbb{E}(\mu)+1}{\mathbb{E}\left(\frac{p_n}{P}\right)} \tau H_{\text{product}}. \tag{A.31}$$

$$\mathbb{E}(\mu) = \frac{\frac{1}{\eta} H_{\text{labor}} + \tau \frac{H_{\text{product}}}{\mathbb{E}\left(\frac{p_n}{P}\right)}}{1 - \tau \frac{H_{\text{product}}}{\mathbb{E}\left(\frac{p_n}{P}\right)}}. \tag{A.32}$$

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

$$\mathbb{E}\left(\omega\right) = \frac{\mathbb{E}\left(\frac{p_n}{P}\right) F'\left(\frac{L^d}{JN}\right)}{1 + \mathbb{E}(\mu)}. \tag{A.33}$$

A.3.1 General Equilibrium

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

$$L^* = \left[\chi\, J^{1-\alpha} \frac{\mathbb{E}\left(\frac{p_n}{P}\right)\alpha A}{1+\mathbb{E}(\mu)}\right]^{\frac{1}{\frac{1}{\eta}+1-\alpha}} N. \tag{A.34}$$

Under symmetric equilibrium,

$$\begin{aligned}
\mathbb{E}\left(\frac{c_n}{C}\right) &= \mathbb{E}\left(\frac{\sum_{j=1}^{J} F\left(\frac{L^*}{NJ}\right)}{\left[\sum_{n=1}^{N}\left(\frac{1}{N}\right)^{\frac{1}{\theta}} e_n^{\frac{1}{\theta}}\left(\sum_{j=1}^{J} F\left(\frac{L^*}{NJ}\right)\right)^{\frac{\theta-1}{\theta}}\right]^{\frac{\theta}{\theta-1}}}\right) \\
&= \mathbb{E}\left(\frac{JF\left(\frac{L^*}{NJ}\right)}{JF\left(\frac{L^*}{NJ}\right)\left[\sum_{n=1}^{N}\left(\frac{1}{N}\right)^{\frac{1}{\theta}} e_n^{\frac{1}{\theta}}\right]^{\frac{\theta}{\theta-1}}}\right) \\
&= \mathbb{E}\left(\frac{1}{\left[\sum_{n=1}^{N}\left(\frac{1}{N}\right)^{\frac{1}{\theta}} e_n^{\frac{1}{\theta}}\right]^{\frac{\theta}{\theta-1}}}\right).
\end{aligned} \tag{A.35}$$

$$\begin{aligned}
\mathbb{E}\left(\frac{p_n}{P}\right) &= \mathbb{E}\left(\left(\frac{1}{N}\right)^{\frac{1}{\theta}} e_n^{\frac{1}{\theta}}\left(\frac{c_n}{C}\right)^{-\frac{1}{\theta}}\right) \\
&= \mathbb{E}\left(\left(\frac{1}{N}\right)^{\frac{1}{\theta}} e_n^{\frac{1}{\theta}}\left(\frac{1}{\left[\sum_{n=1}^{N}\left(\frac{1}{N}\right)^{\frac{1}{\theta}} e_n^{\frac{1}{\theta}}\right]^{\frac{\theta}{\theta-1}}}\right)^{-\frac{1}{\theta}}\right) \\
&= \mathbb{E}\left(\left(\frac{1}{N}\right)^{\frac{1}{\theta}} e_n^{\frac{1}{\theta}}\left[\sum_{n=1}^{N}\left(\frac{1}{N}\right)^{\frac{1}{\theta}} e_n^{\frac{1}{\theta}}\right]^{\frac{1}{\theta-1}}\right).
\end{aligned} \tag{A.36}$$

$$\begin{aligned}
\tau &= \mathbb{E}\left(-\frac{1}{\theta}\frac{p_n}{P}\left(1-\frac{p_n}{P}\frac{c_n}{C}\right)\right) \\
&= \mathbb{E}\left(\frac{1}{\theta}\left(\frac{1}{N}\right)^{\frac{1}{\theta}} e_n^{\frac{1}{\theta}}\left[\sum_{n=1}^{N}\left(\frac{1}{N}\right)^{\frac{1}{\theta}} e_n^{\frac{1}{\theta}}\right]^{\frac{1}{\theta-1}} \frac{e_n^{\frac{1}{\theta}}}{\sum_{m\neq n} e_m^{\frac{1}{\theta}}}\right).
\end{aligned} \tag{A.37}$$

A.4 Mathematical Proofs

We want to show that $\frac{\partial\left(\frac{p_n}{P}\right)}{\partial e_n}$ and $\frac{\partial\left(\frac{p_n}{P}\right)}{\partial e_m}$ are both greater than zero.

$$
\begin{aligned}
\frac{\partial\left(\frac{p_n}{P}\right)}{\partial e_n} &= \frac{1}{\theta}\left(\frac{1}{N}\right)^{\frac{1}{\theta}} e_n^{\frac{1}{\theta}-1}\left(\frac{c_n}{C}\right)^{-\frac{1}{\theta}} \\
&\quad - \frac{1}{\theta}\left(\frac{1}{N}\right)^{\frac{1}{\theta}} e_n^{\frac{1}{\theta}}\left(\frac{c_n}{C}\right)^{-\frac{1}{\theta}-1}\left(\frac{-\frac{1}{\theta}c_n^{\frac{\theta-1}{\theta}}\left(\frac{1}{N}\right)^{\frac{1}{\theta}} e_n^{\frac{1}{\theta}-1}\frac{\theta}{\theta-1}\frac{C}{C^{\frac{\theta-1}{\theta}}}c_n}{C^2}\right) \\
&= \frac{1}{\theta}\left(\frac{1}{N}\right)^{\frac{1}{\theta}} e_n^{\frac{1}{\theta}}\left(\frac{c_n}{C}\right)^{-\frac{1}{\theta}} \\
&\quad + \frac{1}{\theta(\theta-1)}\left(\frac{1}{N}\right)^{\frac{1}{\theta}} e_n^{\frac{1}{\theta}}\left(\frac{c_n}{C}\right)^{-\frac{1}{\theta}}\left(\frac{1}{N}\right)^{\frac{1}{\theta}} e_n^{-1}\left(\frac{c_n}{C}\right) \\
&= \frac{1}{\theta}\left(\frac{p_n}{P}\right)\frac{1}{e_n} + \frac{1}{\theta(\theta-1)}\left(\frac{p_n}{P}\right)^2\left(\frac{c_n}{C}\right)\frac{1}{e_n} \\
&= \frac{1}{\theta}\left(\frac{p_n}{P}\right)\frac{1}{e_n}\left(1+\frac{1}{\theta-1}\left(\frac{p_n}{P}\right)\left(\frac{c_n}{C}\right)\right) > 0.
\end{aligned}
\tag{A.38}
$$

