RESEARCH INSTITUTE OF
INDUSTRIAL ECONOMICS

IFN Working Paper No. 1414, 2021

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November 5, 2021

This paper examines how changes in product market concentration, specifically firm exit, affect prices. I develop a model where firms have variable markups to show that the remaining firms increase their markups and prices after their competitors' exit. The model predictions are tested using micro-data on Swedish firms. I use the exposure of firms to a bank, which was severely affected by the financial crisis abroad, as an instrument to identify the causal relationship between firm exit and prices. I find that the remaining firms increase their prices by 0.3 percent when firms with a combined market share of one percent exit.

JEL classification: D43, E31, E32, L13, L16, L60.

Keywords: price setting, market structure, financial shocks, firm exit.

*Contact: melinda.suveg@ifn.se, Research Institute of Industrial Economics (IFN), P.O. Box 55665, SE-102 15 Stockholm, Sweden. *Acknowledgments:* I would like to thank Nils Gottfries, Teodora Borota Milicevic, Virgiliu Midrigan, Simon Gilchrist and David Vestin for their supervision and continued guidance. I am grateful to Niklas Amberg, Plamen T. Nenov, Stefan Pitschner, Laszlo Tetenyi and Joshua Weiss for their helpful comments. I would also like to thank Hans Grönqvist and August Torngren Wartin for letting me use the bank location dataset they assembled. I am indebted to Mikael Carlsson, Peter Fredriksson, William Gamber, Georg Graetz, Erik Öberg and the seminar participants at Uppsala University and New York University for their comments and suggestions. Financial support from the Marianne and Marcus Wallenberg Foundation (2020.0049), the Department of Economics at Uppsala University and Jan Wallanders och Tom Hedelius stiftelse is gratefully acknowledged.

1 Introduction

Price changes affect the distribution of economic resources and the drivers of inflation are central to monetary policy decisions. To better understand how market structure and product market concentration affect prices, I analyze the effect of firm exit on prices, both theoretically and empirically.

More specifically, I try to answer three questions: How strong is the effect of exit on prices? Did increased exit contribute to higher inflation during the financial crisis - a phenomenon termed as missing disinflation?[1] Is the estimated price effect of exit consistent with the prediction from a heterogeneous firm model with oligopolistic competition and variable markups?

I develop a model in which firms have market power and endogenously vary their markups. I use the model to study how variation in exit, caused by financial shocks, affects producer prices. My model extends the oligopolistic competition model of Atkeson and Burstein (2008) with heterogeneity in firms' pre-funding costs. Firms are heterogeneous in their pre-funding costs and their productivity, and firms may exit when their idiosyncratic pre-funding costs rise exogenously. Following exit, the remaining firms' markups rise. I calibrate my model to moments of the firm size distribution of Sweden in 2008, the year before the trough of the financial crisis in Sweden. I simulate the model to analyze the price response of exit. The model predictions are used as hypotheses for the regression analysis in which I identify the effect of exit on prices.

For the empirical analysis, I use micro data on Swedish firms. Specifically, I combine firm-level price indices, balance sheet variables and information on location-based firm-bank connections into a unique firm-level dataset. Identifying the price effect of exit requires exogenous variation in exit. I follow an approach similar to that of Chodorow-Reich (2014) and Huber (2018) by constructing an instrument for firm exit based on firm-bank connections. I argue that exogenous variation in firm exit is related to variation in firms' exposure to a bank that was severely affected by the financial crisis through its subsidiaries in the Baltic countries. Using firms' exposure to the affected bank as an instrument for firm exit, I identify the price effect of exit.

In the baseline calibrated model, I find that the exit of one percent of industry competitors generates an increase in the markups and prices of the remaining firms, but the

[1] Missing disinflation is a term used by Gilchrist, Schoenle, Sim and Zakrajsek (2017).

effect is quantitatively small. The remaining firms only marginally increase their markups and therefore, the change in the aggregate markup is close to zero. This result is in line with Edmond, Midrigan and Xu (2015) who find small effects of entry on aggregate inflation using a model with the same market structure.

Empirically, I find larger effects from exit. The IV specification shows that the average price increase is 0.3 percent when a set of firms with a combined market share of one percent exit. In other words, the prices of the remaining firms rise by 0.3 percent when one percent of an industry disappears. This result remains unchanged after controlling for the firm's own financial cost and the firm's own marginal cost. Furthermore, this finding holds when I estimate a weighted regression with market shares as weights. These results can help understand the missing disinflation puzzle. Exit is countercyclical and it pushes up aggregate inflation in a recession, so that the increase in market power attenuates the fall in prices during recessions.[2] In addition, my empirical findings have implications for monetary policy as New Keynesian models may overstate the fall in prices during recessions because they omit the effects of exit.

I find that the effect of exit is larger in the data than in the model by at least two orders of magnitude. I consider two potential explanations for this quantitative difference between the model prediction and the estimated effect of exit.

One is that the standard calibration treats industries as markets. This means that the number of firms is much higher and market concentration is much lower than what the industrial organization literature would suggest when defining relevant markets. An extreme example is from Syverson (2008) who shows that the ready-mixed concrete industry in the US has more than 3000 firms while an actual market may only be served by 5 firms simply because ready-mixed concrete hardens after a certain amount of time and it must be discharged from the truck before that happens. I show that the quantitative model can be brought into line with the regression results if I recalibrate the model under the assumption that each 5-digit industry is divided into sub-markets. If each industry consists of local markets so that firms have larger shares of their sub-markets, the exit of firms can substantially increase markups. With segmented markets, the model can rationalize the idea of local granularity, and how shocks to firms which are "locally large" in their sub-markets can generate large changes of markups.

[2]Using my coefficient estimate, the price effect of increased concentration could explain 1.95 percent of the 2 percent forecasted deflation that was not realized.

