Markups, Intangible Capital and Heterogeneous Financial Frictions*

Altomonte, C. — Bocconi University
Favoino, D. — Erasmus University
Morlacco, M. — USC
Sonno, T. — University of Bologna

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Abstract

We study the importance of financial frictions for markups heterogeneity. Heterogeneous credit constraints distort the decision of firms to invest in a cost-reducing technology (akin, but not limited to, intangible capital). The resulting dispersion in marginal costs interact with variable demand elasticity to generate endogenous dispersion in markups. Financial variables operate both at the extensive margin, by acting as a barrier to entry into investment, and at the intensive margin, by distorting the level of investment of individual firms. We test the model predictions in the context of a quasi-natural experiment in France, using balance-sheet data from 2002 to 2013 for a representative sample of French manufacturing firms. Our results shed light on the sources of markup heterogeneity and misallocation.

Keywords: Markups, financial frictions, firm heterogeneity, fixed cost technology

*We thank Gianmarco Ottaviano for useful comments and fruitful discussions. All errors are our own. Email: carlo.altomonte@unibocconi.it (Altomonte); domenico.favoino@gmail.it (Favoino); morlacco@usc.edu (Morlacco); tommaso.sonno@unibo.it (Sonno)

1 Introduction

The observed increase in both markups and markup heterogeneity in recent years has led to concerns about the overall level of efficiency of modern economies (De Loecker et al., 2019; Gutiérrez and Philippon, 2017). While a growing theoretical and empirical literature has studied the aggregate trend, there has been relatively less work analyzing the sources of the vast and increasing differences in price-cost margins across firms.[1] Yet what generates distortions in general equilibrium is the *dispersion* in markups, rather than its absolute level (Lerner et al., 1934), and measured efficiency gains from elimination of markups differences are estimated large (Edmond et al., 2015; Peters, 2020).

A large literature in finance studies the role of financing frictions for firms. The standard view is that by raising the shadow cost of external funds for investment projects, financial constraints may distort the decision to entry, invest, or adopt technology.[2] A second set of studies considers instead the role of finance as a source of capital misallocation across firms (Midrigan and Xu, 2014; Moll, 2014; Gopinath et al., 2017; David and Venkateswaran, 2019). Since differences in marginal costs generate differences in markups under general demand systems, these studies seem to suggest that financial frictions may be an important source of markups dispersion across firms. However, this channel has been largely overlooked in the literature, where the standard assumption is that markups are exogenous and constant across firms.

In this paper we analyze whether financial factors are an important source of markups heterogeneity, both qualitatively and quantitatively. Our premise is that with the rise in information technology and intangible capital investment (Autor et al., 2017; Hsieh and Rossi-Hansberg, 2019), a firm's ability to price over marginal cost have become increasingly tied to its ability to access capital markets, which may be heterogeneous across firms in presence of liquidity or collateral constraints.

We theoretically decompose the effect of financial market imperfections on markups into two channels: an *extensive margin* channel, whereby aggregate financial conditions affect selection into a modern sector featuring lower marginal costs and higher markups; and an *intensive margin* channel, whereby heterogeneous liquidity constraints affect the *level* of marginal cost reduction associated with the investment in the modern technology. While the former channel has been already studied in the financial literature (Peters and

[1] Among studies of the aggregate markup trend, see De Loecker and Eeckhout (2018); De Loecker et al. (2019); Gutiérrez and Philippon (2017); Syverson (2019); Barkai (2019) for explanation based on increasing market power of firms, and Karabarbounis and Neiman (2013); Autor et al. (2017); Aghion et al. (2019); De Ridder (2019) for theories of markup evolution based on technological changes.

[2] See, e.g. Hubbard, 1998; Aghion et al., 2010; Manova, 2012; Chaney, 2016

Schnitzer, 2015; Egger et al., 2018), this paper is the first to investigate the importance of the intensive margin channel. We argue that accounting for both margins is key to rationalize the joint behavior of markups and financial variables observed in the data.

To bear on the question of how markup heterogeneity is related to technology adoption and financial variables, we exploit balance-sheet data from 2002 to 2013 for a large representative sample of French manufacturing firms, retrieved via the Bureau van Dijk's Amadeus database. A number of stylized facts motivate our main analysis. First, we document a positive correlation between fixed cost expenditures and the amount of debt held by firms. As pointed out by a number of studies, fixed cost expenditures may reflect investment in new fixed-cost technologies enabling adopters to produce at lower marginal cost and to charge higher markups (Bloom et al., 2012; Haskel and Westlake, 2018; Hsieh and Rossi-Hansberg, 2019; De Ridder, 2019). We interpret this fact as evidence that firms require routine access to external capital to finance costs not directly related to production. We then show that measures of heterogeneous firm cost of external finance are negatively and significantly correlated with their chosen level of fixed cost expenditures, even after controlling for standard measures of firm size and productivity. Ceteris paribus, firms that face higher cost of financing spend less in fixed costs. This evidence suggests that firms may be constrained in their ability to finance fixed cost investments. Finally, we document a positive and significant cross-sectional correlation between fixed cost expenditures and firm-level markups. Taken together, our stylized facts provide support to the hypothesis that heterogeneous financial frictions may induce equilibrium dispersion in markups by affecting the shadow cost of some cost-reducing technology.

To shed light on the underlying mechanisms, and to provide further guidance on the empirical analysis, we incorporate imperfect financial markets into a theoretical model with heterogeneous firms, fixed cost technology, and endogenous markups. Consistent with the empirical evidence, we allow for two sources of financial frictions. First, we assume that firms are heterogeneous in their cost of accessing external funds. We name the (inverse) cost of external funds as the firm's *financial capability*. Second, we assume that all firms are subject to aggregate collateral constraints. Heterogeneous financial capability induces variation in the shadow cost of external funds. Its role is thus reminiscent of that of heterogeneous liquidity constraints on a firm decision to invest in innovation and R&D emphasized in the finance literature (Mulkay et al., 2001; Hall and Lerner, 2010; Ayyagari et al., 2011; Gorodnichenko and Schnitzer, 2013). The aggregate collateral constraint captures instead frictions that affect all firms equally.

In our economy, firms might choose to operate either in a traditional or in a modern sector. In the traditional sector, firms are identical and use labor as the only input in production. In the modern sector, firms have the option to combine labor with a second input, which we might think of as an intangible input, that allows them to lower the unit cost of production. Entering the modern sector entails both fixed and variable sunk costs (Hsieh and Rossi-Hansberg, 2019; De Ridder, 2019). These costs are front-loaded and cannot be financed with future revenues. Liquidity constrained firms need thus to resort to external capital markets to enter the modern sector.

We show that both financial capability and aggregate collateral requirements affect the equilibrium markups distribution. Variable markups in the model emerge by means of variable elasticity of demand, and move inversely with a firm's marginal cost. Firms with higher financial capability are less constrained in terms of liquidity, invest more in the fixed cost technology and charge higher markups. We refer to this channel as the *intensive margin* channel. High collateral requirements lower the expected profits of prospective entrants into the modern sector, effectively acting as a barrier of entry for less financially capable firms (Aghion et al., 2007). We refer to this channel as the *extensive margin* channel.

To causally test the model predictions, we exploit a quasi-natural experiment in France that limited the credit terms that firms could receive from their suppliers. In 2009, France enacted a law introducing a cap of 60 days on the payment terms authorized in transactions contracted within the country. The law was effectively enforced, and acted as a positive liquidity shock to firms operating in industries in which delays of payment were longer than 60 days, inducing exogenous variation in working capital needs across French firms (Beaumont and Lenoir, 2019). We exploit the exogenous variation in credit terms as an instrument for the variation of French firms' financial capability, and we establish a causal positive relationship between a firm's financial capability and its markup over marginal cost. We show that this effect is mostly driven by an effect of liquidity constraints on the firm's adoption of fixed cost technologies. This result is robust to including a set of fixed effects and control variables accounting for potential confounding factors.

Our results shed light on the sources of markup dynamics in advanced economies. We find evidence in support to the hypothesis that the rise of fixed cost technologies have tied a firm's success to its ability of accessing external capital. To the extent that firms with high markups have better access to external capital, the existence of imperfect capital markets may have contributed to the widening in markups differences across firms observed in recent years. Our results provide support to technology-based explanations of markups dynamics. Industrial policy could dampen the dispersion in markups across firms, and the associated misallocation of resources, by alleviating liquidity constraints of the least financially capable firms.

This paper contributes to the burgeoning literature on the real effects of financial frictions. Credit constraints have been shown to distort firm-level investment and technology adoption (Hubbard, 1998; Aghion et al., 2010; Manova, 2012; Midrigan and Xu, 2014; Chaney, 2016). Traditionally, studies in this literature model finance as a barrier to entry for firms, such that credit constraints operate at the extensive margin. This paper puts forward the idea that as fixed cost expenditures may affect a firm's variable costs, finance can also affect a firm's ability to price over marginal costs.

Our analysis also speaks to the literature on the sources of markup variations across firms. We belong to a burgeoning literature relating markups heterogeneity to variations in marginal cost across firms (Berman et al., 2012; Amiti et al., 2014; Burstein and Gopinath, 2014; Edmond et al., 2015; Arkolakis and Morlacco, 2017; Arkolakis et al., 2018). Existing papers attribute all the differences in marginal costs to a single measure of firm heterogeneity, namely production efficiency. In our model, the productivity residual of firm output consists of two components: a production efficiency component, and a financial component. We show that heterogeneous financial capability is a quantitavely important source of cost and markups variation across firms. Our results thus contribute to opening the black box of firm total factor productivity.