$$
\begin{aligned}
\frac{\partial\left(\frac{p_n}{P}\right)}{\partial e_m} &= -\frac{1}{\theta}\left(\frac{1}{N}\right)^{\frac{1}{\theta}} e_n^{\frac{1}{\theta}}\left(\frac{c_n}{C}\right)^{-\frac{1}{\theta}-1} \\
&\quad \times \left(\frac{-\frac{1}{\theta}c_m^{\frac{\theta-1}{\theta}}\left(\frac{1}{N}\right)^{\frac{1}{\theta}} e_m^{\frac{1}{\theta}-1}\frac{\theta}{\theta-1}\frac{C}{C^{\frac{\theta-1}{\theta}}}c_n}{C^2}\right) \\
&= \frac{1}{\theta(\theta-1)}\left(\frac{1}{N}\right)^{\frac{1}{\theta}} e_n^{\frac{1}{\theta}}\left(\frac{c_n}{C}\right)^{-\frac{1}{\theta}}\left(\frac{1}{N}\right)^{\frac{1}{\theta}} e_m^{-\frac{1}{\theta}}\left(\frac{c_m}{C}\right)^{-\frac{1}{\theta}}\left(\frac{c_m}{C}\right) \\
&= \frac{1}{\theta(\theta-1)}\left(\frac{p_n}{P}\right)\left(\frac{p_m}{P}\right)\left(\frac{c_m}{C}\right)\left(\frac{1}{e_m}\right) > 0.
\end{aligned}
\tag{A.39}
$$

A.5 General Equilibrium

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

$$
\mathbb{E}(\mu) = \frac{\frac{1}{\eta}H_{\text{labor}} + \tau\frac{H_{\text{product}}}{\mathbb{E}\left(\frac{p_n}{P}\right)}}{1-\tau\frac{H_{\text{product}}}{\mathbb{E}\left(\frac{p_n}{P}\right)}}. \tag{A.40}
$$

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

$$
\mathbb{E}(\omega) = \frac{\mathbb{E}\left(\frac{p_n}{P}\right)F'\left(\frac{L^d}{JN}\right)}{1+\mathbb{E}(\mu)}. \tag{A.41}
$$

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

A.5.1 Equilibrium expected values

$$\begin{aligned}
\mathbb{E}\left(\frac{c_n}{C}\right) &= \mathbb{E}\left(\frac{\sum_{j=1}^{J} F\left(\frac{L^*}{NJ}\right)}{\left[\sum_{n=1}^{N}\left(\frac{1}{N}\right)^{\frac{1}{\theta}} e_n^{\frac{1}{\theta}}\left(\sum_{j=1}^{J} F\left(\frac{L^*}{NJ}\right)\right)^{\frac{\theta-1}{\theta}}\right]^{\frac{\theta}{\theta-1}}}\right) \\
&= \mathbb{E}\left(\frac{JF\left(\frac{L^*}{NJ}\right)}{JF\left(\frac{L^*}{NJ}\right)\left[\sum_{n=1}^{N}\left(\frac{1}{N}\right)^{\frac{1}{\theta}} e_n^{\frac{1}{\theta}}\right]^{\frac{\theta}{\theta-1}}}\right) \\
&= \mathbb{E}\left(\frac{1}{\left[\sum_{n=1}^{N}\left(\frac{1}{N}\right)^{\frac{1}{\theta}} e_n^{\frac{1}{\theta}}\right]^{\frac{\theta}{\theta-1}}}\right).
\end{aligned} \tag{A.43}$$

$$\begin{aligned}
\mathbb{E}\left(\frac{p_n}{P}\right) &= \mathbb{E}\left(\left(\frac{1}{N}\right)^{\frac{1}{\theta}} e_n^{\frac{1}{\theta}}\left(\frac{c_n}{C}\right)^{-\frac{1}{\theta}}\right) \\
&= \mathbb{E}\left(\left(\frac{1}{N}\right)^{\frac{1}{\theta}} e_n^{\frac{1}{\theta}}\left(\frac{1}{\left[\sum_{n=1}^{N}\left(\frac{1}{N}\right)^{\frac{1}{\theta}} e_n^{\frac{1}{\theta}}\right]^{\frac{\theta}{\theta-1}}}\right)^{-\frac{1}{\theta}}\right) \\
&= \mathbb{E}\left(\left(\frac{1}{N}\right)^{\frac{1}{\theta}} e_n^{\frac{1}{\theta}}\left[\sum_{n=1}^{N}\left(\frac{1}{N}\right)^{\frac{1}{\theta}} e_n^{\frac{1}{\theta}}\right]^{\frac{1}{\theta-1}}\right).
\end{aligned} \tag{A.44}$$

$$\begin{aligned}
\tau &= \mathbb{E}\left(-\frac{1}{\theta}\frac{p_n}{P}\left(1-\frac{p_n}{P}\frac{c_n}{C}\right)\right) \\
&= \mathbb{E}\left(\frac{1}{\theta}\left(\frac{1}{N}\right)^{\frac{1}{\theta}} e_n^{\frac{1}{\theta}}\left[\sum_{n=1}^{N}\left(\frac{1}{N}\right)^{\frac{1}{\theta}} e_n^{\frac{1}{\theta}}\right]^{\frac{1}{\theta-1}} \frac{e_n^{\frac{1}{\theta}}}{\sum_{m\neq n} e_m^{\frac{1}{\theta}}}\right).
\end{aligned} \tag{A.45}$$