Another reason why there is a discrepancy between the model-implied and the estimated results is the heterogeneous response across firms with different sizes. Empirically I find that larger firms expand their market shares relatively more when their competitors exit. In contrast, the oligopoly model predicts the opposite response: smaller firms expand their market shares relatively more upon the exit of their competitors. Even though small firms have a substantial reaction, they have very little effect on the aggregate economy since their market shares combined and, therefore, their weight in the aggregate calculation is small. The feature that smaller firms respond relatively more to market concentration is one reason why the Atkeson and Burstein (2008) type model does not predict large aggregate markup and price responses upon exit.

The primary contribution of this paper is that it quantifies how market concentration affects prices. Specifically, I identify the effect of exit on producer prices. The quantitative model presented in this paper extends the model of Atkeson and Burstein (2008), Jaimovich and Floetotto (2008) and Edmond, Midrigan and Xu (2015) by modeling the working capital channel which is a requirement that firms pre-fund their labor costs.[3] This channel is introduced in order to show why larger firms may exit and how their exit impacts the remaining firms. Another contribution of this paper is that I find a discrepancy between the prediction of the variable markup model and the estimated price response to firm exit. To reconcile the model implied and the estimated effects, I use the definition of markets from the industrial organization literature. In addition, I show empirically that reallocation after exit is toward larger firms and away from smaller firms, which contradicts the predictions based on models with oligopolistic competition.

This paper is organized as follows. Section 2 summarizes the relevant literature. Section 3 describes the model. In Section 4, I calibrate the model and simulate how exit affects prices. Section 5 describes the micro data and the empirical approach. The empirical results are presented in Section 6 and Section 7 discusses the simulated and the empirical results. Section 8 concludes the paper.

[3]While the model introduces an additional layer of firm heterogeneity in firms' pre-funding costs, it fully preserves the technical features of the original model.

2 Previous literature

This paper relates to two strands of literature. The first strand develops models with large and "strategic" firms in order to analyze the effects of trade, monetary policy and variation in the aggregate markup. The strategic interaction between firms in this literature is often captured by assuming oligopolistic or Bertrand competition among firms. Applications of quantitative oligopolistic competition models begin with the seminal papers of Atkeson and Burstein (2008) who focus on pricing to market and the role of relative prices in a trade model; and Jaimovich and Floetotto (2008) who study the effect of variation in markups for firm dynamics. Extensions include Edmond, Midrigan and Xu (2015) who quantify the procompetitve gains from opening up to trade, and Edmond, Midrigan and Xu (2018) who quantify the welfare cost of markups. Another set of papers investigate how competition affects monetary policy and the New Keynesian Phillips curve. Etro and Rossi (2015a,b) argue that strategic interactions à la Bertrand flatten the Phillips curve. Andres and Burriel (2018) show that more productive firms deliver more muted responses of inflation to exogenous productivity disturbances in a DSGE model with Bertrand competition. In their seminal work, Bilbiie, Ghironi and Melitz (2012) explore the role of endogenous entry as a potential source of dynamics for time-varying markups, prices and quantities. Gamber (2020) studies the effect of cyclical entry on aggregate employment. The latest quantitative model developments are Dhingra and Morrow (2019), Burstein, Grassi and Carvalho (2019) and Werning and Wang (2020).

The second strand of literature is empirical. Starting from the seminal work of Bain (1951) and Bresnahan and Reiss (1990, 1991), a large body of industrial organization research documents a correlation between concentration and profits, and shows that price-cost margins decline toward zero as the number of competitors increase. This literature is largely descriptive. Identifying the causal effect of competition on prices is difficult because instruments for concentration measures such as the Herfindahl-Hirschman Index (HHI) are not easily available. The difficulty for econometricians is the classical problem of endogenous market structure and the simultaneity of supply and demand.

This study also relates to Chodorow-Reich (2014) and Huber (2018) who address their identification issues using financial shocks to firms from banks. I follow this literature and argue that exogenous variation in firm exit in Sweden was generated by firms' exposure to a bank that was severely affected during the financial crisis in the Baltic countries.

3 Model

To model market power, I use the model developed by Atkeson and Burstein (2008) and Edmond, Midrigan and Xu (2015) in which heterogeneous firms engage in oligopolistic competition. To rationalize financial shocks that may cause firms exit, I extend the standard model with a working capital requirement. The working capital requirement states that firms have to pre-fund their operations. Pre-funding production comes at an extra cost which is assumed to differ between firms. Introducing heterogeneity in the cost for pre-funding provides scope for analyzing idiosyncratic shocks that may hit firms differently and cause large and small firms to exit. Even a productive, large firm may exit if its cost for pre-funding becomes sufficiently large. The exit of larger firms was a feature of the financial crisis and it is also a feature of regular business cycles.

The model economy consists of perfectly competitive final good producers, a large number of industries and a finite number, $N(s)$, of intermediate good producers in each industry with index s. The intermediate good producers engage in oligopolistic competition so they take into account the decisions of their competitors when they make optimal production choices. The intermediate good producers are heterogeneous with respect to their productivity and the cost for pre-funding. Heterogeneity across intermediate producers means that all firms have different market shares and that they charge different markups. Firms with large market shares behave more like monopolists, whereas small firms behave more like firms that participate in monopolistic competition.

