CONTRIBUTI DI RICERCA CRENOS

UNIVERSITÀ DI CAGLIARI UNIVERSITÀ DI SASSARI
CENTRE FOR NORTH SOUTH ECONOMIC RESEARCH
CRENoS
CENTRO RICERCHE ECONOMICHE NORD SUD

# FINANCIAL FRICTIONS AND MARKET POWER ACCUMULATION

Giommaria Spano

# WORKING PAPERS

2024/22

arkadia

**CENTRO RICERCHE ECONOMICHE NORD SUD**
**(CRENoS)**
**UNIVERSITÀ DI CAGLIARI**
**UNIVERSITÀ DI SASSARI**

CRENOS was set up in 1993 with the purpose of organising the joint research effort of economists from the two Sardinian universities (Cagliari and Sassari) investigating dualism at the international and regional level. CRENoS' primary aim is to improve knowledge on the economic gap between areas and to provide useful information for policy intervention. Particular attention is paid to the role of institutions, technological progress and diffusion of innovation in the process of convergence or divergence between economic areas. To carry out its research, CRENoS collaborates with research centres and universities at both national and international level. The centre is also active in the field of scientific dissemination, organizing conferences and workshops along with other activities such as seminars and summer schools.
CRENoS creates and manages several databases of various socio-economic variables on Italy and Sardinia. At the local level, CRENoS promotes and participates to projects impacting on the most relevant issues in the Sardinian economy, such as tourism, environment, transports and macroeconomic forecasts.

**www.crenos.unica.it**
**crenos@unica.it**

CRENoS – CAGLIARI
VIA SAN GIORGIO 12, I-09124 CAGLIARI, ITALIA
TEL. +39-070-6756397

CRENoS - SASSARI
VIA MURONI 25, I-07100 SASSARI, ITALIA
TEL. +39-079-213511

Title: FINANCIAL FRICTIONS AND MARKET POWER ACCUMULATION

Prima Edizione: Novembre 2024
ISBN: 978 88 6851 550 8


Viale Bonaria 98 - 09125 Cagliari
Tel. 070/6848663 - info@arkadiaeditore.it
www.arkadiaeditore.it

# Financial frictions and market power accumulation

**Giommaria Spano**[†]
*University of Sassari & CRENoS*

November 2024

**Abstract**

This paper examines the interplay between market power and financial frictions, highlighting the bidirectional relationship between firms' access to finance and competitive dynamics. We develop a theoretical model where firms invest in technology to enhance product quality, which increases their market power. In our model, firms with greater market power can invest more, thereby reinforcing and accumulating additional market power in subsequent periods. However, the general equilibrium effects of reducing financial frictions is not clear. 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.

**Keywords and phrases:** Market power, technology ladder, investment, financial frictions
**Jel Classification:** D22, D43, G31, G32, L13

[†] g.spano3@studenti.uniss.it

# 1 Introduction

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, Eeckhout, and Unger (2020) and Diez, Leigh, and Tambunlertchai (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 with the increase in market power, including a negative impact on business dynamics, a decline in the labor share, and wage stagnation (see De Loecker, Eeckhout, and Mongey (2021), Autor, Dorn, Katz, Patterson, and Van Reenen (2020), Autor, Dorn, Katz, Patterson, and Reenen (2017), Edmond, Midrigan, and Xu (2023), Peters (2020)).

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, Eeckhout, and Unger (2020), De Ridder (2024), Ayyagari, Demirgüç-Kunt, and Maksimovic (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 (this is in line with Bao and Eeckhout (2023), Liu, Mian, and Sufi (2022) that show that leaders might overinvest to acquire more market power). Altomonte, Favoino, Morlacco, and Sonno (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, Fazzari, and Petersen (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, Eeckhout, and Unger (2020), Cho, Grotteria, Kremens, and Kung (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 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 paper 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 firms' investment in technology that leads to the production of better quality consumption goods in a model à 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 in 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, Eeckhout, and Mongey (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 paper is organized as follows: in section 2, we present our model; in section 3, we solve numerically the theoretical model; in section 4, we discuss the interplay between financial frictions and market power; while in section 5, we discuss a possible dynamic development of our theoretical model. At the end, in section 6, we test one mechanism of our theoretical model.

## 2 Model

We consider a two-period economy populated by consumers, firms, and banks living for two periods. 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 while the homogeneous good is produced by perfect competition. The marginal cost is constant for all firms, but they are heterogeneous in terms of the quality of the goods they sell.

Firms receive a technology endowment determined by a random draw from a generic distribution[2]. 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,

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

firms decide how much to produce and whether to invest in technology in order to increase the quality of their products in the following period. This investment is costly and subject to financial frictions.

## 2.1 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

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

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 $\eta > 0$ denotes the substitutability between different varieties, while $\gamma \geq 0$ represents the degree of product differentiation among the varieties. The set $\Omega$ 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

$$q_{0t} + \int_{i\in\Omega} q_{it} p_{it}\, di \leq I_t^c \tag{2}$$

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 $i$ at time $t$:

$$p_{it} = A_{it} - \gamma q_{it} - \eta Q_t, \quad \forall i \in \Omega^* \tag{3}$$

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 for $q_{it}$, we get

$$q_{it}^d = \frac{L}{\gamma} \left( A_{it} - p_{it} - \eta \frac{N(\overline{A}_t - \overline{p}_t)}{\gamma + \eta N} \right) \tag{4}$$

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 4, we derive the maximum price at which variety $i \in \Omega^*$ can be sold in each time:

$$p_{max_t} = A_{it} - \eta \frac{N(\overline{A}_t - \overline{p}_t)}{\gamma + \eta N} \tag{5}$$

The maximum price depends on the size of the 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' investment in technology by affecting the quality of a specific variety affects the vertical product differentiation and not horizontal product differentiation[3]. 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[4].

Rewriting equation (5), we have that

$$p_{max_t} = \frac{\gamma A_{it} + \eta N(A_{it} - \overline{A}_t) + \eta N \overline{p}_t}{\gamma + \eta N} \tag{6}$$

In this case, we can see that for a quality sufficiently low with respect to its average, the maximum price that consumers are willing to pay tends toward zero, resulting in a negative demand of its specific variety. In this case, firms with insufficient quality do 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 as in Melitz and Ottaviano (2008)[5].

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 the 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, a higher level of aggregate quality induces a decrease in maximum price, leading to a lower elasticity.

### 2.2 Firms

We have a market with $N$ firms that produce differentiated goods, each producing a single variety under monopolistic competition. Labor is the sole production input, and as in Melitz and Ottaviano (2008), the numeraire good is produced under constant returns 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

[3]Differently from Di Comite, Thisse, and Vandenbussche (2014), where authors have both horizontal and vertical differentiation.

[4]This is in line with the definition of quality and vertical differentiation provided in the literature. See Di Comite, Thisse, and Vandenbussche (2014) among others.

[5]This is because in their quadratic utility function, all varieties share the same quality that is represented by the parameter $\alpha$

technological adoption. After entering into the market, they have the 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:

$$i_i(a_i) \leq \lambda \, cf_{it} \tag{7}$$

Let $i_i(a_i)$ 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 not be able to invest optimally. For simplicity, we assume that the maximum level of $\lambda$ is common across all firms and is influenced only by external factors that determine the overall value.