A.6 Mathematical Proofs

We want to show that $\frac{\partial\left(\frac{p_n}{P}\right)}{\partial e_n}$ and $\frac{\partial\left(\frac{p_n}{P}\right)}{\partial e_m}$ are both greater than zero.

$$
\begin{aligned}
\frac{\partial\left(\frac{p_n}{P}\right)}{\partial e_n} &= \frac{1}{\theta}\left(\frac{1}{N}\right)^{\frac{1}{\theta}} e_n^{\frac{1}{\theta}-1}\left(\frac{c_n}{C}\right)^{-\frac{1}{\theta}} \\
&\quad - \frac{1}{\theta}\left(\frac{1}{N}\right)^{\frac{1}{\theta}} e_n^{\frac{1}{\theta}}\left(\frac{c_n}{C}\right)^{-\frac{1}{\theta}-1}\left(\frac{-\frac{1}{\theta}c_n^{\frac{\theta-1}{\theta}}\left(\frac{1}{N}\right)^{\frac{1}{\theta}} e_n^{\frac{1}{\theta}-1}\frac{\theta}{\theta-1}\frac{C}{C^{\frac{\theta-1}{\theta}}}c_n}{C^2}\right) \\
&= \frac{1}{\theta}\left(\frac{1}{N}\right)^{\frac{1}{\theta}} e_n^{\frac{1}{\theta}}\left(\frac{c_n}{C}\right)^{-\frac{1}{\theta}} \\
&\quad + \frac{1}{\theta(\theta-1)}\left(\frac{1}{N}\right)^{\frac{1}{\theta}} e_n^{\frac{1}{\theta}}\left(\frac{c_n}{C}\right)^{-\frac{1}{\theta}}\left(\frac{1}{N}\right)^{\frac{1}{\theta}} e_n^{-1}\left(\frac{c_n}{C}\right) \\
&= \frac{1}{\theta}\left(\frac{p_n}{P}\right)\frac{1}{e_n} + \frac{1}{\theta(\theta-1)}\left(\frac{p_n}{P}\right)^2\left(\frac{c_n}{C}\right)\frac{1}{e_n} \\
&= \frac{1}{\theta}\left(\frac{p_n}{P}\right)\frac{1}{e_n}\left(1+\frac{1}{\theta-1}\left(\frac{p_n}{P}\right)\left(\frac{c_n}{C}\right)\right) > 0.
\end{aligned}
\tag{A.46}
$$

$$
\begin{aligned}
\frac{\partial\left(\frac{p_n}{P}\right)}{\partial e_m} &= -\frac{1}{\theta}\left(\frac{1}{N}\right)^{\frac{1}{\theta}} e_n^{\frac{1}{\theta}}\left(\frac{c_n}{C}\right)^{-\frac{1}{\theta}-1} \\
&\quad \times \left(\frac{-\frac{1}{\theta}c_m^{\frac{\theta-1}{\theta}}\left(\frac{1}{N}\right)^{\frac{1}{\theta}} e_m^{\frac{1}{\theta}-1}\frac{\theta}{\theta-1}\frac{C}{C^{\frac{\theta-1}{\theta}}}c_n}{C^2}\right) \\
&= \frac{1}{\theta(\theta-1)}\left(\frac{1}{N}\right)^{\frac{1}{\theta}} e_n^{\frac{1}{\theta}}\left(\frac{c_n}{C}\right)^{-\frac{1}{\theta}}\left(\frac{1}{N}\right)^{\frac{1}{\theta}} e_m^{-\frac{1}{\theta}}\left(\frac{c_m}{C}\right)^{-\frac{1}{\theta}}\left(\frac{c_m}{C}\right) \\
&= \frac{1}{\theta(\theta-1)}\left(\frac{p_n}{P}\right)\left(\frac{p_m}{P}\right)\left(\frac{c_m}{C}\right)\left(\frac{1}{e_m}\right) > 0.
\end{aligned}
\tag{A.47}
$$

Appendix B

Appendix Chapter 2

B.1 Model solution

B.1.1 Workers' problem at time 1

At time 1 worker i solve the following problem

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

subject to

$$(1+r_d)wL_i = \sum_{n=1}^{N} p_n c_{ni}^w. \tag{B.2}$$

The Lagrangian is

$$\mathcal{L} = \left[\sum_{n=1}^{N}\left(\frac{1}{N}\right)^{\frac{1}{\theta}}(e_n)^{\frac{1}{\theta}}\left(c_{ni}^w\right)^{\frac{\theta-1}{\theta}}\right]^{\frac{\theta}{\theta-1}} - \lambda\left(\sum_{n=1}^{N} p_n c_{ni}^w - wL_i(1+r_d)\right). \tag{B.3}$$

The FOC are

$$\frac{\partial\mathcal{L}}{\partial c_{ni}^w} = \left(\frac{1}{N}\right)^{\frac{1}{\theta}}(e_n)^{\frac{1}{\theta}}\left(c_{ni}^w\right)^{\frac{\theta-1}{\theta}-1}\left[\sum_{n=1}^{N}\left(\frac{1}{N}\right)^{\frac{1}{\theta}}(e_n)^{\frac{1}{\theta}}\left(c_{ni}^w\right)^{\frac{\theta-1}{\theta}}\right]^{\frac{\theta}{\theta-1}-1} - \lambda p_n = 0; \tag{B.4}$$

$$\frac{\partial\mathcal{L}}{\partial\lambda} = \sum_{n=1}^{N} p_n c_{ni}^w - wL_i = 0. \tag{B.5}$$

Taking the ratio between the first two equations, we obtain

$$\frac{p_n}{p_m} = \left(\frac{e_n}{e_m}\right)^{\frac{1}{\theta}}\left(\frac{c_{ni}^w}{c_{mi}^w}\right)^{-\frac{1}{\theta}}. \tag{B.6}$$

We solve for c_{ni}^w

$$c_{ni}^w = \frac{e_n}{e_m}\left(\frac{p_n}{p_m}\right)^{-\theta} c_{mi}^w. \tag{B.7}$$

Multiplying for p_n and adding up across n we obtain

$$\sum_n p_n c_{ni}^w = p_m^\theta c_{mi}^w \frac{1}{e_m} \sum_n p_n^{1-\theta} e_n. \tag{B.8}$$