2 Data and main Covariates

We analyze a comprehensive firm-level data set for manufacturing firms in France based on the Orbis database provided by Bureau van Dijk. The dataset includes a wide array of balance sheet information, including profit accounts and financial variables. We merge these data via industry classifiers with Input-Output (IO) tables for France obtained from the World Input-Output Database. Overall, the dataset comprises more than 2.4M observation spanning the period between 2003 and 2017, with information for more than 150K firms per year.

For the econometric analysis, we only consider those firms that report the number of employees for more than 50% of the years in the sample. The final dataset comprises more than 150K manufacturing firms. These data are representative of the official size distribution for firms in France even within narrow sub-categories.[3] In what follows, we present the main covariates at the firm level.

[3]We use linear interpolation techniques on the main variables of interest if the distance between two consecutive non-missing data points is no greater than three years. For total employment, this procedure substantially reduces the mean, median and the standard deviation of the variable. To ensure representativeness, we construct weights based on firm size in terms of employees, building on official information from SBS. The correlation between our dataset and the SBS database is 0.89 for the average number of employees.

Financial Capability. We construct a measure of firm-level *financial capability* using the index of firms' external finance constraints proposed by Whited and Wu (2006; WW henceforth). The WW index captures the shadow cost of external finance for firms, and is estimated via GMM as a structural combination of several balance sheet variables.[4] To facilitate interpretation, we have inverted and normalized the index to take only values between 0 and 1, such that the score ranges from 0 (no financial capability) to 1 (maximum financial capability). The mean average index in our sample is 0.11 (s.d. of 0.17), denoting the presence of a mass of firms with relatively tight financial constraints, and a long, less dense tail of firms exposed to better financial conditions.

Markups and productivity. To estimate markups and productivity at firm level we start from De Loecker and Warzynski (2012, henceforth DLW), who estimate markups combining output elasticity with respect to an input with the share of the input expenditure on total sales. The DLW methodology is particularly suited for our estimation strategy as it obtains output elasticity from the estimation of a general production function, without imposing any particular substitution elasticity with respect to other inputs (variable or fixed) in production, and allowing for different sources of firm heterogeneity, as in our framework.

We thus start from estimating the production function of manufacturing firms using the methodology in Wooldridge (2009). For the baseline sample, we choose a Translog specification for the production function, with a third-order polynomial expansion in (contemporaneous) values of capital, and lagged material and labor inputs. The advantages of using a Translog specification is that it allows for variation across firms in the output elasticities. As a robustness check we also perform our analysis using a Cobb-Douglas specification, but results are not qualitatively affected.[5] Once output elasticities have been estimated, we back-out measures of firm-level revenue productivity as the residual in the production function. We then obtain firm-level markups by dividing the output elasticity with respect to a variable input by the revenue share of that input. As in

[4] We calculate the WW index of a firm i in sector j and period t as:

$$WW_{ijt} = -0.91\frac{CF_{ijt}}{TASS_{ijt}} + 0.021\frac{NCLijt}{TASS_{ijt}} - 0.044log(TASS) + 0.102\overline{\Delta SALES}_{jt} - 0.35\Delta SALES_{ijt}$$

where CF, TASS and NCL denote cashflow, total assets and non-current liabilities, respectively; $\overline{\Delta SALES}_{jt}$ and $\Delta SALES_{ijt}$ is the one period growth rate in sales of sector *j* or firm *ij* between *t-1* and *t*. As a robustness check, we compute the WW-index by incorporating a proxy for dividends and, additionally, by restricting the sample to firms with positive dividends. The results, however, remain virtually unchanged.

[5] De Loecker and Warzynski (2012) discuss how, under a Cobb-Douglas technology, the output elasticity reduces to a constant, so that the bias induced by unobserved output prices affects only the estimated level of the markup, not its correlation with firm characteristics.

De Loecker and Eeckout (2019), the item from the financial statement of the firm that we will use to measure the variable input is "Cost of Goods Sold"(COGS), which is a sum of wage bills and material costs.

Finally, we measure fixed cost expenditures as Overhead costs, booked under "Selling, General and Administrative Expenses" (SG&A), as in De Loecker and Eeckout (2019). This item includes selling expenses (salaries of sales personnel, advertising, rent), general operating expenses, and administration (executive salaries, general support related to the overall administration).

3 Stylized Facts

In what follows we document three basic facts in the data about the interplay between a firm's financial position and markup behavior. These regularities will in turn guide the specification of our formal model in Section 4.

Fact 1: *Firms with higher fixed costs expenditures have higher long term debt and lower short term assets and liabilities.*

Table 1 shows the results of a firm-level fixed effect regression of the SG&A/Sales ratio on measures of long term and short term debts. We try both between regressions and within regressions. In both cases the coefficient on long term debt is positive and significant, and the one on cash flows over asset is negative and significant.[6]

Fact 2: *Firms with higher fixed costs expenditures have higher financial capability*

Table 2 shows the correlation between the SG&A/Sales ratio and financial capability at the firm level. We employ both a within and between specification. More specifically, within regressions control for industry-year and firm fixed effects. Between regressions control for industry-year fixed effects only.

The within specification captures the effect of firm specific changes in financial capability associated to changes in fixed cost expenditures, within a sector-year. Not surprisingly, the coefficient is negative and significant, pointing at the fact that in the year in which the fixed expenditure is sustained, the financial capability of the firm decreases. More interesting for our purposes is the result of the between specification, which captures the overall relation between financial capability and fixed cost expenditures. Within each industry-year, this correlation is positive and significant, consistent with fact 1. Results are robust to the use of different proxies of financial capability (different version

[6] These results are completely robust if we do not include the two controls Size and K/L.

Table 1: Stylized Fact 1

	(1)	(2)	(3)	(4)	(5)	(6)
			OLS			
			SG&A/Sales			
Total Long Term Debt	0.0371***			0.0371***		
	(0.00893)			(0.00893)		
Cash Flow / Assets		-0.0577***			-0.0577***	
		(0.0216)			(0.0216)	
Current Assets / Assets			-0.0382**			-0.0382**
			(0.0165)			(0.0165)
Size	-0.0217***	-0.0231***	-0.0222***	-0.0217***	-0.0231***	-0.0222***
	(0.00164)	(0.00172)	(0.00185)	(0.00164)	(0.00172)	(0.00185)
KL	0.0178***	0.0175***	0.0201***	0.0178***	0.0175***	0.0201***
	(0.00521)	(0.00534)	(0.00564)	(0.00521)	(0.00534)	(0.00564)
Constant	0.401***	0.424***	0.426***	0.401***	0.424***	0.426***
	(0.0105)	(0.0113)	(0.0134)	(0.0105)	(0.0113)	(0.0134)
Observations	5,853	5,662	4,777	5,853	5,662	4,777
R-squared	0.425	0.427	0.423	0.425	0.427	0.423
Year-Sector FE	Yes	Yes	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes	No	No	No

Note: Standard errors are in parentheses, * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$. All variables are in logs. Size is proxied by (log) turnover and KL is the capital/labour ratio (calculated as 0.2*fixed assets / cost of employees).

of the WW-index) as well as to the inclusion of firm-level controls (Size and the Capital/Labor ratio)

Fact 3: *There is a positive and significant correlation between firm-level markups and expenditures on fixed costs, and between firm-level markups and measures of financial capability.*

Table 3 shows the correlation between firms' markups and financial capability, as well as between firms' markups and the SG&A/Sales ratio.

Correlations are positive and significant, across both the within (Columns 1 to 3) and the between (Columns 4 to 6) specifications. Results are robust to different proxies of financial capability, as well as to the inclusion of firm-level controls (size and the capital/labour ratio).

4 Theoretical Framework

Motivated by the stylized facts above, in this section we set up a theoretical model with heterogeneous firms to investigate the equilibrium relationship between financial variables, fixed costs expenditures, and markups.

Table 2: Stylised Fact 2

	(1)	(2)	(3)	(4)
	OLS			
	SG&A/Sales			
Whited and Wu	-0.342***		0.330***	
	(0.107)		(0.114)	
Whited and Wu_D		-0.555***		0.949***
		(0.201)		(0.161)
Size	-0.0303***	-0.0261**	-0.0297***	-0.0454***
	(0.0115)	(0.0129)	(0.00313)	(0.00433)
KL	0.0168***	0.0190***	0.0130*	0.0108*
	(0.00564)	(0.00579)	(0.00666)	(0.00654)
Constant	0.640***	0.713***	0.291***	0.0901
	(0.0847)	(0.0959)	(0.0448)	(0.0562)
Observations	2,873	2,883	4,297	4,314
R-squared	0.915	0.915	0.444	0.453
Year-Sector FE	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	No	No

Note: Standard errors are in parentheses, * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$. All variables are in logs. Whited and $WU_D istheWW - indexincorporatingaproxyfordividends.Sizeisproxiedby(log)turnoverandKListhecapital/labourratio(calculatedas0.2 * fixedassets/costofemployees).$

4.1 Intangibles and Production

A continuum of firms produce differentiated varieties $\omega \in \Omega$ of a final good, where Ω is the set of existing varieties (or firms). As in Midrigan and Xu (2014), we assume that producers operate in one of two sectors: a traditional sector that uses only labor as the input in production, and a modern sector that combines labor with a modern technology, that allows to reduce the variable cost of each unit of output produced, in exchange for a fixed costs (Hsieh and Rossi-Hansberg, 2019; De Ridder, 2019). We let $s \in [0, 1)$ denote the (endogenous) fraction of marginal cost reduction chosen by the firm.