### 2.2.1 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.

### 2.2.2 Firms' problem at time 2

The problem faced by firm $i$ at time 2 is

$$\max_{q_i 2} \quad q_{i2}p_{i2} - cq_{i2} - i_i(a_i)(1 + r_l) \tag{8}$$

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

$$q^d_{i2} = \frac{L}{\gamma}\,(p_{i2} - c) \tag{9}$$

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 exiting if $i_i(a_i) = 0$. By equating supply and demand, we obtain the following equilibrium variables

$$q_{i2} = \frac{1}{2}\frac{L}{\gamma}\left(A_0 + a_i - \frac{\eta N(\overline{A}_2 - \overline{p}_2)}{\gamma + \eta N} - c\right) \tag{10}$$

$$p_{i2} = \frac{1}{2}\left(A_0 + a_i - \frac{\eta N(\overline{A}_2 - \overline{p}_2)}{\gamma + \eta N} + c\right) \tag{11}$$

$$\mu_{i2} = \frac{1}{2}\left(A_0 + a_i - \frac{\eta N(\overline{A}_2 - \overline{p}_2)}{\gamma + \eta N} - c\right) \tag{12}$$

$$\pi_{i2} = \frac{1}{4}\frac{L}{\gamma}\left(A_{i0} + a_i - \frac{\eta N(\overline{A}_2 - \overline{p}_2)}{\gamma + \eta N} - c\right)^2 - i_i(a_i)(1 + r_l) \tag{13}$$

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' willingness to pay, shifting demand upward, thereby increasing equilibrium price and quantity sold. Increased equilibrium price, without incurring higher marginal cost, allows 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 goods and at a lower price compared to others with a quality higher than the average.

### 2.2.3 Firms' problem at time 1

At time 1, firms choose the produced quantities that maximize 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

$$\max_{q_{i1}, i_i} \quad q_{i1}p_{i1} - cq_{i1} + \pi_{i2} \tag{14}$$

s. to

$$i_i \leq \lambda\, cf_{i1} \tag{15}$$

$$a_i = \frac{1}{b} i_i^{\theta} \tag{16}$$

$$\pi_{i2} = \frac{1}{4}\frac{L}{\gamma}\left(A_0 + \frac{1}{b}i_i^{\theta} - \frac{\eta N(\overline{A}_2 - \overline{p}_2)}{\gamma + \eta N} - c\right)^2 - i_i(1 + r_l) \tag{17}$$

where $\theta \in (0, 1)$ represents the elasticity of technology with respect to investment and $b$ is a weight parameter.

By substituting equations (62) and (17) into the objective function, the maximization problem can be reformulated as:

$$\max_{q_{i1}, i_i} \quad q_{i1}p_{i1} - cq_{i1} + \frac{1}{4}\frac{L}{\gamma}\left(A_0 + \frac{1}{b}i_i^{\theta} - \frac{\eta N(\overline{A}_2 - \overline{p}_2)}{\gamma + \eta N} - c\right)^2 - i_i(1 + r_l) \tag{18}$$

s. to

$$i_i \leq \lambda\left(p_{i1}q_{i1} - cq_{i1}\right) \tag{19}$$

The Lagrangian associated with the previous problem is

$$\mathcal{L} = p_{i1}q_{i1} - cq_{i1} + \frac{1}{4}\frac{L}{\gamma}\left(A_0 + \frac{1}{b}i_i^{\theta} - \frac{\eta N(\overline{A}_2 - \overline{p}_2)}{\gamma + \eta N} - c\right)^2 - i_i(1+r_l) + \psi_i\left(i_i - \lambda p_{i1}q_{i1} + \lambda c q_{i1}\right) \tag{20}$$

The first-order conditions (FOC) are

$$\frac{\partial \mathcal{L}}{\partial q_{i1}} = \frac{\partial p_{i1}}{\partial q_{i1}}q_{i1} + p_{i1} - c - \lambda\psi_i\left(\frac{\partial p_{i1}}{\partial q_{i1}}q_{i1} + p_{i1} - c\right) = 0 \tag{21}$$

$$\frac{\partial \mathcal{L}}{\partial i_i} = \frac{1}{2}\frac{L}{\gamma}\left(A_0 + \frac{1}{b}i_i^{\theta} - \frac{\eta N(\overline{A}_2 - \overline{p}_2)}{\gamma + \eta N} - c\right)\frac{\theta}{b}i_i^{\theta-1} - (1 + r_l) + \psi_i = 0 \tag{22}$$

$$\psi_i\left(i_i - \lambda p_{i1}q_{i1} + \lambda c q_{i1}\right) = 0 \tag{23}$$

where $\psi_i$ is the Lagrange multiplier associated with the problem. Since equation (67), 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

$$q_{i1} = \frac{1}{2}\frac{L}{\gamma}\left(A_0 - \frac{\eta N(\overline{A}_1 - \overline{p}_1)}{\gamma + \eta N} - c\right) \tag{24}$$

$$p_{i1} = \frac{1}{2}\left(A_0 - \frac{\eta N(\overline{A}_1 - \overline{p}_1)}{\gamma + \eta N} + c\right) \tag{25}$$

$$\mu_{i1} = \frac{1}{2}\left(A_0 - \frac{\eta N(\overline{A}_1 - \overline{p}_1)}{\gamma + \eta N} - c\right) \tag{26}$$

$$\pi_{i1} = \frac{1}{4}\frac{L}{\gamma}\left(A_0 - \frac{\eta N(\overline{A}_1 - \overline{p}_1)}{\gamma + \eta N} - c\right)^2 \tag{27}$$

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 (69) is satisfied as an equality. Substituting the equilibrium value of profit at time 1 into the equation (69), we obtain the level of investment for a constrained firm

$$i_i^c = \frac{\lambda L}{4\gamma}(A_0 - \frac{\eta N(\overline{A}_1 - \overline{p}_1)}{\gamma + \eta N} - c)^2 \tag{28}$$

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:

$$\frac{1}{2}\frac{L}{\gamma}\left(A_0 + \frac{1}{b}i_i^{u^\theta} - \frac{\eta N(\overline{A}_2 - \overline{p}_2)}{\gamma + \eta N} - c\right)\frac{\theta}{b}i_i^{u^{\theta-1}} = (1 + r_l) \tag{29}$$

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 firms 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.

## 2.3 Theoretical mechanism

After observing their quality shock, firms must decide whether or not to enter into 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 born 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[6]. Figure 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.

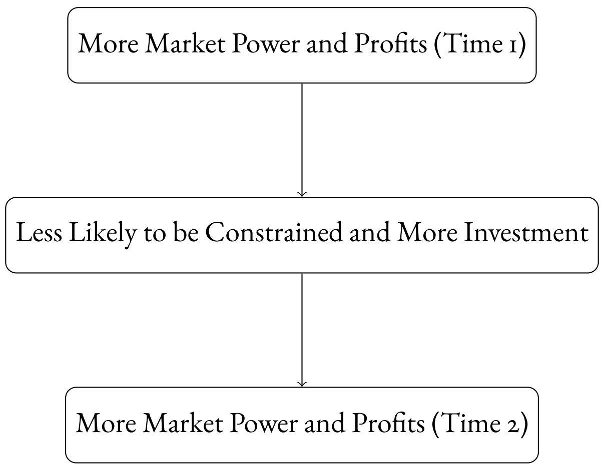



Figure 1: This figure illustrates the theoretical interaction between financial frictions and market power.

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 first derivative of the markup of firm $i$

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

at time 2 is

$$\frac{\partial \mu_{i2}}{\partial \lambda} = \frac{1}{2}\left(\frac{\partial A_{i2}}{\partial \lambda} - \eta \frac{\gamma \frac{\partial N}{\partial \lambda}(\overline{A_2} - \overline{p}_2) + N(\gamma + \eta N)\frac{\partial(\overline{A_2} - \overline{p}_2)}{\partial \lambda}}{(\gamma + \eta N)^2}\right) \tag{30}$$

From this equation, it becomes evident that there are 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, has a positive effect on a 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 goods, 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.