3.1 Final good firm

Final good producers produce a homogeneous final consumption good Y using inputs $y(s)$ from a continuum of industries

$$Y = \left(\int_0^1 y(s)^{\frac{\theta-1}{\theta}} ds \right)^{\frac{\theta}{\theta-1}}, \tag{1}$$

where $\theta > 1$ is the elasticity of substitution across industries indexed by $s \in [0, 1]$. The inverse demand functions for the output of the industries are

$$p(s) = \left(\frac{y(s)}{Y} \right)^{-\frac{1}{\theta}} P. \tag{2}$$

Each industry s consists of a finite number of intermediate goods producers. Industry output is an aggregate of production from $N(s)$ intermediate input producing firms indexed by i

$$y(s) = \left(\sum_{i=1}^{N(s)} y_i(s)^{\frac{\gamma-1}{\gamma}} \right)^{\frac{\gamma}{\gamma-1}}. \tag{3}$$

The inverse demand function for the product of firm i within an industry s is given by

$$p_i(s) = \left(\frac{y_i(s)}{y(s)} \right)^{-\frac{1}{\gamma}} p(s). \tag{4}$$

3.2 The intermediate good producing firm

Intermediate good producer i in industry s produces output using labor

$$y_i(s) = a_i(s) l_i(s), \tag{5}$$

where $a_i(s)$ is the firm-specific productivity and $l_i(s)$ is the firm's labor demand. Productivity $a_i(s)$ is drawn from a productivity distribution that is discussed in Section 4.

Demand for Intermediate Inputs Combining the industry and the product-level inverse demand functions gives the demand function facing the individual firm

$$y_i(s) = \left(\frac{p_i(s)}{p(s)} \right)^{-\gamma} \left(\frac{p(s)}{P} \right)^{-\theta} Y \tag{6}$$

where the aggregate and sectoral price indexes are

$$P = \left(\int_0^1 p(s)^{1-\theta} ds \right)^{\frac{1}{1-\theta}}, \tag{7}$$

$$p(s) = \left(\sum_{i=1}^{N(s)} \phi_i(s) p_i(s)^{1-\gamma} \right)^{\frac{1}{1-\gamma}}. \tag{8}$$

$\phi_i(s) \in 0, 1$ is an indicator function that equals one if producer i operates in its market.

Production cost The firm has to pay the wage bill in advance because there is a lag between paying workers and receiving payments from sales. This pre-funding requirement is often called the working capital requirement since firms need to invest working capital in order to operate. The simplest way to think about pre-funding is that the firm borrows money for its operations via a credit line. The firm's total costs $\Psi_i(s)$ are therefore

$$\Psi_i(s) = \big(1 + r_i(s)\big)\, W l_i(s), \tag{9}$$

and the firm's marginal cost $\psi_i(s)$ is given by

$$\psi_i(s) = \frac{\big(1 + r_i(s)\big)W}{a_i(s)}, \tag{10}$$

where $r_i(s)$ is the exogenous borrowing rate that varies across firms. The firm's borrowing rate $r_i(s)$ is drawn from a distribution that is discussed in Section 4.

Profit maximization Each intermediate good producer engages in Cournot competition within its industry. That is, each firm chooses a quantity $y_i(s)$ taking as given the quantity decisions of its competitors in industry s, the firm-specific interest rate and the aggregate wage W. The problem of the firm can be written as

$$\pi_i(s) \equiv \max_{y_i(s),\phi_i(s)} \Big[\big(p_i(s) - \psi_i(s)\big)y_i(s) - \tau\Big]\phi_i(s), \tag{11}$$

subject to the demand system given by equations (6) - (8). τ is a fixed cost of production that the firm has to cover each period if it chooses to operate, in which case $\phi_i(s) = 1$. A firm can choose to produce zero units of output $\phi_i(s) = 0$ in order to avoid paying the fixed cost τ. The fixed operating cost allows the model to match the operation choice of the firms in the data. The solution to this problem is characterized by a price that is set with a markup over marginal cost

$$p_i(s) = \frac{\epsilon_i(s)}{\epsilon_i(s) - 1}\psi_i(s), \tag{12}$$

where $\epsilon_i(s) > 1$ is the demand elasticity that faces the firm.

Demand Elasticity With the nested CES demand system and Cournot competition, it can be shown that this demand elasticity is a weighted harmonic average of the underlying elasticities of substitution θ and γ

$$\epsilon_{it} = \left(\omega_i(s)\frac{1}{\theta} + (1-\omega_i(s))\frac{1}{\gamma}\right)^{-1}, \tag{13}$$

where $\theta < \gamma$ and $\omega_i(s) \in [0,1]$ is the firm's market share measured as the firm's share of its industry's revenue:

$$\omega_i(s) \equiv \frac{p_i(s)y_i(s)}{\sum_{i=1}^{N(s)} p_i(s)y_i(s)} = \left(\frac{p_i(s)}{p(s)}\right)^{1-\gamma}. \tag{14}$$

In this model, each firm faces a different, endogenously determined demand elasticity. The formula for the firm's demand elasticity in (13) reveals that firms with large market shares behave more like monopolists. They face relatively low demand elasticities, closer to the across-industry elasticity θ, whereas small firms face a relatively high demand elasticity, closer to the within-sector elasticity γ. With $\theta = 1$ and $\gamma = 10$, the elasticity of demand for a smaller firm with a 10 percent market share is $1/(0.1 + 0.9 \times 0.1) = 5.26$ while it is 1.56 for a firm with a 60 percent market share. This difference in demand elasticities means that a smaller firm can increase its quantity sold about three times more than a larger firm can when it cuts its price by the same amount.

Market Shares and Markups The formula for the firm's demand elasticity in (13) implies a linear relationship between a firm's inverse markup and its market share

$$\mu_i(s) = \left(\frac{\gamma-1}{\gamma} - \left(\frac{1}{\theta} - \frac{1}{\gamma}\right)\omega_i(s)\right)^{-1}. \tag{15}$$

where $\mu_i(s) \equiv \frac{\epsilon_i(s)}{\epsilon_i(s)-1}$ is the firm's markup. Since $\theta < \gamma$, firms with relatively high market shares face a low demand elasticity and set high markups. An infinitesimal firm charges a markup of $\gamma/(\gamma-1)$ and a pure monopolist charges $\theta/(\theta-1)$. This relationship is depicted in Figure 1 with $\gamma = 10.5$ and $\theta = 1.24$. The end point of the convex curve to the left-hand side is where the firm has a near zero market share and the markup is minimal $\gamma/(\gamma-1)$; and the end point to the right-hand side is where the firm has a market share of one and the markup is maximal $\theta/(\theta-1)$.