Firms can hire any desired amount of labor at a fixed unitary wage w, which we normalize equal to one. Workers are free to move across sectors such that the wage does not vary by sector. Expenditure on intangibles is governed instead by a twice-differentiable function $f(s)$, which we assume increasing and convex.[7]

In the traditional sector, all firms are identical and produce according to a constant returns technology $q(\omega) = l(\omega)$. The total costs of producing q units of good $\omega \in \Omega$ is

[7] In particular, we impose that $f(\cdot)$ satisfies the following conditions: $f(0) = 0$, $\lim_{s \to 1} f(s) = \infty$, with $f' > 0$ and $f'' > 0$. The latter condition means that the cost of completely eliminating marginal costs is infinite, such that all firms have positive marginal costs in equilibrium.

Table 3: Stylised Fact 3

	(1)	(2)	(3)	(4)	(5)	(6)
	OLS					
	Markup					
SG&A/Sales	1.062***			1.069***		
	(0.0734)			(0.0440)		
Whited and Wu		1.112***			2.128***	
		(0.249)			(0.220)	
Whited and Wu Revenues			1.897***			2.251***
			(0.573)			(0.339)
Size	0.104***	0.0396	0.0256	-0.00723**	-0.0775***	-0.0830***
	(0.0155)	(0.0349)	(0.0391)	(0.00349)	(0.00674)	(0.00961)
KL	0.0553***	0.0414***	0.0347**	0.0443***	0.0410***	0.0384***
	(0.0135)	(0.0141)	(0.0149)	(0.0111)	(0.0136)	(0.0139)
Constant	-0.578***	-0.483**	-0.765***	0.193***	-0.181**	-0.166
	(0.107)	(0.218)	(0.241)	(0.0284)	(0.0853)	(0.117)
Observations	2,551	2,282	2,289	4,208	3,290	3,296
R-squared	0.920	0.903	0.902	0.543	0.490	0.476
Year-Sector FE	Yes	Yes	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes	No	No	No

Note: Standard errors are in parentheses, * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$. All variables are in logs. Whited and WU$_D istheWW - indexincorporatingaproxyfordividends.Sizeisproxiedby(log)turnoverandKListhecapital/labourratio(calculatedas0.2 * fixedassets/costofemployees)$.

equal to $TC(q) = wq = q$, where the latter equality follows from the wage normalization. In constrast, technology in the modern sector can be written as: $q(\omega) = \frac{1}{1-s} l(\omega)$, and features the following total cost function:

$$TC(q) = (1-s)\, q + f(s). \tag{1}$$

Equation (1) makes clear the role of the modern technology, that is, to increases the fixed costs of producing a given good in exchange for a reduction in the variable cost. The effect on the firm's cost structure implies a change in the timing of expenses and revenues for the firm: as expenses become front-loaded, the firm may not be able to cover ethem with internal revenues and may need to recur to capital markets for accessing business credit. This feature of the modern technology is important to establish a role for imperfect financial markets in equilibrium.

4.2 Credit-constrained Producers

Entry into the modern sector requires a up-front sunk investment f_M in entry cost, and an upfront variable investment in the modern technology, summarized by the function$f(s)$. Financial markets are imperfect, and firms cannot pledge future revenues to pay these costs, which means that they are liquidity constrained. Firms have access to an external banking sector, from which they can borrow provided that they pledge a required level of collateral.

We assume that the cost of external finance is heterogeneous to producers, for exogenous reasons.[8] We call the inverse of this cost a firm's *financial capability,* and denote it by $\tau \in \mathbb{R}_+$. To capture the role of heterogeneous financial capability in a tractable way, we assume that a firm whose financial capability is τ has to turn to external capital to finance only a fraction $\frac{1}{1+\tau}$ of the initial investment $f_M + f(s)$. The remaining fraction $\frac{\tau}{1+\tau}$ can be financed through internal funds, available to the firm *before* production takes place, or through costless borrowing. Intuitively, the parameter τ captures the firm's ability to access cheap external finance, and inversely capture a firm's liquidity constraints.

4.2.1 Banks

Firms can pledge a fraction $\theta \in (0, 1)$ of the entry cost f_E as collateral.[9] Firms that fund their intangible expenditures and pledge the required level of collateral have to repay $R(s, \tau)$ to banks. The term θ captures inversely the tightness of the financial market. The lower θ, the lower the amount of collateral that firms are able to pledge, the higher the repayment needed to induce banks to participate.

Repayment is made with exogenous probability $\lambda \in [0, 1]$ as in Manova (2012). With probability $(1 - \lambda)$ the financial contract is not enforced, the firm defaults, and the bank seizes the collateral θf_E. The bank's participation constraint is thus:

$$-\frac{1}{1+\tau}\left(f(s) + f_M\right) + \left[\lambda R(s, \tau) + (1 - \lambda)\theta f_E\right] \geq 0. \tag{2}$$

Given perfect competition in the banking sector, the participation constraint holds with

[8] The exogenous cost of finance can be micro-funded in a dynamic model as the value of the Lagrangean multiplier on the firm's borrowing constraint (e.g. Midrigan and Xu, 2014). Altough this cost is inherently an endogenous object, the exogeneity assumption allows us to work within a tractable static setting. This assumption is justified in our case as we test the model predictions exploiting cross-sectional exogenous variation in the shadow cost of finance generated by a change in the French trade law.

[9] This assumption is without loss of generality. The main model results would be qualitatively unchanged if we assumed that the collateral requirement is revenue-(or quantity-)based. This latter assumption would intuitively capture the fact that financing needs are increasing in firm size.

equality for all banks. It follows that the payment $R(s,\tau)$ is determined by the firms so as to bring the financier to his participation constraint.

4.3 Entry

We finally discuss the timing of the entry game. In order to enter the traditional sector, firms pay a sunk entry cost f_E and draw financial capability τ from a distribution $G(\tau)$ with support over $\mathbb{R}_+$. We assume that firms are endowed with some initial capital which is used to cover these entry costs. Once τ is known, firms can form expectations over profits in both sectors.

Free entry into the traditional sector implies that all "traditional" firms make zero profits. The zero profits condition in the traditional sector pins down the measure of traditional firms, N^t. Entry into the modern sector will depend on whether the expected profits are high enough to cover the expected repayment to banks.

4.4 Demand

Finally, we discuss demand. Consumers have symmetric preferences over goods produced by firms, regardless of the sector they operate in. To allow for endogenous markups in equilibrium, we choose a flexible demand system that encompasses several standard choices in the macro and international literature, following Arkolakis et al. (2018). The representative consumer's demand for variety $\omega \in \Omega$ when income is Y and prices are $\mathbf{p} \equiv \{p_\omega\}_{\omega\in\Omega}$, is

$$q_\omega \equiv q(p_\omega, P, Q) = QD\left(p_\omega/P\right), \tag{3}$$

where $D\left(x\right) \in \mathcal{C}^2(x)$ is a twice continuously differentiable function, with $D'_x < 0$. The aggregate demand shifters $Q(\boldsymbol{p}, Y)$ and $P(\boldsymbol{p}, Y)$ are taken as given by the firms, and are jointly determined from standard utility maximization constraints.[10] We further assume that demand features a choke price, that is, a price p^* such that $D(p^*/P) = 0$.

We denote the elasticity of demand as $\varepsilon(y) = -\partial \ln D(y)/\partial \ln y$, where $y \equiv p/P$. The assumptions on the demand system in (3) imply that the demand elasticity varies across firms, as long as firms charge different prices.

[10] The aggregate shifters $Q(\boldsymbol{p}, Y)$ and $P(\boldsymbol{p}, Y)$ solve the following systen of equations:

$$\begin{array}{rcl} \int_{\omega\in\Omega}\left[H\left(\frac{p_\omega}{P}\right)\right]^\beta\left[p_\omega QD\left(\frac{p_\omega}{P}\right)\right]^{1-\beta}d\omega & = & Y^{1-\beta} \\ Q^{1-\beta}\left[\int_{\omega\in\Omega}p_\omega QD\left(\frac{p_\omega}{P}\right)\right]^\beta d\omega & = & Y^\beta, \end{array}$$

with $\beta \in \{0,1\}$ and $H(\cdot)$ strictly increasing and concave. If $\beta = 1$, preferences are homothetic. Conversely, if $\beta = 0$, preferences are non-homothetic unless utility functions are CES.