# 3 Numerical solution

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

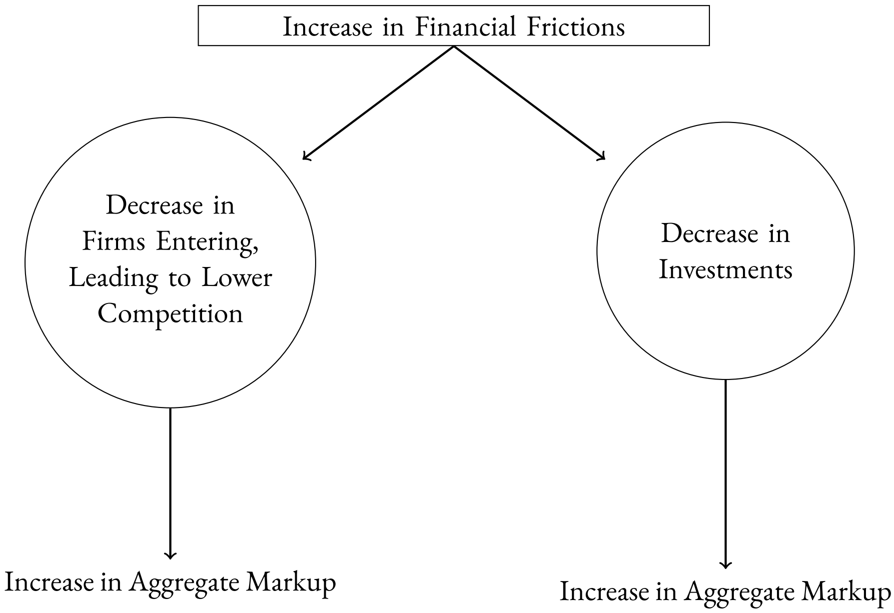



Figure 2: Effects of Increasing Financial Frictions

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 into 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 have not used a specific calibration approach. Our primary objective in this work is to understand the properties of the theoretical model and how financial frictions can influence the growth of market power. This analysis will be expanded in future versions of the model. The table below shows the parameters used to solve the model.

## 3.1 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 (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.

| Parameter | Description | Value |
|---|---|---|
| $\gamma$ | Differentiation | 1.5 |
| $\eta$ | Substitutability across varieties | 2 |
| $\lambda$ | Max ratio of debt to cash flow | 4.58 |
| $R_L$ | Interest rate on loans | 1.1 |
| $\theta$ | Elasticity of investment | 0.03 |
| $L$ | Total labor force | 100 |
| $c$ | Marginal cost | 1 |
| $a_{\text{low}}$ | Lower bound of technological shock | 0 |
| $a_{\text{up}}$ | Upper bound of technological shock | 4 |
| $f_E$ | Fixed entry cost | 2 |
| $b$ | Investment weight parameter | 1.5 |
| $\text{max}_{\text{firms}}$ | Potential entrants | 1000 |

Table 1: Parameter Calibration for Model

A higher level of market power affects a firm's investment level by influencing its financial constraints. Figure (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[7]. 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.

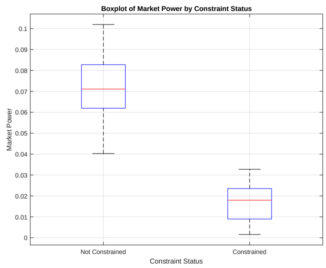
The dashed line in the figure represents the optimal level of investment that would be made if the firm were not constrained. For constrained firms, this line consistently lies above the actual investment level, indicating an aggregate loss in investment due to financial frictions. The inability of these 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 (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 solution 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.

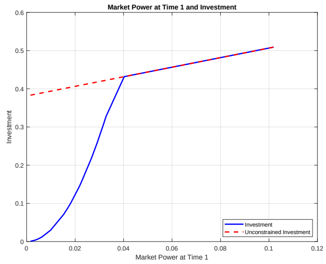
Investment also has an impact on the distribution of markups. From the first period to the second, both the mean and variance of market power increase. While the increase in mean is due to a static effect of firms having better technology, this also results in increased dispersion. Financial frictions 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

[7] 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.

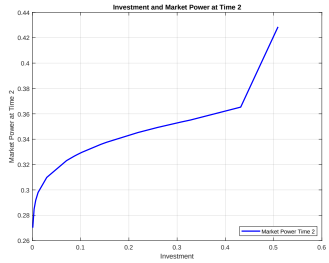
market power over time. In contrast, firms that can invest without constraints do so optimally, allowing them to allocate more resources and gain more market power.




(a) Market Power and Constraint Status.

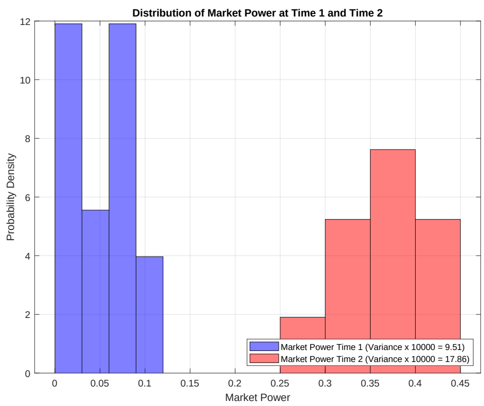



(b) Market Power at Time 1 and Investment.

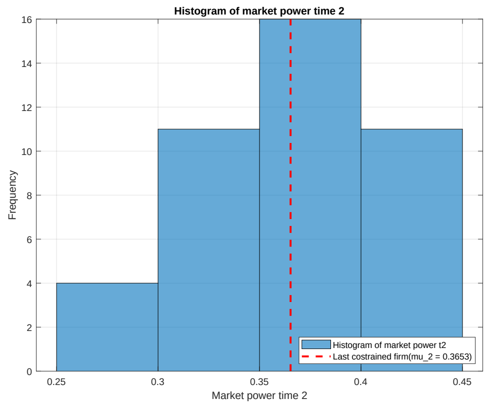



(c) Investment and Market Power at Time 2.

Figure 3: Combined Graphs Showing Market Power Analysis and Investment Relations.




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




(b) Histogram of $\mu_2$ with Vertical Line at Last Unconstrained Firm.

Figure 4: Analysis of Market Power Distribution and Unconstrained Firms.

## 4 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 (6), we observe that as financial frictions—represented by $\lambda$—are reduced, there is a steady increase in average investments. As $\lambda$ increases from values of 1 to 10, average investments rise from approximately 0.2 to over 0.4. This indicates that lower levels of financial friction encourage 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 results in an increase in average market power. Furthermore, when examining Figure 6, specifically the number of constrained firms as a function of $\lambda$, we see a clear decline in the number of constrained firms as financial frictions decrease. Initially, at higher $\lambda$ values, around 40 firms are financially constrained. However, as $\lambda$ is reduced, the number of financially constrained firms falls to below 20.

However, despite these positive outcomes in terms of investment and number of constrained firms, Figure (6) also shows that reducing financial frictions does not lead to an increase in market entry by new firms. Throughout the different $\lambda$ 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 (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 $\lambda$ 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 (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 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 $\lambda$ 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 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 $\lambda$.