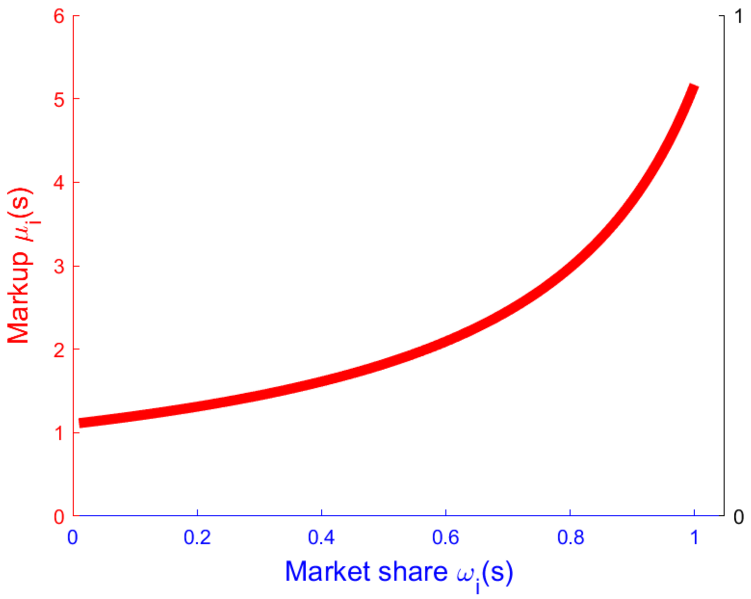

Figure 1: The value of the firm's markup as the firm's market share increases from 0 to 1

The firm's markup is an increasing convex function of its market share.[4] The elasticity of the markup with respect to the firm's market share is positive and increasing in the market share of the firm

$$\varepsilon_{\mu,\omega} = \frac{\partial \mu_i}{\partial \omega_i}\frac{\omega_i}{\mu_i} = \left(\frac{1}{\theta} - \frac{1}{\gamma}\right)\omega_i \mu_i. \tag{16}$$

Equation (16) implies that larger firms increase their markups by a larger percentage than smaller firms when their market shares double. This relative change in markups leads to higher relative prices and lower relative market shares for larger firms than before.[5]

Operating decision Each firm must pay a fixed cost τ to operate in its market. The firm operates in its market as long as

$$\big(p_i(s) - \psi_i(s)\big)y_i(s) \geq \tau. \tag{17}$$

[4]Because of the convexity in markups with respect to market shares, a mean-preserving spread in market shares will increase the average markup. When $\theta = \gamma$, the demand elasticity is constant and independent of the dispersion in market shares, and the model collapses into a standard monopolistic competition model with constant markups as in Atkeson and Burstein (2008).

[5]The markup and the elasticity of the markup with respect to the firm's market share under Bertrand competition are calculated in Appendix A.1. Also under Bertrand competition is the elasticity of the markup with respect to the firm's market share positive and increasing in the market share of the firm. Thus, the model predictions are qualitatively similar and carry over under Bertrand competition.

Firms decide whether to operate based on their draw of productivity $a_i(s)$ and their draw of interest rate $r_i(s)$ relative to the draws of other firms. There are multiple equilibria in any given sector. Different combinations of firms may choose to operate, given that the others do not. As in Atkeson and Burstein (2008) and Edmond, Midrigan and Xu (2015), within each industry s firms are placed in order of their marginal costs $\psi_i(s)$ and I focus on equilibria in which firms sequentially decide on whether to operate or not. Sequential decisions mean that the firm with the lowest marginal cost decides first, given that no other firm operates. Then, given that no other higher-cost firm operates, firms with the second lowest cost decides and so on. Firms that face a low marginal cost always operate and firms with the highest marginal costs never do. These sequential operating decisions may only affect selection among the marginal firms and therefore have a negligible effect on aggregates.[6]

3.3 Price setting

The formula for the firm's markup implies that the price is increasing in the firm's market share and its marginal cost

$$p_i(s) = \left(\frac{\gamma - 1}{\gamma} - \left(\frac{1}{\theta} - \frac{1}{\gamma}\right)\omega_i(s)\right)^{-1} \psi_i(s). \tag{18}$$

If each industry comprises of $N(s) \geq 1$ identical producers who each have an identical market share $\omega_i(s) = 1/N(s)$ then the markup of all producers is identical and equal to

$$\mu_i(s) = \left(\frac{\gamma - 1}{\gamma} - \left(\frac{1}{\theta} - \frac{1}{\gamma}\right)\frac{1}{N(s)}\right)^{-1}, \tag{19}$$

and therefore the prices are

$$p_i(s) = \left(\frac{\gamma - 1}{\gamma} - \left(\frac{1}{\theta} - \frac{1}{\gamma}\right)\frac{1}{N(s)}\right)^{-1} \psi_i(s). \tag{20}$$

In this special case, the markup declines from $\frac{\theta}{\theta-1}$, at $N(s) = 1$ the monopoly case, to $\frac{\gamma}{\gamma-1}$, the case of almost monopolistic competition as $N(s) \to \infty$.

[6] Since entry and exit in the model of Edmond et al. (2015) are only determined by the fixed costs τ, which only affect the marginal firms, they only find very small effects from increased entry of firms upon reducing the fixed operating cost.