We know the price index is $P = \left[\sum_{n=1}^N \frac{1}{N} e_n \left(p_n\right)^{1-\theta}\right]^{\frac{1}{1-\theta}}$. It is easy to check that we can write it also as follows: $NP^{1-\theta} = \left[\sum_{n=1}^N e_n \left(p_n\right)^{1-\theta}\right]$. So the previous equation is equal to

$$c_{mi}^w = \frac{1}{N} \left(\frac{p_m}{P}\right)^{-\theta} e_m \frac{1}{P} \sum_{n=1}^N p_n c_{ni}^w. \tag{B.9}$$

If we replace c_{mi}^w into the equation of C_i^w, we can show that $\sum_{n=1}^N p_n c_{ni}^w = PC_i^w$. Using this relation, we find the optimal choice of variety m consumption as a function of total consumption C_i^w.

$$c_{ni}^w = \frac{1}{N} e_n \left(\frac{p_n}{P}\right)^{-\theta} C_i^w. \tag{B.10}$$

B.2 Workers' problem at time 0

The problem faced by each worker is

$$\max_{C_i^w, L_i} \; w = \mathbb{E}\left(C_i^w - \chi \frac{{L_i}^{1+\frac{1}{\eta}}}{1+\frac{1}{\eta}}\right); \tag{B.11}$$

$$\text{s.to.} \tag{B.12}$$

$$PC_i^w = wL_i(1+r_d). \tag{B.13}$$

Setting $P = 1$ and replacing $C_i^w = wL_i(1+r_d)$ into $\mathbb{E}(U^w)$, we obtain that the objective function depends only on L_i. The maximization problem becomes

$$\max_{L_i} \mathbb{E}(U^w) = (1+r_d)\mathbb{E}\left(\omega\right) L_i - \chi \frac{{L_i}^{1+\frac{1}{\eta}}}{1+\frac{1}{\eta}}. \tag{B.14}$$

The FOC is

$$\frac{\partial \mathbb{E}(U^w)}{\partial L_i} = (1+r_d)w - \chi L_i^{\frac{1}{\eta}} = 0. \tag{B.15}$$

Solving for w, we obtain

$$w = \chi L_i^{\frac{1}{\eta}} \frac{1}{(1+r_d)}. \tag{B.16}$$

Since the workers are homogeneous, we know that $\int_0^N L_i \, di = NL_i$ so $NL_i = L$. Replacing it in the individual inverse labor supply, we obtain the aggregate labor supply

$$w = \chi \left(\frac{L}{N}\right)^{\frac{1}{\eta}} \frac{1}{(1+r_d)}. \tag{B.17}$$

B.3 Firms' problem

At time 0, each firm has to choose L_{nj} to maximize the following function

$$\max_{L_{nj}} \left[\mathbb{E}\left(p_n|\text{succ}\right) F(L_{nj}) - wL_{nj}(1+r_l) + \lambda \left(\sum_{k\neq j}^{J} \mathbb{E}\left(p_n|\text{succ}\right) F(L_{nk}) - wL_{nk}(1+r_l) \right) \right] pds. \tag{B.18}$$

Due to the shock structure, the probability density function cannot be determined analytically. Let x be the random variable representing the transformation of all shocks. Rewriting the previous equation as an integral, we obtain:

$$(1-\mathbb{F}(\widehat{e})) \int_{x(\widehat{e})}^{x_{\max}} \left(p_n\, F(L_{nj}) - wL_{nj}(1+r_l) + \lambda \left(\sum_{k\neq j}^{J} \left(p_n\, F(L_{nk}) - wL_{nk}(1+r_l)\right) \right) \right) f(x \mid x > x(\widehat{e}))\, dx. \tag{B.19}$$

Here, $\mathbb{F}(\widehat{e})$ is the probability of default, computed as the cumulative distribution function of x at the shock zero-profit point $(\widehat{e})$, and $f(x \mid x > x(\widehat{e}))$ is the conditional probability density function of x given that the project is successful. Since $[1-\mathbb{F}(\widehat{e})]\, f(x \mid x > x(\widehat{e})) = f(x)$, we can rewrite the previous equation as:

$$\int_{x(\widehat{e})}^{x_{\max}} \left(p_n\, F(L_{nj}) - wL_{nj}(1+r_l) + \lambda \left(\sum_{k\neq j}^{J} \left(p_n\, F(L_{nk}) - wL_{nk}(1+r_l)\right) \right) \right) f(x)\, dx. \tag{B.20}$$

Using Leibniz's rule, we can calculate the following FOC[1]

$$\begin{aligned} \int_{x(\widehat{e})}^{x_{\max}} \Big(& \frac{\partial p_n}{\partial L_{nj}} F(L_{nj}) + p_n \frac{\partial F(L_{nj})}{\partial L_{nj}} - w\,(1+r_l) - \frac{\partial w}{\partial L_{nj}} L_{nj}\,(1+r_l) \\ & + \lambda \Big(\sum_{k\neq j}^{J} \Big(\frac{\partial p_n}{\partial L_{nj}} F(L_{nk}) - \frac{\partial w}{\partial L_{nj}} L_{nk}\,(1+r_l) \Big) \Big) \Big) f(x)\, dx \;=\; 0 \end{aligned} \tag{B.21}$$

By factoring out the common factor and splitting the integral, we obtain the following expression:

$$\begin{aligned} & \int_{x(\widehat{e})}^{x_{\max}} \frac{\partial p_n}{\partial L_{nj}} \left(F(L_{nj}) + \lambda \sum_{k\neq j}^{J} F(L_{nk}) \right) f(x)\, dx + \int_{x(\widehat{e})}^{x_{\max}} p_n \frac{\partial F(L_{nj})}{\partial L_{nj}} f(x) dx \\ & - \int_{x(\widehat{e})}^{x_{\max}} w(1+r_l)\, f(x)\, dx - \int_{x(\widehat{e})}^{x_{\max}} \frac{\partial w}{\partial L_{nj}} (1+r_l) \left(L_{nj} + \lambda \sum_{k\neq j}^{J} L_{nk} \right) f(x) dx = 0. \end{aligned} \tag{B.22}$$