## 4.1 Entry Channel and Financial Frictions

In this subsection, we introduce a new parametrization to facilitate the entry of new firms into the market[8], enabling us to examine the entry channel more effectively. Specifically, we increase the

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

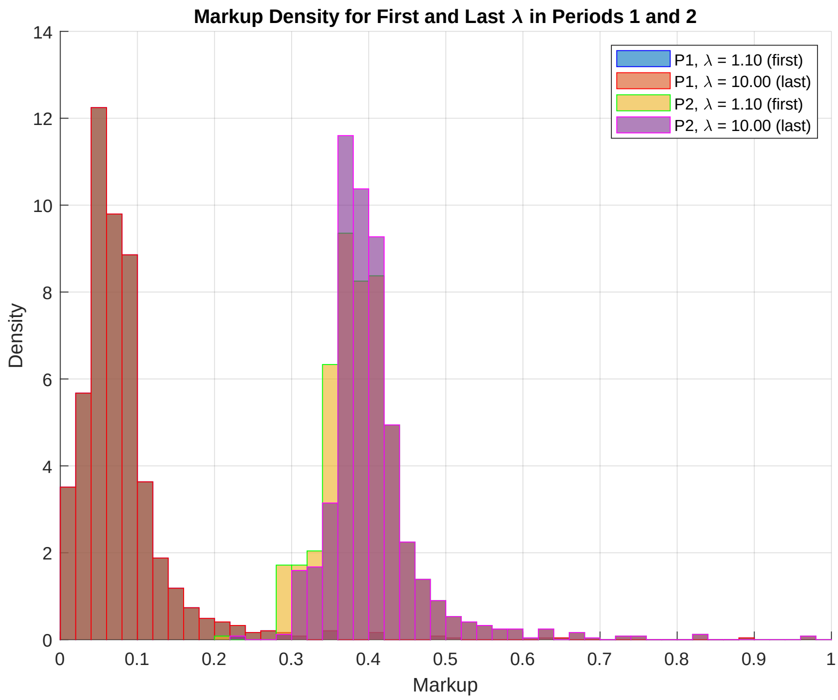



Figure 5: Markup Density for First and Last $\lambda$ in Periods 1 and 2. This figure shows the density distributions for both periods, for the first and last values of $\lambda$.

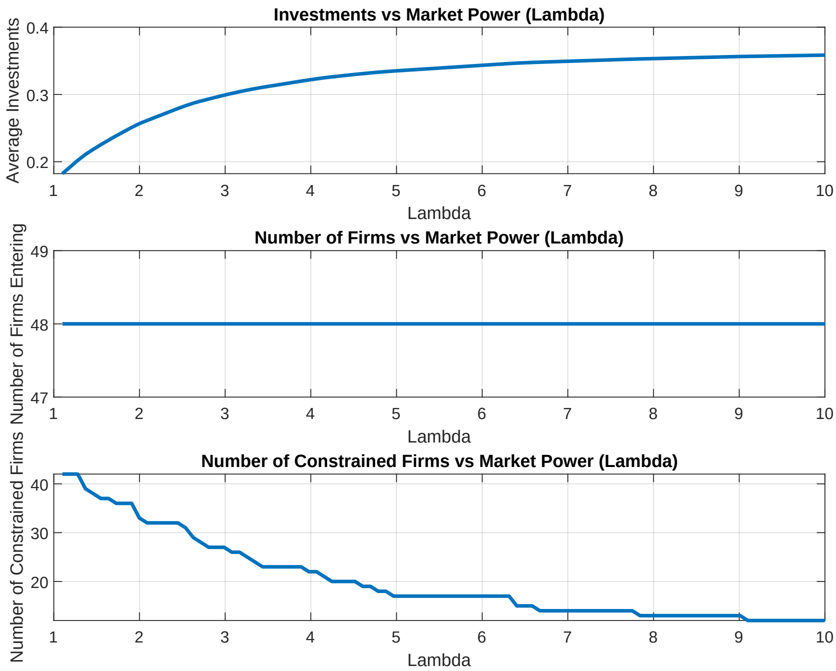



Figure 6: Investments vs Market Power. The plots show average investments, the number of firms entering, and the number of constrained firms as a function of $\lambda$.

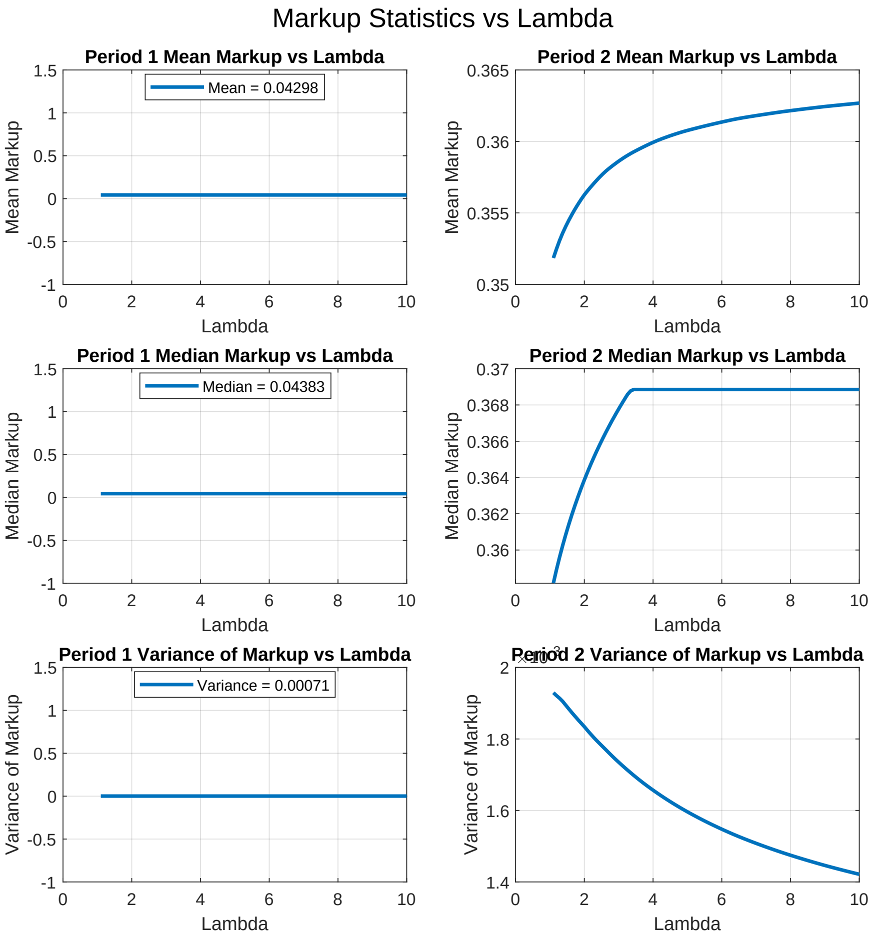



Figure 7: Subplots display the mean, median, and variance of markups as a function of $\lambda$ for both periods.

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 those firms that entered in the prior iteration with a lower $\lambda$ 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 (8) and (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 into 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 largely driven by partial equilibrium effects, since markup levels are 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 $\lambda$; however, the investment levels in the fixed-firm scenario remain consistently higher, indicating that entry has a negative impact on aggregate markup.