3.4 Comparative statics: price change upon competitors' exit

In order to build intuition for how an exiting firm's market share affects the remaining firms' prices, I consider a particular case in which all operating firms are homogeneous with market share $1/(N-1)$ and only the exiting firms' market shares are different. When k firms exit, there will be $N-k$ firms operating in the current period and the exiting firms' combined market share will be the sum of their individual market shares $\sum_k^N \omega_k$. Given the price setting equation in (18), the difference in firm i's price due to the exit of other firms can be written as the difference between its current price $p_i(s)$ and its price in the previous period $p_{i,-1}(s)$:

$$p_i(s) - p_{i,-1}(s) = \left(\frac{\gamma-1}{\gamma} - \left(\frac{1}{\theta} - \frac{1}{\gamma}\right)\frac{1}{(N-k)}\right)^{-1} \psi_i(s) - \left(\frac{\gamma-1}{\gamma} - \left(\frac{1}{\theta} - \frac{1}{\gamma}\right)\frac{(1-\sum_k^N \omega_k)}{(N-k)}\right)^{-1} \psi_{i,-1}(s). \tag{21}$$

We see that firm i's price is increasing in the sum of the market shares of all exiting firms. The case where the remaining firms have heterogeneous costs is more complicated and it will be discussed later via a numerical simulation.

The cost channel Equation (21) highlights the existence of a cost channel as the firm's price is increasing in its marginal cost $\psi_i(s)$. When financing costs increase, an increase in the firm's price can happen for two reasons. One is due to exit, leading to an increase in the firm's markup, and the other is due to an increase in the firm's marginal cost. In the model economy, it is straightforward to run experiments where the markup (competition) channel can be separated from the cost channel. However, when estimating a regression, akin to equation (21), it is challenging to separate the price response via the cost and the competition channels. This identification problem will be discussed in more detail.

3.5 Aggregation

I define industry productivity as industry production divided by industry labor input

$$a(s) \equiv \frac{y(s)}{l(s)}. \tag{22}$$

The industry markup can be defined as the total value of production divided by the total cost of production

$$\mu(s) \equiv \frac{p(s)y(s)}{R(s)Wl(s)}, \tag{23}$$

where $R(s) \equiv (1 + r(s))$ is the industry-level interest factor and it is given by

$$R(s) = \sum_{i=1}^{N(s)} R_i(s) \frac{y_i(s)}{y(s)} \frac{a(s)}{a_i(s)}, \tag{24}$$

with $R_i(s) \equiv (1 + r_i(s))$.[7]

Markup Using the ratio of the firm-level equation (18) and the industry-level equation (23), the industry markup can be expressed as the sales-weighted harmonic average of individual markups

$$\mu(s) = \left(\sum_{i=1}^{N} \frac{\omega_i(s)}{\mu_i(s)} \right)^{-1}. \tag{25}$$

The relation between the Herfindahl-Hirschman (HH) index of industry concentration and industry prices can be derived by substituting the expression for firm-level markups (15) into equation (25)

$$\mu(s) = \left(\sum_{i=1}^{N} \omega_i(s) \left(\frac{\gamma - 1}{\gamma} - \left(\frac{1}{\theta} - \frac{1}{\gamma} \right) \omega_i(s) \right) \right)^{-1}. \tag{26}$$

Given that the sum of firm market shares is one, $\sum_{i=1}^{N} \omega_i(s) = 1$, and that the HH index is the sum of squared market shares $HHI(s) = \sum_{i=1}^{N} \omega_i(s)^2$, the industry markup can be expressed as a function of the HH index

$$\mu(s) = \left(\frac{\gamma - 1}{\gamma} - \left(\frac{1}{\theta} - \frac{1}{\gamma} \right) HHI(s) \right)^{-1}. \tag{27}$$

In the symmetric case, the HH index is just $1/N(s)$.

[7] To derive $R(s)$, I use that the industry-wide total variable cost function is $\Psi(s) \equiv R(s)Wl(s)$. I take the ratio of the firm-level total cost function $\Psi_i(s) = R_i(s)Wl_i(s)$ to the industry-wide total cost function $\Psi(s)$ and I combine it with the firm-level production function and the definition of $a(s)$ in (22).

To derive the aggregate markup, I define the quantity of final output as

$$Y = A\tilde{L}, \tag{28}$$

where A is the endogenous level of aggregate productivity and $\tilde{L}$ is the aggregate amount of labor employed net of fixed costs. Taking the ratio of firm-level prices to the aggregate price index, the aggregate markup can be written as a revenue-weighted harmonic mean of firm-level markups

$$\mathcal{M} = \left(\int_0^1 \left(\sum_{i=1}^{N(s)} \frac{1}{\mu_i(s)} \frac{p_i(s)y_i(s)}{PY} \right) ds \right)^{-1}. \tag{29}$$

Productivity Substituting the firm-level production function and $l_s = \sum_i l_i$ into (22) yields that $a(s)$ is the quantity-weighted harmonic average of firm productivities

$$a(s) = \left(\sum_{i=1}^{N(s)} \frac{1}{a_i(s)} \frac{y_i(s)}{y(s)} \right)^{-1}. \tag{30}$$

A similar expression can be derived for aggregate productivity using the market clearing condition for labor

$$A = \left(\int_0^1 \left(\sum_{i=1}^{N(s)} \frac{1}{a_i(s)} \frac{y_i(s)}{Y} \right) ds \right)^{-1}. \tag{31}$$

4 Model predictions

In the special case in equation (21), when all remaining firms are equal and symmetric, the model predicts that firm i's price is increasing in the market share of the exiting firms. To derive the average response in an economy with heterogeneous firms, I now show the quantitative prediction of the model calibrated to Sweden in 2008.[8]

4.1 Experiment

Although the main question of this paper extends beyond studying the financial crisis, the financial crisis provides a convenient application. During the crisis, there was a significant

[8] The calibration exercise is based on the sample of industries that is used in the econometric estimation in order to be able to compare the simulated and the estimated results.

increase in firm exit and international events generated disruptions in financial markets which were exogenous to Swedish firms' operations. A description of the financial crisis in Sweden is presented in Appendix A.2.