4.5 Equilibrium in the traditional sector

We first describe equilibrium for firms that are active in the traditional sector. Because firms in the traditional sector are homogeneous and produce at unitary marginal cost, the problem of a representative firm in this sector can be written as:

$$\begin{aligned}&\max_{p}(p-1)q(p,P,Q)\\&\text{s.t.}q(p,P,Q)=QD\left(p/P\right).\end{aligned} \tag{4}$$

Each firm will choose the price equal to a markup over the unitary marginal cost. The price can be found by solving the implicit function:

$$p=\frac{\varepsilon\left(p/P\right)}{\varepsilon\left(p/P\right)-1},$$

where P is the price index, taken as given by the firms, which reflect prices in both the traditional and the modern sector, and where $\mu(y)\equiv\varepsilon(y)/(\varepsilon(y)-1)$ is a markup that depends on the slope of the demand function $\varepsilon=-D'$. Notice that because firms are homogeneous, they will charge the same markup over marginal cost which will be a function of the aggregate price index only: $\mu=\tilde{\mu}(P)$. Because consumer preferences are symmetric over varieties, the aggregate price index will both reflect prices of firms in the traditional and the modern sector. Total sales by each firm operating in the traditional sector will be given by:

$$x(y)=LQ\mu(y)D(y). \tag{5}$$

4.6 Intangibles, Financial Markets, and Markups

In the modern sector, each firm maximizes operating profits by statically choosing the optimal price p and the fraction by which it reduces marginal costs s, subject to demand, liquidity and bank participation constraints. Heterogeneous financial capability τ only affect the firm's problem through its effect on the entry costs. Each firm thus solves the following problem

$$\max_{p,s} p \cdot q(p,P,Q) - (1-s)q(p,P,Q) - \left[\lambda R(s,\tau) + (1-\lambda)\theta f_E\right],$$

$$\text{s.t.} q(p,P,Q) = QD\left(p/P\right) \tag{6}$$

$$\left[p-(1-s)\right] q(p,P,Q) \geq R(s,\tau) \tag{7}$$

$$-\frac{1}{1+\tau}\left(f(s)+f_M\right) + \left[\lambda R(s,\tau) + (1-\lambda)\theta f_E\right] \geq 0. \tag{8}$$

We solve the problem by first considering instances when the liquidity constraint (7) does not bind. Substituting the bank participation constraint (8) and demand (6) in the profit function, the firm's maximization problem simply reads as:

$$\max_{p,s}\left[p+s-1\right] D\left(p/P\right) Q - \frac{1}{1+\tau}\left(f(s)+f_M\right). \tag{9}$$

For a given level of intangible input s, the problem of the firm is isomorphic to that of a firm producing with constant marginal cost $(1-s)$, which means that the optimal prices, markups, revenues and profits are at first-best levels and are the same as in Arkolakis et al. (2018). In particular, the optimal price will satisfy:

$$p = \frac{\varepsilon\left(p/P\right)}{\varepsilon\left(p/P\right)-1}(1-s), \tag{10}$$

where $\varepsilon(\cdot) > 1$ is the price elasticity of demand and $c \equiv (1-s)$ is the firm's (endogenous) marginal cost. Sales of each firm will depend both on the price index, as in the traditional sector, but also on the level of firm investment s :

$$x(s,y) = LQ(1-s)\mu(y)D(y)$$

Notice that because $s \in [0,1)$, the marginal cost $c \leq 1$, which means that firms in the modern sector have lower marginal cost than firms in the traditional sector and charge higher markups, given $\varepsilon = -D' > 0$. The higher the choice of s, the lower the marginal cost and the higher the price-cost margin. We use this insight to characterize the optimal choice of intangibles s in the next section.

4.6.1 Intangibles

Let $r(s) = \left(\mu(y(s))-1\right)(1-s)QD\left(y(s)\right)$ denote a firm's net revenues. Given problem (9), it is easy to show that the optimal firm choice of intangible s satisfies the following condition:

$$r_s' = \frac{1}{1+\tau} f_s'. \tag{11}$$

Condition (11) simply states that the firm chooses s to set marginal benefits equal to marginal costs. In the Appendix we prove the following proposition:

Proposition 1 : *All else constant, firms with higher financial capability τ choose a higher level of intangibles s, and thus have lower marginal costs.*

The proposition follows from the fact that equation (11) admits a unique solution of the form $s = s(\tau)$, with $s' > 0$.

4.6.2 Markups and Financial Frictions

We now discuss the markups implication of Proposition 1. Let us denote by $\Gamma \equiv -\frac{d \ln \mu(y)}{d \ln y} = \Gamma(y)$ the markup elasticity to relative price y. While Γ can both take positive and negative values, we will restrict to demand functions that feature $\Gamma \geq 0$, which is the empirically relevant case (Burstein and Gopinath, 2014).[11] By log differentiating equation (10), and rearranging terms, one can show that:

$$d \ln \mu(\tau) = \frac{\Gamma}{1+\Gamma} \frac{s(\tau)}{1-s(\tau)} d \ln s(\tau) + \frac{\Gamma}{1+\Gamma} d \ln P. \tag{12}$$

Equation (12) says that dispersion in markups across firms depends on the dispersion of financial capability, via their effect on optimal investment in the modern technology s. Firms with high τ choose higher s, and charge higher markups given $\frac{\Gamma}{1+\Gamma} > 0$. We can summarize this discussion with the following comparative statistics on markups (see Appendix for a derivation):

$$\tfrac{\partial \mu}{\partial \tau} = \tfrac{\Gamma}{1+\Gamma} \cdot \tfrac{1}{1-s(\tau)} \cdot \mu(\tau) \cdot \tfrac{\partial s}{\partial \tau} > 0;$$

The latter leads to the following:

Proposition 2 : *All else constant, firms with higher financial capability τ, charge higher markups.*

4.7 Extensive Margin

Having characterized the equilibrium distribution of markups and intangibles for firms that are far from the liquidity constraint, we now turn to discuss selection into the modern

[11] Note that in the limit case when demand is CES, markups are constant and $\Gamma = 0$.

sector. The liquidity constraint determines the set of firms partecipating in the modern sector, as it will bind for firms with low levels of τ. To determine the firm's participation cutoff, one can infer the payment $R(s,\tau)$ from the bank's participation constraint and substitute it in (7) to write:

$$r(\tau) - \frac{1}{\lambda}\left[\frac{f(\tau)+f_M}{1+\tau}\right] = -\left(\frac{1-\lambda}{\lambda}\right)\theta f_E, \tag{13}$$

where we substituted $s^* = s(\tau)$. In the Appendix we show that the left hand side of (13) is monotonically increasing in τ, and is negative for $\tau \to 0$ given $\lambda \in (0,1)$. It follows that entry into the modern sector features a cutoff rule whereby only firms with high enough values of τ will enter. We denote the entry cutoff as $\tau^*(\lambda,\theta)$. Low values of θ or high values of λ, which corresponds to tighter financial markets, raises the entry barriers and raises the entry cutoff.

Proposition 3 : *Entry into the modern sector features a cutoff entry rule whereby only firms with $\tau > \tau^*(\theta,\lambda)$ will decide to enter. The cutoff value increases in the severity of the financial frictions, namely:*

$$\frac{\partial\tau^*}{\partial\theta} < 0 \quad \& \quad \frac{\partial\tau^*}{\partial\lambda} < 0.$$

4.8 Discussion

The theoretical model highlighted a channel, related to investments in a fixed-cost technology (akin, but not limited to, intangible capital), that can explain the equilibrium relationship between financial variables, namely financial capability and borrowing constraints, and firm-level markups. The model is admittedly simple, and a number of caveats apply before bringing the same model to the data for a validation.

First, the effect of relaxing aggregate constraints on aggregate markups are ambiguous in the model. Tighter collateral constraints raises the entry cutoff and the markups of firms operating in the modern sectors thereof. However, less firms will find it profitable to operate the modern technology and will move to the traditional sector, characterized bylower markups. Overall, the effect on aggregate markup depends on whether the intensive or extensive margin prevails, and thus remains an empirical question.[12] Second, all heterogeneity in the model stems from financial capability. In reality, firms are heterogeneous also in TFP, and even conditional on financial capability. Theoretically it is easy to extend the model to a version where firms are also heterogeneous in TFP, and all the

[12]Solving the model for the aggregate markups would require extending it in general equilibrium, an exercise beyond the scope of this paper

results would go through, conditional on TFP. In the empirical analysis, we will discuss the effect of this extra layer of unobserved heterogeneity.

Third, the model is static in nature and has no multiple sectors, potentially characterized by different cost-saving technologies. Our results are thus average effects. In the empirical validation of the model We will control for sector-year fixed effects.

5 Empirical Specification

The model delivers a number of testable predictions for the effect of financial market imperfections on the markup distribution through the channel of fixed-cost expenditures. This section derives an estimation procedure for these predictions.

5.1 Quasi-Experimental Setting

For identification, we exploit the progressive enactment of a French law in 2009, the French Decret 2009-1377, affecting the terms of contractual payments receivable by firms. The reform prohibited firms to accept contractual payment terms exceeding sixty days after reception of the invoice, for transactions contracted under the French trade code.[13] The implementation and enforcement of the law was particularly efficient and credible, and it was managed by 7 regional Directorats of the Economic Ministry.[14]

For firms that were paid in more than 60 days before the policy change, this reform has generated what we can interpret as an exogenous positive credit shock.

Following Beaumont and Lenoir (2019), we proxy the average time to receive payments as number of days of sales outstanding (DSO) for a firm i in year t, which we construct as:

$$\text{DSO}_{it} = \frac{\text{Accounts receivable}_{it}}{\text{Sales}_{it}} \times 365$$

The average of DSO is 59.8 for firms in our sample, but individual values range between 0 and above 150 days. In order to provide some descriptives on the relevance of the credit shock, we consider Nace 4-digits sectors j as our units of observations, before moving to firm-level analysis.