## 5 A Tentative dynamic quantitative model

In this section, we aim to outline how our model might be extended into a dynamic framework that, appropriately 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[9]. 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

[9]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

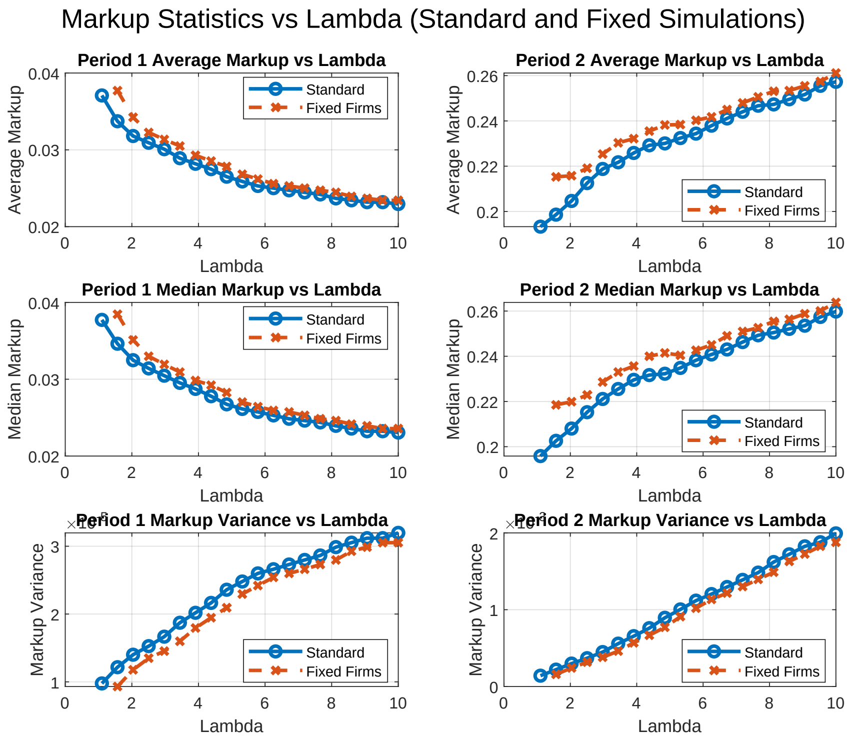



Figure 8: Relationship between average, median, and variance of markup and $\lambda$. The red line represents the model without the entry channel, highlighting the effect of reduced financial frictions in the first period, where increased profitability leads to greater market entry and competitive pressure.

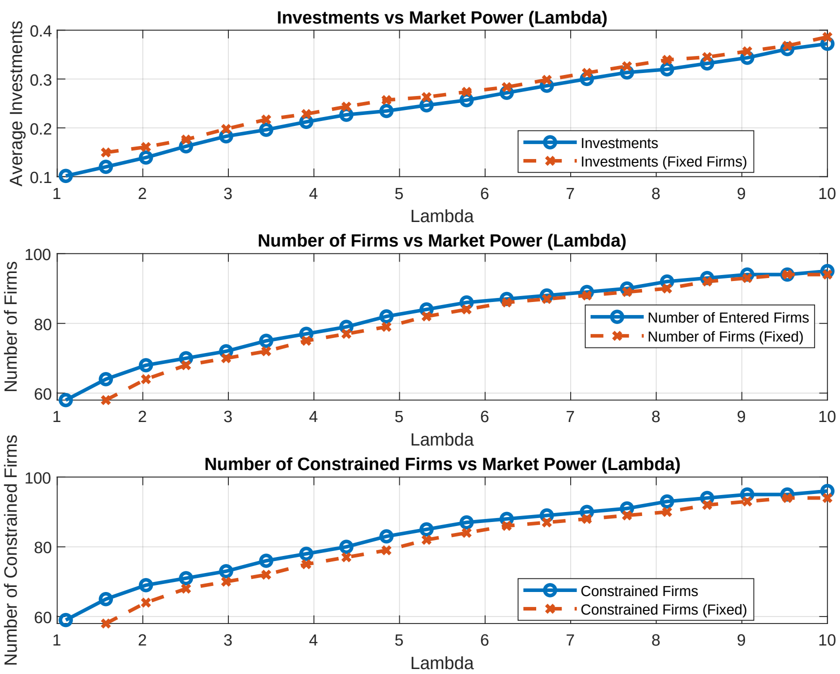



Figure 9: Investments and number of firms as a function of $\lambda$. Reduced financial frictions lead to an increase in the number of entering firms, which reduces first-period profits, while increased investment levels are sustained in the fixed-firm scenario.

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 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 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.

## 6 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 do so, we need both a financial friction indicator and a market power indicator.

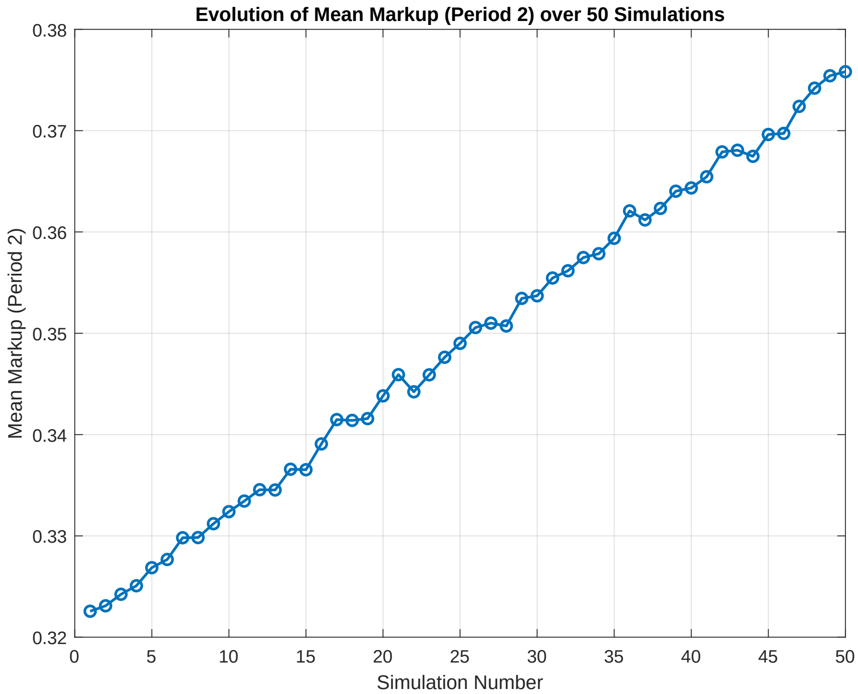



Figure 10: Evolution of Mean Markup (Period 2). The plot illustrates the progression of the mean markup in period 2 across multiple simulations.

Identifying a firm's financial frictions indicator is very challenging[10]. In the literature, as far as we know, there are two different ways to identify firm-specific financial frictions indicators. 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 all types of financial constraints to which a firm may be subjected[11]. 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 broad 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.

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

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

[11] A firm may be constrained on its assets or on its profits, or it may not be constrained but have to pay a higher interest rate. See Brunnermeier, Eisenbach, and Sannikov (2012) for a complete survey.

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 firm's markup is

$$\mu_{it} = \theta_{it}^{v} \frac{p_{it}Q_{it}}{p_{it}^{V}V_{it}} \tag{31}$$

where $\theta_{it}^{v}$ 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 measures of it. One is constant and following De Loecker, Eeckhout, and Unger (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 provided in De Loecker, Eeckhout, and Unger (2020), and the last one is the so-called cost-share approach. This approach is less time-consuming, and De Loecker, Eeckhout, and Unger (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

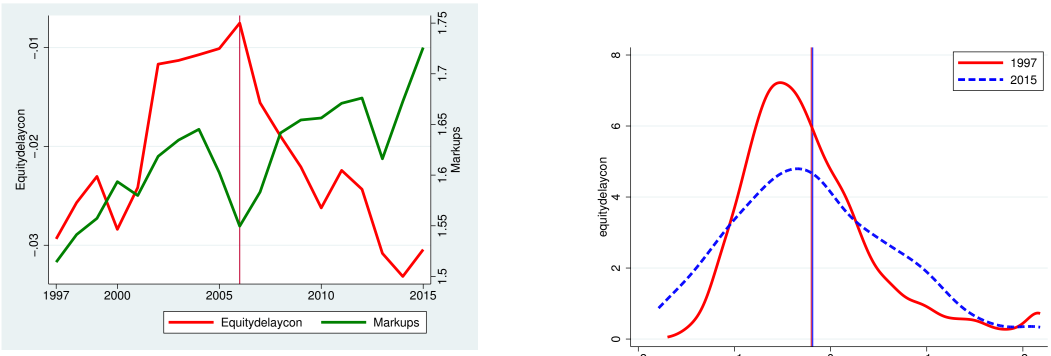
$$\alpha_{vt} = \frac{p^{V}V}{p^{V}V + rK + p^{X}X} \tag{32}$$

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 $\theta_{it}^{v}$ as the median of $\theta_{it}^{v} = \textbf{median}\ \{\alpha_{vt}\}$.