The baseline experiment that I consider in the model imitates the credit rationing feature of the financial crisis where banks' lending restrictions led some Swedish firms' credit lines to dry up. Since loan volumes were reduced, it became difficult, expensive, and even prohibitive for some firms to obtain credit from their own or other financial institutions. To simulate a scenario with similar features, the baseline experiment increases the lending rate for one percent of the firms to a level where they cannot break even and find it optimal not to operate. The experiment is designed to show the price response of the remaining firms when on average one percent of their industry competitors exit due to a large financial shock. Since I do not know which firms closed down during the crisis because of financing problems, I consider three experiments in the model. I show the percentage change in firms' prices when one percent of their smallest, median or largest competitors exits. The baseline experiment does not include a cost channel because I find indications in the data that financial costs did not, on average, increase for firms which remained in operation. In fact, the bank lending rates on outstanding and new agreements declined during 2009.[9]

Note that in the calibrated model economy, many industries have less than one hundred firms, so it is not possible to eliminate exactly one percent of firms in each industry. To mimic the regression, the baseline experiment will generate the exit of one percent of firms from industries with the same number of firms. In other words, one out of a hundred firms is eliminated in industries with 0-10 firms, 10-20 firms, 20-30 firms and so on. At the aggregate level, approximately one percent of producers are induced to exit.

4.2 Calibration

The model is calibrated to moments of the firm size distribution and industry concentration measures in 2008 in Sweden. The parameterization that achieves these moments is presented in Table 1.

[9]The experiment could be supplemented by decreasing the interest rates for surviving firms. Decreasing the rates for surviving firms was an attribute of the financial crisis in Sweden. This cost channel is not implemented in the model because aggregate changes affect neither the aggregate markup nor the markup distribution.

The draws of the idiosyncratic productivity $a_i(s) \geq 1$ are assumed i.i.d. Pareto across producers with the shape parameter $\xi > 0$. The shape parameter enables the structural model to match the market share distribution of firms and the concentration measures such as the inverse Herfindahl-Hirschman (HH) index.

The draws of $R_i(s)$ are from a negatively skewed distribution with a mean of 1.06 so that most firms have higher gross interest rates and only very few firms have the lowest gross interest rates. This distribution helps me match the negative correlation between interest rates and firm sizes in the data, where large firms have lower interest rates. In the data, I measure gross interest rates as the ratio of interest expenses to debt at the firm level.

Table 1: Model calibrated to moments of the firm size distribution and industry concentration measures in 2008 in Sweden.

Moments	Data	Model		Data	Model
5-digit industries	208	208	Coefficients in regression of		
p10 number producers	9	20	labor share on market share		
p50 number producers	50	50	Ratio of coefficients b1 / b0	-1.15	-1.15
p90 number producers	485	76			
			Mean gross interest rate within		
Concentration measures			firm market share percentiles		
Mean inverse HH	16.7	6.46	p0-p10	1.078	1.072
p10 inverse HH	1.46	1.95	p10-p20	1.069	1.069
Median inverse HH	5.47	5.47	p20-p30	1.065	1.066
p90 inverse HH	36.05	15.48	p30-p40	1.062	1.064
			p40-p50	1.060	1.061
Distribution of firm market shares			p50-p60	1.057	1.058
Mean share	0.004	0.02	p60-p70	1.053	1.055
Median share	0.0001	0.0025	p70-p80	1.048	1.051
p75 share	0.0007	0.0087	p80-p90	1.044	1.046
p95 share	0.008	0.093	p90-p100	1.038	1.038
p99 share	0.06	0.35			
SD share	0.03	0.067			
Parameter values					
γ	10.5				
θ	2.17				
productivity Pareto tail ξ	5.2				
fixed cost τ	0.00002				
R distribution mean	1.06				
R distribution sd	0.01				
R distribution skew	-0.6				
R distribution kurt	2.6				

Notes: The HH index measures market concentration $HHI_s = \sum_i \omega_i^2$ and the inverse HH index is $1/HH$, which equals $N(s)$ with symmetric firms. In the data, I measure gross interest rates as the ratio of interest expenses to debt at the firm level.

The parameter γ is taken from the previous literature and set to 10.5 as in Edmond, Midrigan and Xu (2015). For a given γ, I calculate θ using the relationships in the model.

The relationship between the pre-funded labor share and the market share is

$$\frac{(1+r_i(s))Wl_i(s)}{p_i(s)y_i(s)} = \frac{\gamma-1}{\gamma} - \left(\frac{1}{\theta} - \frac{1}{\gamma}\right)\omega_i(s). \tag{32}$$

Following Edmond, Midrigan and Xu (2015), I approximate this in the data by using an indirect inference approach to retrieve the coefficients b_0 and b_1 from the data with the regression

$$\frac{(1+r_i(s))Wl_i(s)}{p_i(s)y_i(s)} = b_0 - b_1\omega_i(s). \tag{33}$$

For a given γ, θ is given by

$$\theta = \left(\frac{1}{\gamma} - \frac{b_1}{b_0}\left(\frac{\gamma-1}{\gamma}\right)\right)^{-1}. \tag{34}$$

In this way, the model is required to match the correlation between the producer's labor share and market share. The estimation on Swedish data gives the intercept $b_0 = 0.26$ and slope $b_1 = -0.3$, so the model is required to match the ratio $b_1/b_0 = 1.15$, and therefore $\theta = 2.17$.