Using the definition of $[1-\mathbb{F}(\widehat{e})]\, f(x \mid x > x(\widehat{e})) = f(x)$ and simplifing both side for $[1-\mathbb{F}(\widehat{e})]$ we obtain the following function

$$\begin{aligned} & \int_{x(\widehat{e})}^{x_{\max}} \frac{\partial p_n}{\partial L_{nj}} \left(F(L_{nj}) + \lambda \sum_{k\neq j}^{J} F(L_{nk}) \right) f(x \mid x > x(\widehat{e}))\, dx - \int_{x(\widehat{e})}^{x_{\max}} w(1+r_l)\, f(x \mid x > x(\widehat{e}))\, dx \\ & - \int_{x(\widehat{e})}^{x_{\max}} \frac{\partial w}{\partial L_{nj}} (1+r_l) \left(L_{nj} + \lambda \sum_{k\neq j}^{J} L_{nk} \right) f(x \mid x > x(\widehat{e})) dx = 0 \end{aligned} \tag{B.23}$$

[1] Note that the value of the previous function evaluated at the point $e_n = \widehat{e}$ equals zero, as the firm makes zero profit at this point.

By solving the integrals and defining the expression $\int_{x(\widehat{e})}^{x_{\max}} p_n\, f(x \mid x > x(\widehat{e}))\, dx = \mathbb{E}\,(p_n \mid \text{succ})$, and noting that $F'(L_{nj}) = \frac{\partial F(L_{nj})}{\partial L_{nj}}$, we can rewrite the previous equation as:

$$\mathbb{E}\,(p_n|\text{succ})\,F'(L_{nj}) + \frac{\partial \mathbb{E}\,(p_n|\text{succ})}{\partial L_{nj}} \times \left(F(L_{nj}) + \lambda \sum_{k \neq j}^{J} F(L_{nk}) \right) - w(1+r_l) - \frac{\partial w}{\partial L_{nj}}(1+r_l) \left(L_{nj} + \lambda \sum_{k \neq j}^{J} L_{nk} \right) = 0. \tag{B.24}$$

Now we have to calculate $\partial \mathbb{E}(p_n|succ)/\partial L_{nj}$. We know that

$$\mathbb{E}\,(p_n|succ) = \mathbb{E}\left(\left(\frac{1}{N} \right)^{\frac{1}{\theta}} e_n^{\frac{1}{\theta}} \left(\frac{c_n}{C} \right)^{-\frac{1}{\theta}} |succ \right). \tag{B.25}$$

Hence

$$\begin{aligned}
\frac{\partial \mathbb{E}(p_n|succ)}{\partial L_{nj}} &= \left(-\frac{1}{\theta} \left(\frac{1}{N} \right)^{\frac{1}{\theta}} e_n^{\frac{1}{\theta}} \left(\frac{c_n}{C} \right)^{-\frac{1}{\theta}-1} \frac{\left(F'(L_{nj})C - \frac{\theta-1}{\theta} c_n^{\frac{\theta-1}{\theta}-1} \left(\frac{1}{N} \right)^{\frac{1}{\theta}} e_n^{\frac{1}{\theta}} \frac{\theta}{\theta-1} \frac{C}{C^{\frac{\theta-1}{\theta}}} F'(L_{nj}) c_n \right)}{C^2} |succ \right); \\
&= \left(-\frac{1}{\theta} \left(\frac{1}{N} \right)^{\frac{1}{\theta}} e_n^{\frac{1}{\theta}} \left(\frac{c_n}{C} \right)^{-\frac{1}{\theta}} \left(1 - \left(\frac{1}{N} \right)^{\frac{1}{\theta}} e_n^{\frac{1}{\theta}} \left(\frac{c_n}{C} \right)^{-\frac{1}{\theta}} \frac{c_n}{C} \right) \frac{F'(L_{nj})}{c_n} |succ \right); \\
&= \left(-\frac{1}{\theta} p_n \left(1 - p_n \frac{c_n}{C} \right) \frac{F'(L_{nj})}{c_n} |succ \right).
\end{aligned} \tag{B.26}$$

We define $s_{nj}^L = \frac{L_{nj}}{L}$, $s_{n-j}^L = \frac{\sum_{k \neq j} L_{nk}}{L}$, and $s_{nj} = \frac{F(L_{nj})}{c_n}$. The FOC becomes

$$\mathbb{E}\,(p_n|\text{succ})\,F'(L_{nj}) - (1+r_l)w - (1+r_l)\frac{\partial w}{\partial L_{nj}} L \left[s_{nj}^L + \lambda s_{n-j}^L \right] + \frac{\partial \mathbb{E}(p_n|\text{succ})}{\partial L_{nj}} c_n \left[s_{nj} + \lambda(1 - s_{nj}) \right] = 0 \tag{B.27}$$

Dividing both sides by the expected value of real wages and by $(1+r_l)$, we obtain

$$\mathbb{E}(\mu|\text{succ}) = \frac{1}{\eta} \left[s_{nj}^L + \lambda s_{n-j}^L \right] + \frac{1}{w(1+r_l)} \frac{\partial \mathbb{E}(p_n|\text{succ})}{\partial L_{nj}} c_n \left[s_{nj} + \lambda(1 - s_{nj}) \right], \tag{B.28}$$

where $\mathbb{E}(\mu|\text{succ}) = \frac{\mathbb{E}(p_n|\text{succ})F'(L_{nj}) - (1+r_l)w}{(1+r_l)w}$ is the expected value of markdown of real wages, and $\frac{1}{\eta}$ is the inverse elasticity of labor supply.