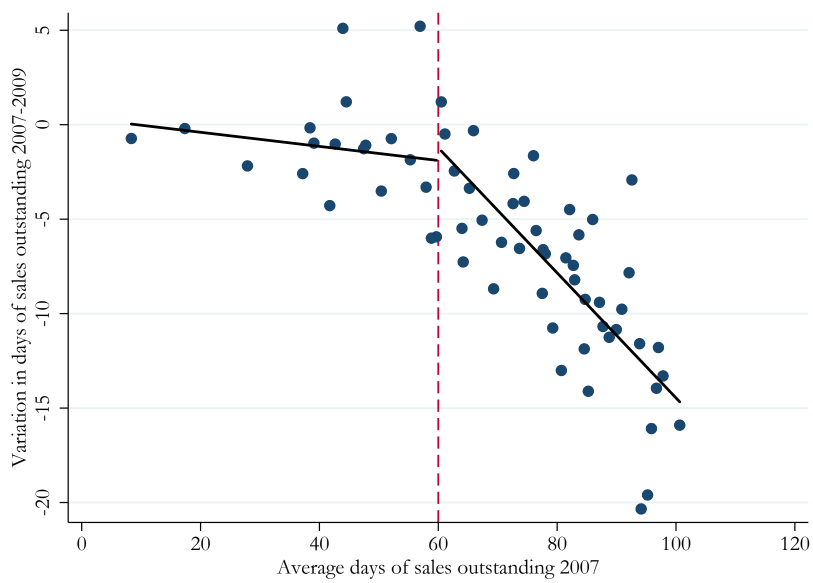
[13] See Beaumont and Lenoir (2019) for a detailed description of the policy.

[14] Large sanctions for non-complying firms were introduced and the French competition authority conducted audits to identify bad payers.

Graphically, the reasoning is depicted in Figures 1 and 2. In both plots, the x-axis represents the percentiles of the sectoral averages in days of sales outstanding DSO_{it} in 2007. The year is chosen as this is two-years before the introduction of the policy and one year before the financial crisis of 2008. The y-axis represents the mean difference in actual days of sales outstanding over time. Figure 1 refers to the change in DSO at the end of 2009 in comparison to 2007 (vertical axis), w.r. to the same figure in 2007. The kink in the relationship between original days of sales outstanding and the policy measure in 2009 shows how the reduction in payment periods left the firms with low initial payment periods (i.e. firms with less than 60 DSOs in 2007) unaffected, while above the threshold there is a clearly negative link between the two variables. Hence firms with days of sales outstanding ≥ 60 are affected by the policy treatment.

Figure 2 is a placebo test. It repeats the same exercise plotting on the vertical axis the mean difference in DSOs between 2003 and 2005: in this case the treatment is ineffective above the 60 DSOs threshold, a finding that lends support to the exogeneity of the policy change.

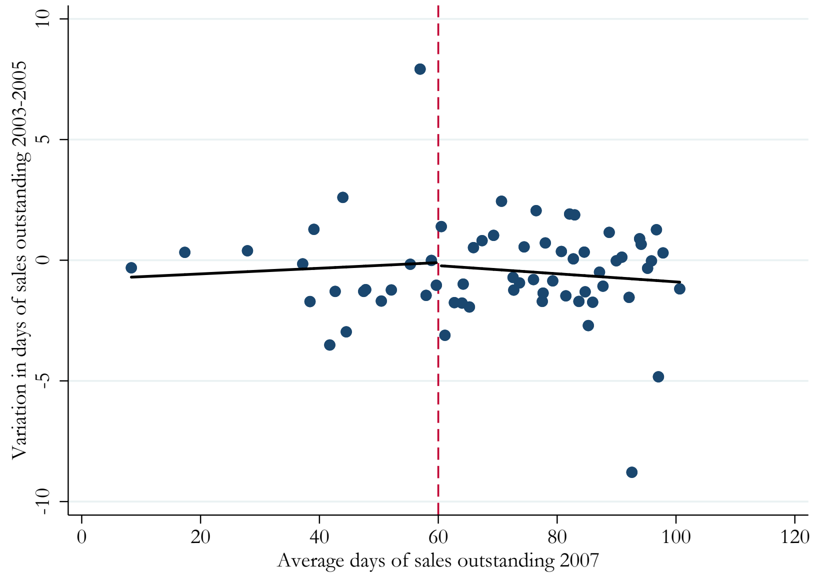
Figure 1: Impact of the policy on payment periods, 2007-09



Note: This graph displays the difference in days of sales outstanding between 2007 and 2009 as a function of DSOs in 2007. The latter is the unweighted, sectoral average of days of sales outstanding. It is computed as the firm-level ratio of accounts receivable over sales multiplied by 365. The data set is split in 100 percentiles along the x-axis; the ordinate axis represents the average value of the y variable in each percentile.

From the above evidence we can thus construct our treatment variable as a simple dummy $T_i = 1$ if a firm had an average number of DSO >60 days before 2007, i.e. if the firm has been positively exposed to the policy change since 2009.

Figure 2: Impact of the policy on payment periods, 2003-05



Note: This graph displays the difference in days of sales outstanding between 2003 and 2005 as a function of DSOs in 2007. The latter is the unweighted, sectoral average of days of sales outstanding. It is computed as the firm-level ratio of accounts receivable over sales multiplied by 365. The data set is split in 100 percentiles along the x-axis; the ordinate axis represents the average value of the y variable in each percentile.

This treatment variable, interacted with year dummies, will be used as our first-stage IV in order to link the exogenous improvement in financial conditions to the the fixed cost expenditures of firms. In the second stage, we will then relate the (instrumented) fixed cost expenditures to firms' markups. The latter allows us to provide evidence in line with both proposition 1 (firms with higher financial capability choose a higher level of intangibles) and 2 (firms with higher intangibles, as induced by higher financial capability, charge higher markups).

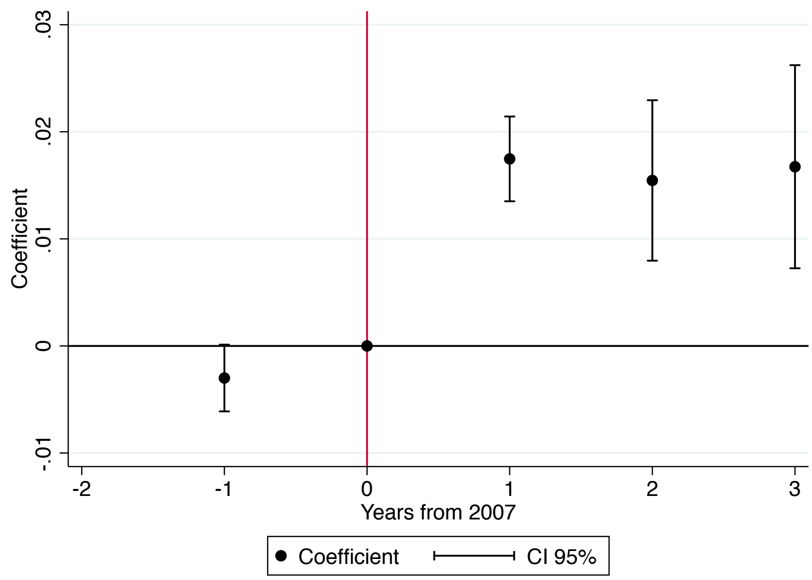
5.2 Baseline Results

We can visualize the first stage by comparing 4 periods of 3-years each: 2004-2006, 2008-2010, 2011-2013, 2014-2016. These are -1, 1, 2, 3 periods, respectively, from the shock. In particular, to assess the pre-trend and the effect of the treatment on the fixed cost expenditure of firms (SG&A/Sales), we regress

$$\ln(\text{SGA}/\text{Sales})_{it} = \alpha_i + \lambda_t + \sum_{j=m}^{-1} \pi_j \Gamma_{ij} + \sum_{j=1}^{g} \phi_j K_{ij} + \epsilon_{ij} \tag{14}$$

where $j = (m, ..., -3, -2, -1, 1, 2, 3, ..., g)$, and Γ_{ij} are interactions of the treatment indicator T_i (which equals one if the firm had an average DSO > 60 before 2007) and time dummies for all periods before time 0. Likewise K_{ij} are interactions of the treatment indicator T_i with time dummies for all periods after time 0. Figure 3 below plots the coefficients π_j and ϕ_j, with 95% confidence intervals.[15]

Figure 3: Impact of the policy on SGA/Sales



Note: The graph displays the coefficients π_j and ϕ_j, with 95% confidence intervals, obtained from the following regression $\ln(\text{SGA/Sales})_{it} = \alpha_i + \lambda_t + \sum_{j=m}^{-1} \pi_j \Gamma_{ij} + \sum_{j=1}^{g} \phi_j K_{ij} + \epsilon_{ij}$ where Γ_{ij} and K_{ij} are interactions of the treatment indicator T_i with the different time periods j reported on the horizontal axis.

Figure 3 clearly shows that treated firms, i.e. those that have benefited from an improvement in financial conditions, are characterized by a significantly higher expenditure on fixed costs in the period immediately after the policy change, while no such effect was there before the policy was implemented. The effect seems to persist in the subsequent periods, albeit with a slightly lower elasticity / higher variance (although still significantly different from zero). Results are robust to the use of the 99% confidence interval (see Figure in Appendix).