The model fits the median number of producers well, the concentration in the median industry and the correlation between interest rates and firm sizes. The baseline calibration focuses on matching the concentration in the median industries (p50 inverse HH index) and this leads to undershooting for the least concentrated industries (p90 inverse HH index). The lack of industry-specific productivity draws makes it difficult to match the most concentrated and the least concentrated industries at the same time. An alternative calibration is presented in Appendix A.3, where I focus on matching the least concentrated industries with a larger Pareto tail parameter 7.5. The alternative calibration yields similar outcomes for the markup effect of exit. In the discussion, I elaborate on why this is the case.

4.3 Model implied price response

In the model, the exit of one percent of competitors in the industry generates an increase in the markups and prices of the remaining firms. The simple average percentage change in the markups is shown in column (1) of Table 2. The remaining firms increase their markups so little when their smallest competitors exit that the change rounds to zero. The remaining firms increase their markups only marginally when one percent of their median or largest competitors exits.

Table 2: Percentage change in firm-level markups when one percent of the smallest, median or largest industry competitors exit.

	(1) Avg. % change in markups	(2) Weighted % change in markups
Experiment 1 (small)	0%	0%
Experiment 2 (medium)	0.000020%	0.0016 %
Experiment 3 (large)	0.000019%	0.0011 %

Notes: A one percent increase in the markup is, for example, from 1.1 to 1.111. The simple average percentage change in markups is the arithmetic average of the percentage changes in the markups of firms that are present in both periods. The percentage change in the economy weighted-average markup is calculated according to equation (29) only using the markup of firms that are present in both periods such that the weights in both periods are the firms' market shares after the shock.

Column (2) of Table 2 shows the percentage change in the weighted-average markup calculated according to equation (29) using only the markup of firms that are present in both periods, exclusive of the aggregate change from the missing markups of the exiting firms. Column (2) shows that the increase in the weighted-average markup is larger than the increase in the simple average. This is because the calculation for the weighted-average markup gives more weight to larger firms whose markup changes are larger.

Two mechanisms determine the markup changes of small firms relative to large firms. One relates to the response of markups to changes in market shares. From the equation of the markup in (15), we can see that larger firms increase their markups by a larger percentage in response to an increase in their market shares because the elasticity of the markup with respect to the market share is increasing in the market share of the firm. The second mechanism depends on the response of market shares to exit. In the model, the remaining small firms increase their market shares relatively more than large firms when their competitors exit. The net of these two effects is that the weighted-average markup increases more than the simple average because the markup response of larger firms outweighs the response of smaller firms.[10]

[10] As an example, we can consider a firm with a 10 percent market share which increases its market share by ten percent (from 10 to 11 percent); and a firm with a 60 percent market share increases its market share by five percent (from 60 to 63 percent). Then, equation (15) prescribes that the change in their markup will be one percent and seven percent, respectively. Even though the relative change in market shares is larger for smaller firms, high markup firms will get more weight in the weighted-average markup calculation.

Considering the magnitude of the change across the three experiments, only the weighted-average markup increases by a noticeable amount. Comparing experiments 2 and 3 in terms of the weighted-average markup change in column (2), the model generates an interesting outcome. The exit of larger firms increases the weighted-average markup by less than the exit of median firms. This outcome arises because the markup increase of the remaining firms is less than the decrease in the average markup due to the exit of firms with the highest markups.

The model allows us to compare the change in the aggregate markup between the baseline case and the new equilibrium. The change is calculated as the log difference between $\mathcal{M}^{new}$ and $\mathcal{M}^{old}$ where $\mathcal{M}$ is given by equation (29). Table 3 shows that the aggregate markup increases by 0.003 percent when one percent of the medium firms exit.[11]

Table 3: Percentage change in the aggregate markup

	% change in the aggregate markup
Experiment 1 (small)	0%
Experiment 2 (medium)	0.003 %
Experiment 3 (large)	0.002 %

The reason why the aggregate markup change is larger than the weighted-average markup change is because the aggregate markup in the initial period is calculated by including one percent more firms that will exit in the next period.

5 Estimation

In this section, I implement the econometric analysis to examine whether the effect of firm exit on prices is close to zero as the model predictions imply.

5.1 Data

Three datasets are merged: firm-level monthly price index data (1992m1-2017m12), firm-level annual balance sheet data (1985-2017) and a dataset containing municipality-level numbers of bank branches (2000-2009).

[11] The difference between column (2) of Table 2 and column (2) of Table 3 is that the aggregate markup calculation is based on *all* producing firms in both periods, whereas the weighted-average markup calculation compares the markup changes of only those firms who participate in both periods.

The price data consists of firm-level monthly price indices for over 2,000 firms. From this price index data, I exclude monthly price changes that are below the bottom one percentile and above the top 99th percentile of the monthly price change distribution. Extreme values are excluded because they likely represent reporting mistakes by the firms. Firm-level annual price changes are constructed from the monthly price indices by taking the log price change between the prices reported in December. Around 80 percent of firms included in the price data are in the manufacturing industry. 20 percent of firms in the price data operate in the wholesale, retail, construction and services industries.

The annual business statistics dataset contains information on firm-level annual balance sheet variables for all firms in Sweden. Using data on sales, it is possible to calculate market shares in Sweden for all firms operating in Sweden.

The third dataset lists bank branch locations at the 4-digit municipality level. This is a unique dataset constructed by Grönqvist and Torngren Wartin (2019) from bank branch address lists published in "Bankplatser i Sverige" by The Swedish Bankers' Association. "Bankplatser i Sverige" was published once or twice a year until 2009.