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

The FOC becomes

$$\mathbb{E}(\mu|\text{succ}) = \frac{1}{\eta} \left[\frac{1}{JN} + \lambda \frac{(J-1)}{J} \right] + \frac{1}{w(1+r_l)} \frac{\partial \mathbb{E}\,(p_n|\text{succ})}{\partial L_{nj}} c_n \left[\frac{1}{J} + \lambda \frac{(J-1)}{J} \right]. \tag{B.29}$$

We define $H_{product} = \left[\frac{1}{J} + \lambda \frac{(J-1)}{J} \right]$ and $H_{labor} = \left[\frac{1}{JN} + \lambda \frac{(J-1)}{J} \right]$. Replacing these definitions into the FOC, we obtain

$$\mathbb{E}(\mu|\text{succ}) = \frac{1}{\eta} H_{labor} + \frac{1}{w} \frac{\partial \mathbb{E}\,(p_n|\text{succ})}{\partial L_{nj}} c_n H_{product}. \tag{B.30}$$

Now we have to evaluate $\frac{\partial \mathbb{E}(p_n|\text{succ})}{\partial L_{nj}} c_n$ in a symmetric equilibrium.

$$\frac{\partial \mathbb{E}\,(p_n|\text{succ})}{\partial L_{nj}} c_n = \mathbb{E}\left(-\frac{1}{\theta} p_n \left(1 - p_n \frac{c_n}{C} \right) F'(L_{nj}) |\text{succ} \right) = \tau F'(L_{nj}); \tag{B.31}$$

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

Hence the FOC is

$$\mathbb{E}(\mu|\text{succ}) = \frac{1}{\eta}H_{labor} + \frac{\mathbb{E}(\mu|\text{succ})+1}{\mathbb{E}\left(p_n|\text{succ}\right)}\tau H_{product} \tag{B.32}$$

$$\mathbb{E}(\mu|\text{succ}) = \frac{\frac{1}{\eta}H_{labor}+1}{1-\frac{\tau H_{product}}{\mathbb{E}(p_n|\text{succ})}} - 1 \tag{B.33}$$

Using the definition of $\mathbb{E}(\mu|\text{succ})$ we can find the aggregate demand

$$w = \frac{\mathbb{E}\left(p_n|\text{succ}\right)F'(\frac{L^d}{JN})}{\left(1+\mathbb{E}(\mu|\text{succ})\right)\left(1+r_l\right)}. \tag{B.34}$$

B.3.1 General Equilibrium

Matching aggregate supply and demand we find total employment in equilibrium

$$L^* = \left[\chi\, J^{1-\alpha}\frac{\mathbb{E}\left(p_n|\text{succ}\right)\alpha A}{\left(1+\mathbb{E}(\mu|\text{succ})\right)}\frac{(1+r_d)}{(1+r_l)}\right]^{\frac{1}{\frac{1}{\eta}+1-\alpha}} N. \tag{B.35}$$

To find w we solve (B.34) and (B.17) for L obtaining

$$L^d = \left[\frac{\mathbb{E}\left(p_n|\text{succ}\right)\alpha A(JN)^{1-\alpha}}{w(1+r_l)\left(1+\mathbb{E}(\mu|\text{succ})\right)}\right]^{\frac{1}{1-\alpha}}; \tag{B.36}$$

$$L^s = \left(\frac{(1+r_d)}{\chi}\right)^{\eta} N w^{\eta}. \tag{B.37}$$

Matching demand and supply, we get

$$\left(\frac{(1+r_d)}{\chi}\right)^{\eta} N w^{\eta} = \left[\frac{\mathbb{E}\left(p_n|\text{succ}\right)\alpha A(JN)^{1-\alpha}}{w(1+r_l)\left(1+\mathbb{E}(\mu|\text{succ})\right)}\right]^{\frac{1}{1-\alpha}}. \tag{B.38}$$

$$w = \left[\left(\frac{\chi}{(1+r_d)}\right)^{\eta}\left(\frac{\mathbb{E}\left(p_n|\text{succ}\right)\alpha A}{\left(1+\mathbb{E}(\mu|\text{succ})\right)\left(1+r_l\right)}\right)^{\frac{1}{1-\alpha}} J\right]^{\frac{1}{\eta+\frac{1}{1-\alpha}}} \tag{B.39}$$

To find the critical value of e_n, we use the zero profit condition

$$p_n A\left(\frac{L}{JN}\right)^{\alpha} - (w)\frac{L^*}{JN}(1+r_l) = 0. \tag{B.40}$$

Replacing the value of p_n

$$\left(\frac{1}{N}\right)^{\frac{1}{\theta}} \widehat{e}_n^{\frac{1}{\theta}}\left(\frac{c_n}{C}\right)^{-\frac{1}{\theta}} = w^{\left(\frac{L}{JN}\right)^{1-\alpha}}(1+r_l); \tag{B.41}$$

$$\left[\left(\frac{1}{N}\right)^{\frac{1}{\theta}}\left(\sum_{m\neq n} e_m^{\frac{1}{\theta}} + \widehat{e}_n^{\frac{1}{\theta}}\right)\right]^{\frac{1}{\theta-1}} \widehat{e}_n^{\frac{1}{\theta}} = w\left(\frac{L}{JN}\right)^{1-\alpha}\frac{1}{A}(1+r_l)N^{\frac{1}{\theta}}. \tag{B.42}$$

Taking the expected value, we obtain

$$\mathbb{E}\left[\left[\left(\frac{1}{N}\right)^{\frac{1}{\theta}}\left(\sum_{m\neq n} e_m^{\frac{1}{\theta}}+\widehat{e}_n^{\frac{1}{\theta}}\right)\right]^{\frac{1}{\theta-1}}\widehat{e}_n^{\frac{1}{\theta}}\right]=w\left(\frac{L}{JN}\right)^{1-\alpha}\frac{1}{A}(1+r_l)N^{\frac{1}{\theta}}. \tag{B.43}$$

We define total employment and the expected real equilibrium wage as

$$L^*=L^{wf}\left(\frac{(1+r_d)}{(1+r_l)}\right)^{\frac{1}{\frac{1}{\eta}+1-\alpha}}; \tag{B.44}$$

$$w^*=w^{wf}\left(\frac{1}{(1+r_d)}\right)^{\frac{(\eta-\alpha\eta)}{(\eta+1-\eta\alpha)}}\left(\frac{1}{(1+r_l)}\right)^{\frac{1}{(\eta+1-\eta\alpha)}}. \tag{B.45}$$