In the following Table we confirm these findings through a formal IV regression. Specifically, we regress the log of firm-level markups on the log of SGA/Sales, where the latter is instrumented with our treatment dummy T_i (equal to one if the firm had an average DSO > 60 before 2007), interacted with a dummy assuming value 1 after 2007. Consistently with the model, we have opted for a between specification, using the size of the firm (log employment) as a firm-time specific control, together with year-region and sector FE.

[15]Due to data limitation, we can only set $m = -1$. The same Graph with 99% confidence intervals is reported in Appendix.

Table 4: Markups and SGA/Sales

	(1) IV ln(MU)	(2) IV ln(MU)	(3) IV ln(MU)	(4) IV ln(MU CD)	(5) IV ln(MU CD)	(6) IV ln(MU CD)
ln(SGA/Sales)	0.530***	0.533***	0.550***	0.920***	0.974***	1.045***
	(0.0380)	(0.0356)	(0.0360)	(0.108)	(0.106)	(0.110)
ln(Employees)	0.00136**	0.00210***	0.00350***	-0.0255***	-0.0239***	-0.0206***
	(0.000629)	(0.000633)	(0.000688)	(0.00263)	(0.00276)	(0.00313)
Observations	323,010	298,831	264,103	410,376	379,446	334,665
R-squared	0.417	0.404	0.361	0.407	0.387	0.355
Year-Region FE	Yes	Yes	Yes	Yes	Yes	Yes
Sector FE	Yes	Yes	Yes	Yes	Yes	Yes
Years	2004-2016	2004-2013	2004-2010	2004-2016	2004-2013	2004-2010
Kleibergen-Paap	70.73	87.96	94.73	85.16	101.4	114.1

Note: The table shows the results from IV-regressions using T_i interacted with a time dummy equal to one after 2007. All regressions include year-region and sector fixed effects. Standard errors are in parentheses, * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$.

The sign of our (instrumented) variable of interest, i.e. the fixed costs expenditures as proxied by SG&A/Sales, is always positive and significant. The F-statistic of the first stage is well above the conventional value of acceptance.[16] Consistent with what we have observed in Figure 3, results are not sensitive to the choice of the time period (2016 as the last year in Col.1-4; 2013 in Col. 2-5; 2010 in Col. 3-6). Results are also robust to different measures of markups, obtained either through the estimation of a Translog production function in Col. 1-3, or a Cobb-Douglas in Col. 4-6 (see Appendix for more details on the production function estimation).

5.3 Robustness and Heterogeneity

One potential problem in our baseline specification is that, as our instrument T_i is defined at the firm level, it might pick-up some unobserved heterogeneity leading to a spurious correlation with our fixed-cost expenditure variable in the between specification. To counter this argument, we have thus constructed an industry-region instrument. We have first followed Beaumont and Lenoir (2019) constructing an industry-specific variable as:

$$\overline{d(DSO,60)_{j,2007}} = \frac{1}{N_{j,2007}} \sum_{i \in \Omega_{j,2007}} \max(DSO_{ij,2007} - 60, 0)$$

[16] All the first stages of these regressions are positive, both the T_i and its interaction with the time dummy. **[WE SHOULD REPORT THE FIRST STAGE SOMEWHERE]**

The variable is constructed as the firm i's average DSO within industry j. It ranges between 0 (firms with a value of DSO below 60 days, who should not be influenced by the policy) and the difference between the DSO of the firm in 2007 and 60 days: the larger this difference, the more strongly the firm is positively affected by the policy. As before, the observation of DSO is taken at 2007, i.e. two years before the policy is introduced, and one year before the start of the financial crisis. In line with Beaumont and Lenoir (2019) we also condition our measure to those firms $i \in \Omega_{j,2007}$, i.e. the set of firms with export shares below 10% in 2007 in a given sector, as there is evidence that exporting firms have been less affected by the treatment.

To further exploit the time dimension of the data, we multiply this variable by a dummy variable equal to 1 for all years after 2006:

$$DSO_{jt} = 1[t \geq 2007] * \overline{d(DSO, 60)_{j,2007}}$$

To this we add the consideration that not only the average DSO within a firm's own industry, but also the DSO's in its buyers' sectors are likely to affect a firm's financial capability. We factor this notion by exploiting input-output tables. Due to the absence of these data on the Nace 4-digits level, we calculate DSO_{st} as the equivalent to DSO_{jt} in a Nace 2-digits sector s. Then, we define a sector's DSO as the weighted average between its own DSO and the other sectors' DSO's weighted by their importance in the input-output tables. Formally, we compute our variable for a NACE-4 digit industry j contained in a NACE-2 digit industry s by:

$$DSO^{IO}_{jt} = \omega_{s,s,2007}\, DSO_{jt} + \sum_{s' \neq s} \omega_{s,s',2007}\, DSO_{s't}$$

where $\omega_{s,k,2007} = \frac{Y_{s,k,2007}}{\sum_k Y_{s,k,2007}}$, $\forall k = \{s, s'\}$ and $Y_{s,k,2007}$ denotes the nominal value of all goods produced in sector s and sold in sector k in 2007. This strategy allows us to incorporate the input-output linkages driving the magnitude of the treatment, while retaining the variation of the instrument at the Nace 4-digits level.

In line with the first instrument employed in our baseline estimates, DSO^{IO}_{jt} measures the intensity of the treatment using the *ex ante* exposure to the policy change. To rule out potential equilibrium effects and endogeneity, the industry structure and the weights are kept constant over the whole sample, following the conventional reasoning of Bartik-style instruments (Bartik, 1991). Recently, the literature has put forward several necessary requirements for the validity of these instruments (Goldsmith-Pinkham et al., 2018; Borusyak et al., 2018). First, individuals firms should not affect the sectoral averages.

Given the sample size and our approach relying on unweighted means, this should be less of a concern. Second, the heterogeneity in the base year should be uncorrelated with other factors affecting markups or pre-existing trends. This is the reason why we always control for a time-varying firm-size in our estimates.

Our aggregate measure of DSO varies at the sector-year level. We induce further exogenous variation in this measure relying on the regional differences in the enforcement of the policy. The idea is as follows. Insofar, the treatment is based on changes in the legislation. However, what really matters for firms is the *de facto* variation in days of sales outstanding, i.e. the enforcement of the policy. In Figure 1 we have seen that on average the change has been significant, but we cannot exclude some territorial variation. In fact, the enforcement of the law belongs to the field of responsibility of the seven Regional Directorates of the Economic Ministry (Table 6 in the Appendix). Due to potential differences in the efficiency of these regional directorates, the legislation may have had heterogeneous effects on companies depending on their region. We therefore interact DSO^{IO}_{jt} with seven regional dummies. This strategy allows us to include region-year fixed effects in the regression, while being agnostic with respect to the specific features of the regional directorates determining its efficiency.[17] Results are shown in Table 5.

Table 5: Markups and SGA/Sales - Districts specification

	(1) IV ln(MU)	(2) IV ln(MU)	(3) IV ln(MU)	(4) IV ln(MU CD)	(5) IV ln(MU CD)	(6) IV ln(MU CD) [b]
ln(SGA/Sales)	0.373***	0.396***	0.428***	0.777***	0.825***	0.896***
	(0.0244)	(0.0242)	(0.0254)	(0.0883)	(0.0872)	(0.0918)
ln(Employees)	-0.000176	0.000581	0.00188***	-0.0282***	-0.0271***	-0.0242***
	(0.000519)	(0.000526)	(0.000562)	(0.00232)	(0.00242)	(0.00273)
Observations	323,010	298,831	264,103	410,376	379,446	334,665
R-squared	0.546	0.532	0.500	0.432	0.418	0.394
Year-Region FE	Yes	Yes	Yes	Yes	Yes	Yes
Sector FE	Yes	Yes	Yes	Yes	Yes	Yes
Years	2004-2016	2004-2013	2004-2010	2004-2016	2004-2013	2004-2010
Kleibergen-Paap	38.05	39.60	36.85	31.73	35.08	35.88

Note: The table shows the results from IV-regressions using DSO^{IO} interacted with regional dummies. All regressions include year-region and sectoral fixed effects. Standard errors are in parentheses, * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$.

Once again, the sign of our (instrumented) variable of interest, i.e. the fixed costs expenditures as proxied by SG&A/Sales, is always positive and significant. The F-statistic of the first stage is lower than our baseline estimates, as we are now using an industry-

[17] We incorporate this idea by exploiting the regional information available in the Orbis data.

region specific instrument for a firm-specific variable, but still above the conventional value of acceptance.[18] As before, results are not sensitive to the choice of the time period (2016 as the last year in Col.1-4; 2013 in Col. 2-5; 2010 in Col. 3-6) or to different measures of markups, obtained either through the estimation of a Translog production function in Col. 1-3, or a Cobb-Douglas in Col. 4-6.

6 Conclusions

In this paper we study the importance of financial frictions for markups heterogeneity. Firms can invest in a cost-reducing technology (akin to intangible capital), but heterogeneous credit constraints distort this decision. The latter generates endogenous dispersion in markups. We show that financial variables operate both at the extensive margin, by acting as a barrier to entry into investment, and at the intensive margin, by distorting the level of investment of individual firms. We are able to find significant causal evidence of the role of heterogeneous financial frictions postulated in the model, exploiting a quasi-natural experiment undertaken in France in 2009, in which payments periods for a certain group of firms have been substantially reduced.