## 6.1 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. 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, Eeckhout, and Unger (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, Eeckhout, and Unger (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 not have the index constraint observation, and we consider only the manufacturing 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 11: Aggregate Markup and Financial Constraints

Figure (11a) shows a graphical representation of the estimated aggregate markups together with the time series of the aggregate *equitydelaycon* 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 continuing 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 levels of financial conditions. 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 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 (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[12] 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 constructed 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 the financial crisis, where the dependent variable indicates whether a firm exited from the dataset. The results, presented in Table (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.

| **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 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.

[12] 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.

## 6.2 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

$$equitydelaycon_{it} = \beta_1 + \beta_2\mu_{it-1} + \beta_3\mu_{it-1}^2 + \beta_x X_{it-1} + \epsilon_{it} \quad (33)$$

Where *equitydelaycon* represents the indicator of financial frictions for firm $i$ at time $t$, $\mu_{it-1}$ is the logarithm of markup for firm $i$ at time $t-1$ and $X$ is a set of control variables, and $\epsilon_{it}$ 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 regressions, we accounted for firm and industry year fixed effects and adjusted for standard errors clustered at the 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 chosen 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) and (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 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 specifications 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)<br>cost-share<br>equitydelaycon | (2)<br>production function<br>equitydelaycon | (3)<br>constant<br>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: 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.

| | (1) | (2) | (3) |
|---|---|---|---|
| | cost-share | production function | constant |
| VARIABLES | equitydelaycon | equitydelaycon | 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 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)<br>2 digit<br>equitydelaycon | (2)<br>3 digit<br>equitydelaycon | (3)<br>4 digit<br>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<br>(Firm Sector*Year) | YES | YES | YES |
| Cluster<br>(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 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)<br>2 digit<br>equitydelaycon | (2)<br>3 digit<br>equitydelaycon | (3)<br>4 digit<br>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<br>(Firm Sector*Year) | YES | YES | YES |
| Cluster<br>(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 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.

## 7 Conclusion

In this paper, we analyze how corporate market power and financial frictions interact with each other, highlighting the intricate relationship between access to finance and competitive dynamics. Through our theoretical model, we identify two main channels through which financial frictions can influence market power, each exerting distinct effects on firms and the broader market environment.

On one hand, firms with greater market power have easier access to financial resources. This enhanced ability to secure funding allows these firms to further expand their investment in technology, and ultimately strengthen their market power. This creates a reinforcing cycle, where greater market power leads to better financing opportunities, which in turn increases their capacity to grow and maintain dominance.

On the other hand, reducing financial frictions does not always lead to straightforward or uniform effects across the economy. The overall impact depends heavily on how the channels of general equilibrium and partial equilibrium interact.

In general, a reduction in financial frictions tends to allow firms to invest more, which can lead to an increase in their market power. By gaining easier access to finance, firms can expand investment plans. This often results in existing firms strengthening their positions within the market, potentially leading to a more concentrated market.

However, a decrease in financial frictions could also have the opposite effect by encouraging new firms to enter the market. When financial constraints are reduced, it becomes easier for emerging firms and startups to access the necessary capital to launch and sustain their businesses. This can generate a positive effect on competition, fostering a more dynamic marketplace. With more entrants competing for market share, the concentration of market power among a few large firms may be reduced, ultimately benefiting consumers through lower prices, increased innovation, and more diverse offerings.

The overall impact of financial frictions on market power is, therefore, the combined result of these two contrasting effects. Future versions of this model should focus on parameterizing it using real-world data to provide a more concrete and empirically grounded perspective. Incorporating actual economic data would allow us to better understand the complex interactions between these channels, as well as identify under what conditions each channel becomes dominant.

## References


Aghion, A., and P. Howitt (1992): "A Model of Growth Through Creative Destruction," Econometrica.

Altomonte, C., D. Favoino, M. Morlacco, and T. Sonno (2021): "Markups, intangible capital and heterogeneous financial frictions," .

Autor, D., D. Dorn, L. F. Katz, C. Patterson, and J. V. Reenen (2017): "Concentrating on the Fall of the Labor Share," American Economic Review, 107(5), 180–185.

Autor, D., D. Dorn, L. F. Katz, C. Patterson, and J. Van Reenen (2020): "The fall of the labor share and the rise of superstar firms," The Quarterly Journal of Economics, 135(2), 645–709.

Ayyagari, M., A. Demirgüç-Kunt, and V. Maksimovic (2024): "The rise of star firms: Intangible capital and competition," The Review of Financial Studies, 37(3), 882–949.

Bao, R., and J. Eeckhout (2023): "Killer Innovation," Discussion paper, Mimeo.

Brown, J. R., S. M. Fazzari, and B. C. Petersen (2009): "Financing innovation and growth: Cash flow, external equity, and the 1990s R&D boom," The Journal of Finance, 64(1), 151–185.

Brunnermeier, M. K., T. M. Eisenbach, and Y. Sannikov (2012): "Macroeconomics with financial frictions: A survey," .

Buehlmaier, M. M., and T. M. Whited (2018): "Are financial constraints priced? Evidence from textual analysis," The Review of Financial Studies, 31(7), 2693–2728.

Caggese, A., and G. Mesters (2023): "Identifying Firm-Level Financial Frictions using Theory-Informed Restrictions," .

Cho, T., M. Grotteria, L. Kremens, and H. Kung (2024): "The Present Value of Future Market Power," .

De Loecker, J., J. Eeckhout, and S. Mongey (2021): "Quantifying market power and business dynamism," University of Chicago, Becker Friedman Institute for Economics Working Paper, (2021-54).

De Loecker, J., J. Eeckhout, and G. Unger (2020): "The rise of market power and the macroeconomic implications," The Quarterly Journal of Economics, 135(2), 561–644.

De Ridder, M. (2024): "Market power and innovation in the intangible economy," American Economic Review, 114(1), 199–251.

Demirgüç-Kunt, A., and R. Levine (2018): Finance and growth. Edward Elgar Publishing Limited.

Di Comite, F., J.-F. Thisse, and H. Vandenbussche (2014): "Verti-zontal differentiation in export markets," Journal of International Economics, 93(1), 50–66.

Diez, M. F., M. D. Leigh, and S. Tambunlertchai (2018): Global market power and its macroeconomic implications. International Monetary Fund.

Drechsel, T. (2023): "Earnings-based borrowing constraints and macroeconomic fluctuations," American Economic Journal: Macroeconomics, 15(2), 1–34.

Edmond, C., V. Midrigan, and D. Y. Xu (2023): "How costly are markups?," Journal of Political Economy, 131(7), 1619–1675.

Farre-Mensa, J., and A. Ljungqvist (2016): "Do measures of financial constraints measure financial constraints?," The review of financial studies, 29(2), 271–308.

Grossman, G. M., and E. Helpman (1991): "Quality ladders in the theory of growth," The review of economic studies, 58(1), 43–61.

Hadlock, C. J., and J. R. Pierce (2010): "New evidence on measuring financial constraints: Moving beyond the KZ index," The review of financial studies, 23(5), 1909–1940.

Hoberg, G., and V. Maksimovic (2015): "Redefining financial constraints: A text-based analysis," The Review of Financial Studies, 28(5), 1312–1352.

Kaplan, S. N., and L. Zingales (1997): "Do investment-cash flow sensitivities provide useful measures of financing constraints?," The quarterly journal of economics, 112(1), 169–215.