By substituting the equilibrium values into the previous equation, we obtain

$$\mathbb{E}\left[\left[\left(\frac{1}{N}\right)^{\frac{1}{\theta}}\left(\sum_{m\neq n} e_m^{\frac{1}{\theta}}+\widehat{e}_n^{\frac{1}{\theta}}\right)\right]^{\frac{1}{\theta-1}}\widehat{e}_n^{\frac{1}{\theta}}\right]=w^{wf}\left(\frac{L^{wf}}{JN}\right)^{1-\alpha}\frac{1}{A}N^{\frac{1}{\theta}}. \tag{B.46}$$

Appendix C

Appendix Chapter 3

C.1 Consumers' problem

$$U = q_{0t} + \int_{i\in\Omega} A_{it} q_{it}\, di - \frac{1}{2}\gamma \int_{i\in\Omega} (q_i)^2\, di - \frac{1}{2}\eta \left(\int_{i\in\Omega} q_i\, di \right)^2. \tag{C.1}$$

$$\max_{q_i, p_i} \quad \mathcal{L} = U + \phi(I - q_0 + \int q_i p_i \;\; di). \tag{C.2}$$

The FOCs' are

$$\frac{\partial \mathcal{L}}{\partial q_0} = 1 - \phi = 0; \tag{C.3}$$

$$\frac{\partial \mathcal{L}}{\partial q_i} = A_{it} - \gamma q_i - \eta \int q_i \; di - p_i \phi = 0; \tag{C.4}$$

$$\frac{\partial \mathcal{L}}{\partial \phi} = I - q_0 + \int q_i p_i \;\; di = 0. \tag{C.5}$$

Solving the problem we get

$$p_{it} = A_{it} - \gamma q_{it} - \eta Q_t, \tag{C.6}$$

where $Q_t = \int q_{it}\; di$ is the integration of the previous equation for all varieties

$$\underbrace{\int p_{it}\; di}_{\overline{p}_t N} = \underbrace{\int A_{it}\; di}_{N\overline{A}_t} - \underbrace{\gamma q_{it}\; di}_{\gamma Q_t} - \underbrace{\int \eta Q_t\; di}_{N\eta\; Q_t}. \tag{C.7}$$

Solving for Q we have

$$\overline{p}_t N = N\overline{A}_t - \gamma Q_t - \eta N Q_t; \tag{C.8}$$

$$Q_t = \frac{N(\overline{A}_t - \overline{p}_t)}{\gamma + \eta N}. \tag{C.9}$$

Sub the value of Q_t into the demand function

$$p_{it} = A_{it} - \gamma q_{it} - \eta \frac{N(\overline{A}_t - \overline{p}_t)}{\gamma + \eta N}. \tag{C.10}$$

In order to find the aggregate demanded quantity we have to solve the above problem for q_{it} and multiply for L (remember that we have a mass L of worker that provide one unity of work and the real wage is equal to 1)

$$q_{it} = \frac{L}{\gamma}\left(A_{it} - \eta\frac{N(\overline{A}_t - \overline{p}_t)}{\gamma + \eta N} - p_{it}\right) \tag{C.11}$$

$$;p_{it} = A_{it} - \eta\frac{N(\overline{A}_t - \overline{p}_t)}{\gamma + \eta N} - \frac{\gamma}{L}q_{it}. \tag{C.12}$$

C.2 Firms'problem

At time 2 firm i the problem faced by firm i is

$$\max_{q_i 2} \quad q_{i2}p_{i2} - cq_{i2} - i_i(1 + r_l). \tag{C.13}$$

The FOC is

$$\frac{\partial p_{i2}}{\partial q_{i2}}q_{i2} + p_{i2} - c = 0. \tag{C.14}$$

From we know that $\frac{\partial p_{i2}}{\partial q_{i2}} = -\frac{\gamma}{L}$ so sub in the previous equation we have

$$-\frac{\gamma}{L}q_{i2} + p_{i2} - c = 0. \tag{C.15}$$

Solving for q_i we have the quantity supplied

$$q^d_{i2} = \frac{L}{\gamma}\left(p_{i2} - c\right). \tag{C.16}$$

Equaling demand and supply we have

$$\underbrace{\frac{L}{\gamma}\left(p_{i2} - c\right)}_{\text{supply}} = \underbrace{\frac{L}{\gamma}\left(\eta\frac{N(\overline{A}_2 - \overline{p}_2)}{\gamma + \eta N} - p_{i2}\right)}_{demand} \tag{C.17}$$

$$p^*_{i2} = \frac{1}{2}\left(\eta\frac{N(\overline{A}_2 - \overline{p}_2)}{\gamma + \eta N} + c\right) \tag{C.18}$$

sub price in the demand we

$$q_i = \frac{L}{\gamma}\left(c_D - \underbrace{\frac{1}{2}\left(\eta\frac{N(\overline{A}_2 - \overline{p}_2)}{\gamma + \eta N} + c\right)}_{\text{equilibrium price}}\right) \tag{C.19}$$

$$q_i = \frac{1}{2}\frac{L}{\gamma}\left(\eta\frac{N(\overline{A}_2 - \overline{p}_2)}{\gamma + \eta N} - c\right). \tag{C.20}$$

Markup is equal to

$$\mu_{i2} = p_{it} - c; \tag{C.21}$$

$$\mu_{i2} = \frac{1}{2}\left(\eta\frac{N(\overline{A}_2 - \overline{p}_2)}{\gamma + \eta N} + c\right) - c; \tag{C.22}$$

$$\mu_{i2} = \frac{1}{2}\left(\eta\frac{N(\overline{A}_2 - \overline{p}_2)}{\gamma + \eta N} - c\right). \tag{C.23}$$

Profits are equal to

$$\pi_{i2} = \mu_{i2} q_{i2} - i_i(1 + r_l); \tag{C.24}$$

$$\pi_{i2} = \frac{1}{2}\left(\eta\frac{N(\overline{A}_2 - \overline{p}_2)}{\gamma + \eta N} - c\right) * \frac{1}{2}\frac{L}{\gamma}\left(\eta\frac{N(\overline{A}_2 - \overline{p}_2)}{\gamma + \eta N} - c\right) - i_i(1 + r_l); \tag{C.25}$$

$$\pi_{i2} = \frac{1}{4}\frac{L}{\gamma}\left(\eta\frac{N(\overline{A}_2 - \overline{p}_2)}{\gamma + \eta N} - c\right)^2 - i_i(1 + r_l). \tag{C.26}$$