From our results we can derive two policy implications. First, the documented rise of markups in modern economies can be the result of a higher investment of firms in intangible capital. The markedly higher difference between US and European markups registered in the last decade can thus be partly explained by the higher level of intangible capital investment by US firms. Second, access to finance is a critical component in the ability of firms to rise intangible capital. Heterogeneous access to finance lead to sub-optimal investments in intangibles, higher markup dispersion, and a higher misallocation of capital in the economy.

[18] All the first stages of these regressions are positive, both the T_i and its interaction with the time dummy.

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A Theoretical results

A.1 Derivation of Proposition 1

The optimal price satisfies $p = \frac{\varepsilon(p/P)}{\varepsilon(p/P)-1}(1 - s(\varphi, \tau))$, which can be written in log terms as $\ln p = \ln \mu(p/P) + \ln(1 - s(\varphi, \tau))$. We denote by $\Gamma \equiv -\frac{d \ln \mu(y)}{d \ln y} = \Gamma(y)$ the markup elasticity to relative price y, and log differentiate to write $d \ln p = -\Gamma_i \left(d \ln p - d \ln P\right) - \frac{s_i}{1-s_i} d \ln s$, where both Γ_i and s_i are indexed by i to indicate that these quantities can vary by firms. It is now easy to show, by simple algebra, that:

$$d \ln p = -\frac{s_i}{(1+\Gamma_i)(1-s_i)} d \ln s(\varphi, \tau) + \frac{\Gamma_i}{1+\Gamma_i} d \ln P.$$

Similarly, the optimal markup can be found as:

$$d \ln \mu \equiv d \ln p - d \ln c^q(s) = \frac{\Gamma_i}{1+\Gamma_i} \frac{s_i}{1-s_i} d \ln s(\varphi, \tau) + \frac{\Gamma_i}{1+\Gamma_i} d \ln P.$$

It follows that

$$\frac{d \ln \mu}{d \ln s} = \frac{\Gamma_i}{1+\Gamma_i} \frac{s_i}{1-s_i} > 0 \tag{15}$$

Equation (15) implies that firms that choose a higher level of intangibles s, and thus have lower marginal cost, charge higher markups. Moreover, given our assumption that $\Gamma' < 0$, equation (15) also implies that any given shock to marginal costs will be absorbed into markups, the more so the lower the marginal cost to begin with. In other words, firms with lower marginal costs will have lower pass-through of cost shocks into final prices.

A.2 Derivation of Proposition 2

Let $r(s) = (\mu(s) - 1)\,(1-s) QD\,(y(s)))$ denote firm net revenues, where $y \equiv p/P$ is the variable price. Let $f(s)$ be the fixed cost function, which we assumed increasing and convex, with $\lim_{s \to 1} f(s) = \infty$. The first order condition for the optimal choice of intangibles is

$$r'_s = \frac{1}{1+\tau} f'_s. \tag{16}$$

Given our regularity conditions on both the functions $D(\cdot)$ and $f(\cdot)$, the functions in both sides are everywhere continuous. The left hand side can be found as $r'_s \equiv \frac{dr}{ds} =$

$QD\left(y(s)\right) > 0$. Notice also that $r''_s = \frac{QD(y)\varepsilon(y)}{(1+\Gamma)(1-s)} > 0$ and

$$r_s''' = \frac{\varepsilon D\Gamma}{(1+\Gamma)^2(1-s)}\left[-(\Gamma^2-1)\varepsilon + \phi_\Gamma + (1+\Gamma)\left(\frac{(\Gamma+1)^2}{\Gamma} - 1\right)\right] > 0.$$

We impose that $f''' > 0$, that means that the marginal cost function is also convex in s.

Hence, in equation (16), we look for the intersection of two monotonically increasing convex functions. There can be many solutions to this problem. However, notice that as s goes to 1, it is required that $f_s > r'_s$, namely that the marginal cost is strictly higher than the maginal benefit of investment. If this was not true, then firms would choose $s = 1$, but that contradicts the assumption that $\lim_{s\to 1} f(s) = \infty$. On the other hand, when s is close to 0, it must be that the marginal benefit exceeds the marginal cost, otherwise no firms would enter the modern sector. We assume that these conditions are always satisified in our model, such that an interior solution for s always exists, and is unique given the monotonicity of the two functions.

The optimal choice of s will depend on the value of τ. Ceteris paribus, higher levels of financial capability shifts the marginal cost curve downwards, which means that the firm will choose a higher level of intangible investment s. Therefore, the first order condition in (16) features a unique solution of the kinf: $s^* = s(\underset{+}{\tau})$.

B Production Function and Markups Estimation

In order to estimate markups, we follow the production function approach pioneered by De Loecker and Warzynski (2012), and extend their methodology to account for the details of our model. For firms that are active in the modern sector, we discussed above that prices are at their first-best levels. Therefore, we can apply standard results and write markups as:

$$\mu_{it} = \frac{\theta_{it}^V}{\alpha_{it}^V}, \tag{17}$$

where $\theta_{it}^V \equiv \partial \ln Q_{it} / \partial \ln V_{it}$ is the output elasticity with respect to variable input V, and $\alpha_{it}^V \equiv \frac{P_t^V V_{it}}{P_{it} Q_{it}}$ is the share of expenditure on input V on total firm revenues. Equation (17) can be derived from the static first order condition of input V.

The first step to construct measures of markups using (17) is to estimate the elasticities θ_{it}^V. We do that by adopting techniques in the production function estimation literature. We adapt existing techniques to our model to build control variables for unobserved heterogeneity. We describe our procedure in the next section.

B.1 Production Function Estimation

We consider the following class of production technologies for firm i at time t:

$$Q_{it} = \exp(\omega_{it} + \phi(s_{it}) + \epsilon_{it})F_t(K_{it}, L_{it}, M_{it}; \beta), \tag{18}$$

where Q_{it} is physical output, obtained using capital (K_{it}), labor (L_{it}), and intermediate inputs (M_{it}). The function $F(\cdot)$ satisfies standard regularity conditions. The term ω_{it} reflects a Hicks-neutral firm-specific productivity shock, which is observed to the firm when she chooses inputs. The term $\phi(s_{it}) = \ln \frac{1}{1-s_{it}}$ is the productivity advantage of firms that invest in intangibles, while ϵ_{it} captures measurement error and idiosyncratic shocks to production unobserved to the firm. We consider both the capital and the labor input as dynamic inputs, chosen one period in advance by the firm. The state variable vector of firm i at time t is thus given by $\varsigma_{it} = \{\omega_{it}, s_{it}, K_{it}, L_{it}\}$.

Neither ω_{it} nor s_{it} nor ϵ_{it} are observed by the researcher. However, we can observe a measure of total expenditures on fixed costs, which we denote as SGA_{it}. Notice that in the model, total expenditure on fixed cost is only a function of s_{it}. However, it is likely that high efficiency firms are able to obtain a larger cost reduction, for a given level of fixed cost expenditure SGA (De Ridder, 2019). We allow for this dependence in the empirical analysis by writing $SGA_{it} = f(s_{it}, \exp(\omega_{it}))$.

Even though we can allow for a general specification of the production function $F_t(\cdot)$, for exposition we assume a Cobb-Douglas specification, which allows us to write:

$$q_{it} = \beta_k k_{it} + \beta_l l_{it} + \beta_m m_{it} + \omega_{it} + \phi(s_{it}) + \epsilon_{it}.$$

As it is well-known in the literature, estimation of (18) requires dealing with several biases. Not only we have to deal with the unobserved term $\omega_{it} + \phi(s_{it})$, but we also have to deal with the input and an output price bias in estimation, which are potentially large when markups are heterogenous across firms (De Loecker and Goldberg, 2014; Foster et al., 2008). Because we do not observe input prices, and we abstract from input price effects in the model, we deal with the input price bias by imposing the following assumption:

A1 *Firms take the price P^X_{it} of input $X = K, M, L$ as given.*

Assumption A1 implies that input quantities can be consistently measured as deflated expenditures, provided that a control function for exogenous input price variation can be constructed. In estimation, we will control for the input price dispersion using a control function as in De Loecker et al., 2016. Dealing with the output price bias is more complicated, as in the model we explicitly allow for markup differences across firms. To make the bis explicit, let us rewrite the output variable in (18) in terms of observed deflated revenues. Specifically, we measure output q_{it} as deflated revenues $\tilde{r}_{it}$, which is defined as $\tilde{r}_{it} = r_{it} - p_{st}$, where r_{it} is log revenues of firm i, and p_{st} is a sector-level deflator for output. Notice that this means that: $q_{it} = \tilde{r}_{it} - (p_{it} - p_{st})$, where the term $(p_{it} - p_{st})$ represent the deviation of the unobserved firm-level price from the sectoral price.