Liu, E., A. Mian, and A. Sufi (2022): "Low interest rates, market power, and productivity growth," Econometrica, 90(1), 193–221.

Loecker, J. D., and F. Warzynski (2012): "Markups and firm-level export status," American economic review, 102(6), 2437–2471.

Melitz, M. J., and G. I. Ottaviano (2008): "Market size, trade, and productivity," The review of economic studies, 75(1), 295–316.

Peters, M. (2020): "Heterogeneous markups, growth, and endogenous misallocation," Econometrica, 88(5), 2037–2073.

Whited, T. M., and G. Wu (2006): "Financial constraints risk," The review of financial studies, 19(2), 531–559.

# A Consumers' problem

$$U = q_{0t} + \int_{i\in\Omega} A_{it} q_{it}\, di - \frac{1}{2}\gamma \int_{i\in\Omega} (q_i)^2\, di - \frac{1}{2}\eta \left( \int_{i\in\Omega} q_i\, di \right)^2 \tag{34}$$

$$\max_{q_i, p_i} \; \mathcal{L} = U + \phi(I - q_0 + \int q_i p_i \; di) \tag{35}$$

The FOCs' are

$$\frac{\partial \mathcal{L}}{\partial q_0} = 1 - \phi = 0 \tag{36}$$

$$\frac{\partial \mathcal{L}}{\partial q_i} = A_{it} - \gamma q_i - \eta \int q_i\, di - p_i \phi = 0 \tag{37}$$

$$\frac{\partial \mathcal{L}}{\partial \phi} = I - q_0 + \int q_i p_i \; di = 0 \tag{38}$$

Solving the problem we get

$$p_{it} = A_{it} - \gamma q_{it} - \eta Q_t \tag{39}$$

where $Q_t = \int q_{it}\, di$ Itegration the previous equation for all varieties

$$\underbrace{\int p_{it}\, di}_{\overline{p}_t N} = \underbrace{\int A_{it}\, di}_{N\overline{A}_t} - \underbrace{\gamma q_{it}\, di}_{\gamma Q_t} - \underbrace{\int \eta Q_t\, di}_{N\eta\, Q_t} \tag{40}$$

Solving for $Q$ we have

$$\overline{p}_t N = N\overline{A}_t - \gamma Q_t - \eta N Q_t \tag{41}$$

$$Q_t = \frac{N(\overline{A}_t - \overline{p}_t)}{\gamma + \eta N} \tag{42}$$

Sub the value of $Q_t$ into the demand function

$$p_{it} = A_{it} - \gamma q_{it} - \eta \frac{N(\overline{A}_t - \overline{p}_t)}{\gamma + \eta N} \tag{43}$$

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)

$$q_{it} = \frac{L}{\gamma} \left( A_{it} - \eta \frac{N(\overline{A}_t - \overline{p}_t)}{\gamma + \eta N} - p_{it} \right) \tag{44}$$

$$p_{it} = A_{it} - \eta \frac{N(\overline{A}_t - \overline{p}_t)}{\gamma + \eta N} - \frac{\gamma}{L} q_{it} \tag{45}$$

## B Firms'problem

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

$$\max_{q_i 2} \quad q_{i2}p_{i2} - cq_{i2} - i_i(1+r_l) \tag{46}$$

The FOC is

$$\frac{\partial p_{i2}}{\partial q_{i2}} q_{i2} + p_{i2} - c = 0 \tag{47}$$

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

$$-\frac{\gamma}{L} q_{i2} + p_{i2} - c = 0 \tag{48}$$

Solving for $q_i$ we have the quantity supplied

$$q_{i2}^d = \frac{L}{\gamma}\left(p_{i2} - c\right) \tag{49}$$

Equaling demand and supply we have

$$\underbrace{\frac{L}{\gamma}\left(p_{i2} - c\right)}_{\text{supply}} = \underbrace{\frac{L}{\gamma}\left(\eta \frac{N(\overline{A}_2 - \overline{p}_2)}{\gamma + \eta N} - p_{i2}\right)}_{demand} \tag{50}$$

$$p_{i2}^* = \frac{1}{2}\left(\eta \frac{N(\overline{A}_2 - \overline{p}_2)}{\gamma + \eta N} + c\right) \tag{51}$$

sub price in the demand we

$$q_i = \frac{L}{\gamma}\left(c_D - \underbrace{\frac{1}{2}\left(\eta \frac{N(\overline{A}_2 - \overline{p}_2)}{\gamma + \eta N} + c\right)}_{\text{equilibrium price}}\right) \tag{52}$$

$$q_i = \frac{1}{2}\frac{L}{\gamma}\left(\eta \frac{N(\overline{A}_2 - \overline{p}_2)}{\gamma + \eta N} - c\right) \tag{53}$$

Markup is equal to

$$\mu_{i2} = p_{it} - c \tag{54}$$

$$\mu_{i2} = \frac{1}{2}\left(\eta \frac{N(\overline{A}_2 - \overline{p}_2)}{\gamma + \eta N} + c\right) - c \tag{55}$$

$$\mu_{i2} = \frac{1}{2}\left(\eta \frac{N(\overline{A}_2 - \overline{p}_2)}{\gamma + \eta N} - c\right) \tag{56}$$

Profits are equal to

$$\pi_{i2} = \mu_{i2}q_{i2} - i_i(1 + r_l) \tag{57}$$

$$\pi_{i2} = \frac{1}{2}\left(\eta\frac{N(\overline{A}_2 - \overline{p}_2)}{\gamma + \eta N} - c\right) * \frac{1}{2}\frac{L}{\gamma}\left(\eta\frac{N(\overline{A}_2 - \overline{p}_2)}{\gamma + \eta N} - c\right) - i_i(1 + r_l) \tag{58}$$

$$\pi_{i2} = \frac{1}{4}\frac{L}{\gamma}\left(\eta\frac{N(\overline{A}_2 - \overline{p}_2)}{\gamma + \eta N} - c\right)^2 - i_i(1 + r_l) \tag{59}$$

## B.1 Problem time 1

The problem faced by firm $i$ at time 1 si

$$\max_{q_{i1}, i_i} \quad q_{i1}p_{i1} - cq_{i1} + \pi_{i2} \tag{60}$$

s. to

$$i_i \leq \lambda\, cf_{i1} \tag{61}$$

$$a_i = \frac{1}{b}i_i^{\theta} \tag{62}$$

$$\pi_{i2} = \frac{1}{4}\frac{L}{\gamma}\left(A_0 + a_i - \frac{\eta N(\overline{A}_2 - \overline{p}_2)}{\gamma + \eta N} - c\right)^2 - i_i(1 + r_l) \tag{63}$$

Sub the last two equation into the max problem we have

$$\max_{q_{i1}, i_i} \quad q_{i1}p_{i1} - cq_{i1} + \frac{1}{4}\frac{L}{\gamma}\left(A_0 + \frac{1}{b}i_i^{\theta} - \frac{\eta N(\overline{A}_2 - \overline{p}_2)}{\gamma + \eta N} - c\right)^2 - i_i(1 + r_l) \tag{64}$$

s. to

$$i_i - \lambda\left(p_{i1}q_{i1} - cq_{i1}\right) \leq 0 \tag{65}$$

The lagrangian is

$$\mathcal{L}(q_i1, i_i) = p_{i1}q_{i1} - cq_{i1} + \frac{1}{4}\frac{L}{\gamma}\left(A_0 + \frac{1}{b}i_i^{\theta} - \frac{\eta N(\overline{A}_2 - \overline{p}_2)}{\gamma + \eta N} - c\right)^2 + i_i(1 + r_l) - \psi_i\left(\lambda p_{i1}q_{i1} - \lambda cq_{i1} - i_i\right) \tag{66}$$