C.2.1 Problem time 1

The problem faced by firm i at time 1 si

$$\max_{q_{i1}, i_i} \quad q_{i1} p_{i1} - c q_{i1} + \pi_{i2} \tag{C.27}$$

s. to

$$i_i \leq \lambda\, c f_{i1} \tag{C.28}$$

$$a_i = \frac{1}{b} i_i^{\theta} \tag{C.29}$$

$$\pi_{i2} = \frac{1}{4}\frac{L}{\gamma}\left(A_0 + a_i - \frac{\eta N(\overline{A}_2 - \overline{p}_2)}{\gamma + \eta N} - c\right)^2 - i_i(1 + r_l). \tag{C.30}$$

Sub the last two equation into the max problem we have

$$\max_{q_{i1}, i_i} \quad q_{i1} p_{i1} - c q_{i1} + \frac{1}{4}\frac{L}{\gamma}\left(A_0 + \frac{1}{b} i_i^{\theta} - \frac{\eta N(\overline{A}_2 - \overline{p}_2)}{\gamma + \eta N} - c\right)^2 - i_i(1 + r_l) \tag{C.31}$$

s. to

$$i_i - \lambda\left(p_{i1} q_{i1} - c q_{i1}\right) \leq 0 \tag{C.32}$$

The lagrangian is

$$\mathcal{L}(q_i 1, i_i) = p_{i1} q_{i1} - c q_{i1} + \frac{1}{4}\frac{L}{\gamma}\left(A_0 + \frac{1}{b} i_i^{\theta} - \frac{\eta N(\overline{A}_2 - \overline{p}_2)}{\gamma + \eta N} - c\right)^2 + i_i(1 + r_l) - \psi_i\left(\lambda p_{i1} q_{i1} - \lambda c q_{i1} - i_i\right). \tag{C.33}$$

FOCS' are

$$\frac{\partial \mathcal{L}}{\partial q_{i1}} = \frac{\partial p_{i1}}{\partial q_{i1}} q_{i1} + p_{i1} - c - \lambda\psi_i\left(\frac{\partial p_{i1}}{\partial q_{i1}} q_{i1} - p_{i1} - c\right) = 0; \tag{C.34}$$

$$\frac{\partial \mathcal{L}}{\partial i_i} = \frac{1}{2}\frac{L}{\gamma}\left(A_0 + \frac{1}{b} i_i^{\theta} - \frac{\eta N(\overline{A}_2 - \overline{p}_2)}{\gamma + \eta N} - c\right)\frac{\theta}{b} i_i^{\theta - 1} - (1 + r_l) + \psi_i = 0; \tag{C.35}$$

$$\psi_i\left(\lambda p_{i1} q_{i1} - \lambda c q_{i1} - i_i\right) = 0. \tag{C.36}$$

Notice that the equation C.34 is verified only if

$$\frac{\partial p_{i1}}{\partial q_{i1}} q_{i1} + p_{i1} - c = 0 \tag{C.37}$$

so, form C.12 we have that $\frac{\partial p_i}{\partial q_i} = -\frac{\gamma}{L}$. Solving C.37 for q_{i1} we have

$$q_{i1}^d = \frac{1}{2}\frac{L}{\gamma}\left(p_{i1} - c\right). \tag{C.38}$$

Matching demand and supply we have that

$$q_{i1} = \frac{1}{2}\frac{L}{\gamma}\left(A_0 - \frac{\eta N(\overline{A}_1 - \overline{p}_1)}{\gamma + \eta N} - c\right). \tag{C.39}$$

$$p_{i1} = \frac{1}{2}\left(A_0 - \frac{\eta N(\overline{A}_1 - \overline{p}_1)}{\gamma + \eta N} + c\right); \tag{C.40}$$

$$\mu_{i1} = \frac{1}{2}\left(A_0 - \frac{\eta N(\overline{A}_1 - \overline{p}_1)}{\gamma + \eta N} - c\right); \tag{C.41}$$

$$\pi_{i1} = \frac{1}{4}\frac{L}{\gamma}\left(A_0 - \frac{\eta N(\overline{A}_1 - \overline{p}_1)}{\gamma + \eta N} - c\right)^2. \tag{C.42}$$

Constrained firm invests up to the financial constraints is satisfied as equation. It means that $\psi > 0$ and so from equations C.36 and C.42 we have that

$$\lambda\frac{1}{4}\frac{L}{\gamma}\left(A_0 - \frac{\eta N(\overline{A}_1 - \overline{p}_1)}{\gamma + \eta N} - c\right)^2 - i_i = 0. \tag{C.43}$$

Solving for i_i we have that

$$i_i^c = \lambda\frac{1}{4}\frac{L}{\gamma}\left(A_0 - \frac{\eta N(\overline{A}_1 - \overline{p}_1)}{\gamma + \eta N} - c\right)^2. \tag{C.44}$$

When a specific firm is unconstrained $\psi = 0$. So FOC becomes

$$\frac{1}{2}\frac{L}{\gamma}\left(A_0 + \frac{1}{b}i_i^\theta - \frac{\eta N(\overline{A}_2 - \overline{p}_2)}{\gamma + \eta N} - c\right)\frac{\theta}{b}i_i^{\theta-1} = (1 + r_l) - \psi_i. \tag{C.45}$$

This equation cannot be solved analytically because its degree depends on the value of θ. Given this, we solve this problem using numerical methods. The second derivative is

$$\frac{\partial^2\mathcal{L}}{\partial^2 i_i} = \frac{1}{2}\frac{L}{\gamma}\left[\frac{\theta}{b}i_i^{\theta-1}\frac{\theta}{b}i_i^{\theta-1} + \frac{(\theta-1)\theta}{b}i_i^{\theta-2}\left(A_0 + \frac{1}{b}i_i^\theta - \frac{\eta N(\overline{A}_2 - \overline{p}_2)}{\gamma + \eta N} - c\right)\right]. \tag{C.46}$$