We substitute this information in (18) to write:

$$\tilde{r}_{it} = \beta_k k_{it} + \beta_l l_{it} + \beta_m m_{it} + \omega_{it} + \phi(s_{it}) + (p_{it} - p_{st}) + \epsilon_{it}.$$

The term $(p_{it} - p_{st})$ is unobserved, and correspond to the output price bias. To make progress, we use the insights from our model. The model tells us that:

$$p_{it} = \mu\,(p_{it} - p_{st}) + c_{it},$$

where c_{it} is (log) marginal cost, which we can write as $c(\Phi_{it}, s_{it}, \omega_{it})$, where $\Phi_{it} = (r_t, w_{it}, p^m_{it})$ is the vector of firm-level input unit prices. Therefore, we can write:

$$p_{it} - p_{st} = \mu\,(p_{it} - p_{st}) + c(\Phi_{it}, s_{it}, \omega_{it}) - p_{st},$$

which can be solved implicitly as:

$$(p_{it} - p_{st}) = f(\Phi_{it}, s_{it}, \omega_{it}, p_{st}).$$

The estimating equation becomes:

$$\tilde{r}_{it} = \beta_k \tilde{k}_{it} + \beta_l \tilde{l_{it}} + \beta_m \tilde{m_{it}} + B(\Phi_{it}) + \omega_{it} + \phi(s_{it}) + f(\Phi_{it}, s_{it}, \omega_{it}, p_{st}) + \epsilon_{it}. \tag{19}$$

The term $B(\Phi_{it}, \Phi_{st})$ is a function of input price deviation from sector-level input deflators, and derives from having expressed inputs in terms of observed deflated expenditure, e.g. $\tilde{m}_{it} \equiv e^m_{it} - p^m_{st}$.

The only unobserved terms in equation (19) are now unobserved heterogeneity ω_{it}, and the term s_{it}. To solve for this bias, we follow Ackerberg et al., 2015 and consider the first order condition for material inputs $m_{it.}$ We write this condition as:

$$\tilde{m_{it}} = h(\tilde{k}_{it}, \tilde{l_{it}}, \Phi_{it}, s_{it}, \omega_{it}). \tag{20}$$

Assuming that the term Φ_{it} is known, the only unobservables in (20) are (s_{it}, ω_{it}). We thus consider the following system of equations:

$$\begin{cases} sga_{it} = f(s_{it}, \omega_{it}) \\ \tilde{m_{it}} = h(\tilde{k}_{it}, \tilde{l_{it}}, \Phi_{it}, s_{it}, \omega_{it}). \end{cases}$$

Since we have a system of two equations in two unknowns, and the system is invertible, we can solve it to express the unobserved terms as function of observables:

$$\begin{cases} s_{it} = g(\tilde{k}_{it}, \tilde{l_{it}}, \Phi_{it}, m_{it}, sga_{it}) \\ \omega_{it} = \tilde{t}(\tilde{k}_{it}, \tilde{l_{it}}, \Phi_{it}, m_{it}, sga_{it}). \end{cases}$$

Therefore, we write:

$$\tilde{r}_{it} = \beta_k \tilde{k}_{it} + \beta_l \tilde{l_{it}} + \beta_m \tilde{m_{it}} + B(\Phi_{it}) + h(\tilde{k}_{it}, \tilde{l_{it}}, \Phi_{it}, m_{it}, sga_{it}) + \epsilon_{it}. \tag{21}$$

Following De Loecker et al., 2016, we can construct a control for input prices using a polynomial in outout prices and region dummies:

$$\begin{aligned} \Phi_{it} &= p(p_{it}, G_i) \\ &= p(\tilde{k}_{it}, \tilde{l_{it}}, m_{it}, sga_{it}, G_i), \end{aligned} \tag{22}$$

where the second equality follows from out discussion above. Putting all pieces together, we obtain:

$$\tilde{r}_{it} = \beta_k \tilde{k}_{it} + \beta_l \tilde{l_{it}} + \beta_m \tilde{m_{it}} + H(\tilde{k}, \tilde{l_{it}}, m_{it}, sga_{it}, G_i) + \epsilon_{it}. \tag{23}$$

The polynomial $H(\cdot)$ is a function of observable objects, and correct for both input price bias, output price bias, and simultaneity bias from unobserved productivity. Note that our discussion implies that none of these terms can be recovered from estimation, given that we wrote the biases as function of the same set of unobservable variables. The corollary is that neither unobserved TFPQ $TFPQ_{it} \equiv (\omega_{it} + \phi(s_{it}))$, nor TFPR $TFPR_{it} \equiv p_{it} TFPQ_{it}$ can be estimated in our context. Only if we are willing to rule out variations in input prices across firms, that means only if $\Phi_{it} = 0 \; \forall i$, doea the polynomial H identify a residual revenue productivity term.

We estimate (23) using the two stages GMM procedure in Ackerberg et al. (2015). We construct moments based on the interaction of lagged material inputs and current capital and labor inputs with the innovation in the productivity term ω_{it}.

We assume Translog production function as the baseline specification. Our estimating equation thus reads:

$$\tilde{r_{it}} = \beta_k \tilde{k}_{it} + \beta_l l_{it} + \beta_m \tilde{m}_{it} + \beta_{kk} \tilde{k_{it}^2} + \beta_{ll} \tilde{l_{it}^2} + \beta_{mm} \tilde{m_{it}^2} \tag{24}$$

$$+ \beta_{km} \tilde{k_{it}} \tilde{m}_{it} + \beta_{kl} \tilde{k_{it}} l_{it} + \beta_{ml} l_{it} \tilde{m}_{it} + \tag{25}$$

$$+ H(\tilde{k}, \tilde{l_{it}}, m_{it}, sga_{it}, G_i) + \epsilon_{it}. \tag{26}$$

B.2 Markups

Once we have estimated the main elasticities, we can proceed to compute markups. We first compute the output elasticity of the variable input, which in our case is intermediate inputs:

$$\hat{\theta_{it}^m} \equiv \frac{dq_{it}}{dm_{it}} = \hat{\beta}_m + 2\hat{\beta}_{mm} m_{it} + \hat{\beta_{km}} k_{it} + \hat{\beta}_{lm} l_{it}.$$

Markups are then computed as:

$$\mu_{it} = \hat{\theta_{it}^m} \left(\frac{e_{it}^m}{r_{it} / \hat{\epsilon}_{it}} \right)^{-1},$$

where e_{it}^m is expenditure on materials, as observed in Orbis, r_{it} is total sales, and $\hat{\epsilon_{it}}$ is the estimated OLS residual from the first stage estimation of (26)

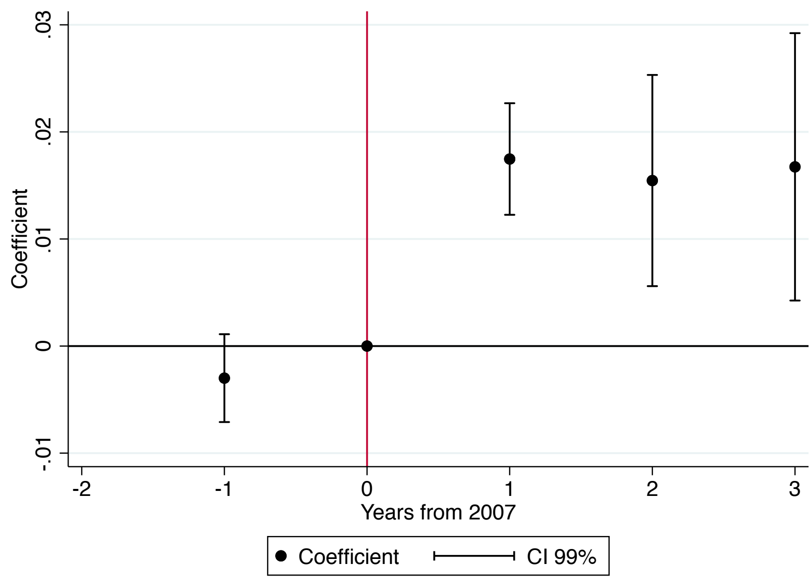
C Empirical results

Table 6: Regional enforcement of the policy

Regional directorate	Region
Direction régionale du Nord	Nord - Pas-de-Calais Picardie
Direction régionale de Lorraine	Champagne-Ardenne Lorraine Alsace
Direction régionale de RhÃŽne-Alpes	Bourgogne Franche-Comté RhÃŽne-Alpes Auvergne
Direction régionale de Provence-Alpes-Cote d'Azur	Languedoc-Roussillon Provence-Alpes-Cote d'Azur Corse
Direction régionale d'Aquitaine	Aquitaine Midi-Pyrénées Limousin Poitou-Charentes
Direction régionale des Pays de la Loire	Bretagne Pays de la Loire Centre
Direction régionale d'Ile-de-France	Ile-de-France Basse-Normandie Haute-Normandie Réunion Mayotte Saint-Pierre-et-Miquelon

This table shows the allocation of the regional directorates of the to the NUTS2-regions in France as described in *Décret n. 2009-1377 du 10 novembre 2009 relatif á l'organisation et aux missions des directions régionales des entreprises, de la concurrence, de la consommation, du travail et de l'emploi, Annexe I.*

Figure C1: Impact of the policy on SGA/Sales



Note: The graph displays the coefficients π_j and ϕ_j, with 95% confidence intervals, obtained from the following regression $\ln(\text{SGA/Sales})_{it} = \alpha_i + \lambda_t + \sum_{j=m}^{-1} \pi_j \Gamma_{ij} + \sum_{j=1}^{g} \phi_j K_{ij} + \epsilon_{ij}$ where Γ_{ij} and K_{ij} are interactions of the treatment indicator T_i with the different time periods j reported on the horizontal axis.