FOCS' are

$$\frac{\partial\mathcal{L}}{\partial q_{i1}} = \frac{\partial p_{i1}}{\partial q_{i1}}q_{i1} + p_{i1} - c - \lambda\psi_i\left(\frac{\partial p_{i1}}{\partial q_{i1}}q_{i1} - p_{i1} - c\right) = 0 \tag{67}$$

$$\frac{\partial\mathcal{L}}{\partial i_i} = \frac{1}{2}\frac{L}{\gamma}\left(A_0 + \frac{1}{b}i_i^{\theta} - \frac{\eta N(\overline{A}_2 - \overline{p}_2)}{\gamma + \eta N} - c\right)\frac{\theta}{b}i_i^{\theta-1} - (1 + r_l) + \psi_i = 0 \tag{68}$$

$$\psi_i\left(\lambda p_{i1}q_{i1} - \lambda cq_{i1} - i_i\right) = 0 \tag{69}$$

Notice that the equation ?? is verified only if

$$\frac{\partial p_{i1}}{\partial q_{i1}} q_{i1} + p_{i1} - c = 0 \tag{70}$$

so, form 45 we have that $\frac{\partial p_i}{\partial q_i} = -\frac{\gamma}{L}$. Solving 70 for $q_{i1}$ we have

$$q^d_{i1} = \frac{1}{2}\frac{L}{\gamma}\left(p_{i1} - c\right) \tag{71}$$

Matching demand and supply we have that

$$q_{i1} = \frac{1}{2}\frac{L}{\gamma}\left(A_0 - \frac{\eta N(\overline{A}_1 - \overline{p}_1)}{\gamma + \eta N} - c\right) \tag{72}$$

$$p_{i1} = \frac{1}{2}\left(A_0 - \frac{\eta N(\overline{A}_1 - \overline{p}_1)}{\gamma + \eta N} + c\right) \tag{73}$$

$$\mu_{i1} = \frac{1}{2}\left(A_0 - \frac{\eta N(\overline{A}_1 - \overline{p}_1)}{\gamma + \eta N} - c\right) \tag{74}$$

$$\pi_{i1} = \frac{1}{4}\frac{L}{\gamma}\left(A_0 - \frac{\eta N(\overline{A}_1 - \overline{p}_1)}{\gamma + \eta N} - c\right)^2 \tag{75}$$

Constrained firm invests up to the financial constraints is satisfied as equation. It means that $\psi > 0$ and so from equations 69 and 75 we have that

$$\lambda\frac{1}{4}\frac{L}{\gamma}\left(A_0 - \frac{\eta N(\overline{A}_1 - \overline{p}_1)}{\gamma + \eta N} - c\right)^2 - i_i = 0 \tag{76}$$

Solving for $i_i$ we have that

$$i^c_i = \lambda\frac{1}{4}\frac{L}{\gamma}\left(A_0 - \frac{\eta N(\overline{A}_1 - \overline{p}_1)}{\gamma + \eta N} - c\right)^2 \tag{77}$$

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

$$\frac{1}{2}\frac{L}{\gamma}\left(A_0 + \frac{1}{b}i_i^\theta - \frac{\eta N(\overline{A}_2 - \overline{p}_2)}{\gamma + \eta N} - c\right)\frac{\theta}{b}i_i^{\theta-1} = (1 + r_l) - \psi_i \tag{78}$$

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

$$\frac{\partial^2 \mathcal{L}}{\partial^2 i_i} = \frac{1}{2}\frac{L}{\gamma}\left[\frac{\theta}{b}i_i^{\theta-1}\frac{\theta}{b}i_i^{\theta-1} + \frac{(\theta-1)\theta}{b}i_i^{\theta-2}\left(A_0 + \frac{1}{b}i_i^\theta - \frac{\eta N(\overline{A}_2 - \overline{p}_2)}{\gamma + \eta N} - c\right)\right] \tag{79}$$

## Ultimi Contributi di Ricerca CRENoS

*I Paper sono disponibili in:* http://www.crenos.unica.it

**24/21** *Giommaria Spano,* "Common ownership and uncertainty"

**24/20** *Luca Deidda, Ettore Panetti,* "Bank Recovery and Resolution Planning, Liquidity Management and Fragility"

**24/19** *Steven B. Caudill, Laura Ciucci, Claudio Detotto,* "Bargaining power: Do individuals outperform groups?"

**24/18** *Marta Meleddu, Dimitri Paolini, Valeria Posadas,* "Determinants of Tourists' Expenditure: Systematic Literature Review, Meta-analysis, and Econometric Analysis"

**24/17** *Pasqualina Arca, Gianfranco Atzeni and Luca Deidda,* "Collateral requirements, cost of credit, and firms' discouragement from applying for bank loans"

**24/16** *Giampiero M. Gallo, Ostap Okhrin, Giuseppe Storti,* "Dynamic tail risk forecasting: what do realized skewness and kurtosis add?"

**24/15** *Stefano Borgioli, Giampiero M. Gallo, Chiara Ongari,* "Financial Returns, Sentiment and Market Volatility: a Dynamic Assessment"

**24/14** *Vincenzo Candila, Oguzhan Cepni, Giampiero M. Gallo, Rangan Gupta,* "Influence of Local and Global Economic Policy Uncertainty on the volatility of US state-level equity returns: Evidence from a GARCH-MIDAS approach with Shrinkage and Cluster Analysis"

**24/13** *Ester Rita Lucia Sanna, Marta Meleddu,* "Integrating justice and ecological economics: a theoretical framework and indicator toolkit for analysing conflict in protected areas"

**24/12** *Federico Aresu, Emanuela Marrocu, Raffaele Paci,* "EU funds and TFP growth: how the impact changed over time and space"

**24/11** *Ivan Etzo, Raffaele Paci, Cristian Usala,* "Brain gain vs. brain drain. The effects of universities' mobile students on territorial inequalities"

**24/10** *Giommaria Spano,* "Financial frictions, common ownership and firms' market power in a general equilibrium model"

**24/09** *Roberto Saba, Anna Pireddu,* "Energy and Environmental Synergy: Cooperative Strategies for the Euro-Mediterranean Transition"

**24/08** *Maria Grazia Pittau, Francesco Politano, Roberto Zelli,* "Educational divide between voters: A nationwide trend?"

**24/07** *Federico Atzori, Vittorio Pelligra,* "Framed norms. The effect of choice-belief information on tax compliance"

**24/06** *Simone Nobili,* "Concentration, Market Power and International Tax Competition"

**24/05** *Maria Grazia Pittau, Pier Luigi Conti, Roberto Zelli,* "Inference for deprivation profiles in a binary setting"

**24/04** *Edoardo Otranto,* "A Vector Multiplicative Error Model with Spillover Effects and Co-movements"

**24/03** *Luca Serafini, Emanuela Marrocu, Raffaele Paci,* "Smart Strategies, Smarter Performance: the Impact of S3 and Industry 4.0 on Firms' Outcomes"

**24/02** *Hugues Champeaux, Elsa Gautrain, Karine Marazyan,* "Men's premarital migration and marriage payments: Evidence from Indonesia"

**24/01** *Pablo Álvarez-Aragón, Hugues Champeaux,* "Measuring Norms and Enumerator Effects: Survey Method Matters"

**23/15** *Fabio Cerina, Xavier Raurich,* "Saving Behaviour and the Intergenerational Allocation of Leisure Time"

**23/14** *Leonardo Vargiu, Bianca Biagi, Maria Giovanna Brandano, Paolo Postiglione,* "Research Infrastructures and Regional Growth: the case of Europe" www.crenos.unica.it

ISBN 978-88-6851-550-8