The estimation uses annual data. For the OLS panel regressions, I use data for the period between 2000-2016. The instrumental variable approach is implemented using a cross-sectional data set of firms in 2009. The variation in prices is at the firm-product-group-level, where product groups are defined at the 2-digit-level of the European Harmonized System. Examples of the 2-digit product groups are "pharmaceutical products" and "wood and articles of wood (not furniture)". 80 percent of firms produce goods within the same product group and only five percent of firms produce goods in more than two product groups. In the final data, the right-hand side industry variation in exit is measured at the 5-digit industry-level. An example of a 5-digit industry is "manufacture of mattresses", which belongs to the 2-digit industry "manufacture of furniture".

Measure of markets Over two-thirds of the price data refer to firms that operate in the manufacturing sector which constituted around 17 percent of the Swedish economy in 2008-2009. The rest of the firms are in the wholesale, retail, construction and services industries, which constitute the rest of the Swedish economy.

Measure of exit Exit is measured at the 5-digit industry level in two ways denoted by RExit(number) and RExit(share) where R stands for relative:

$$\begin{aligned}\text{RExit}_{s,t,t-1}(\text{number}) &= \frac{N^{exiters}_{s,t}}{N_{s,t-1}},\\ \text{RExit}_{s,t,t-1}(\text{share}) &= \sum_{j}^{N} \omega^{exiters}_{j,t-1}.\end{aligned}$$

RExit(number) is the number of firms that exited relative to the number of firms in the previous year. RExit(share) is measured by the market share in the previous year of the firms that exited in year t.

5.2 Empirical approach

In this section, I discuss the classical identification problem with respect to estimating equation (21) and propose an instrumental variable approach as a solution.

5.2.1 Fixed effects OLS

Consider first an OLS panel regression with fixed-effects that can be expressed as

$$\Delta lnP_{i,s,t,t-1} = \alpha_i + \beta RExit_{s,t,t-1} + \gamma_{k,t} + \epsilon_{i,s,t} \tag{35}$$

where k is an index for 2-digit industries and s denotes the 5-digit industry. Here, $\gamma_{k,t}$ denote industry-time dummies at the 2-digit level, which are meant to capture supply and demand shocks at the 2-digit industry level. Still, an identification problem may remain. For example, an industry demand shock at the 5-digit level may reduce exit and increase prices, creating spurious correlation and a negative bias. Similarly, industry cost shocks may increase exit as well as prices, thus creating a positive bias.

5.2.2 Instrumental variable approach

To identify the effect of firm exit on prices, I use an instrumental variable (IV) approach. The instrument used for exit is a measure of the industry's exposure to the bank SEB (Skandinaviska Enskilda Banken) which was significantly affected by the financial crisis for reasons orthogonal to developments within the Swedish economy. Amberg, Jacobson and von Schedvin (2020) argue that differences in lending behavior of banks in 2009 were a consequence of the banks' differential exposures to the Baltic countries; see also Ingves (2010); Bryant et al. (2012) and IMF (2012). Figure 2 shows that SEB significantly reduced its loans to Swedish firms as compared to other large banks.

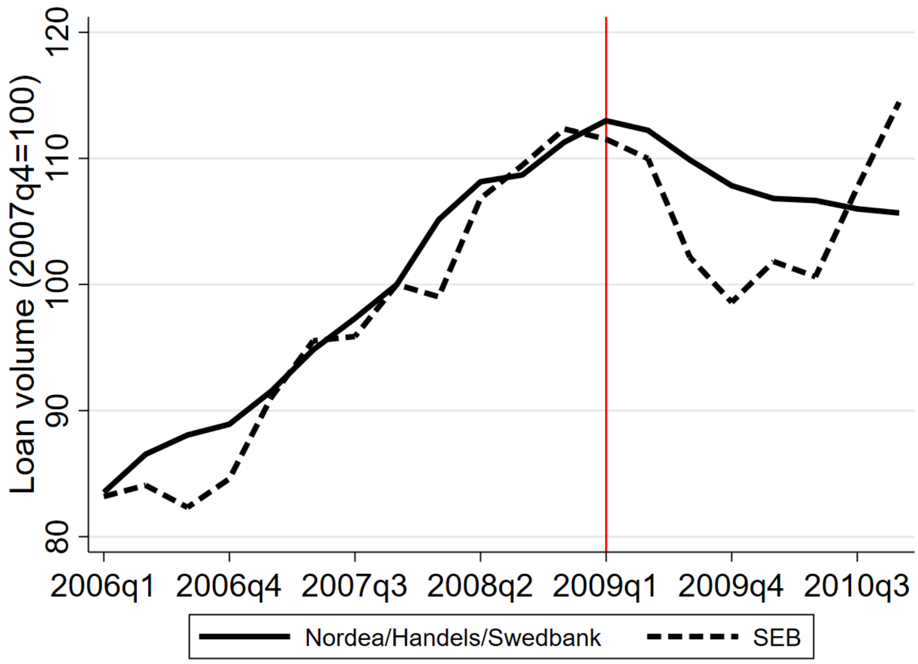

Figure 2: Outstanding loans to Swedish non-financial firms

The reason why SEB reduced its loan supply relatively more is that it chose to opt out of the government insurance program, whereas other banks decided to participate. This decision is only problematic for identification if the bank's choice is based on a-priori sorting between firms and banks. Amberg, Jacobson and von Schedvin (2020) argue that there is little sorting between firms and banks in the corporate segment of the Swedish bank market. I further investigate whether there is sorting between firms and banks (i) by reporting pre- and post-trends in exit given exposure to SEB and (ii) by presenting the covariate balance of firms at the onset of the crisis in 2008.

The instrument is a measure of the industry's financial exposure to SEB at the trough of the crisis in 2009:

$$Z_{s,2009} \equiv \frac{\mathrm{D}_{s,2008}}{\mathrm{A}_{s,2008}} \times \mathrm{SEB}_{s,2009}. \tag{36}$$

The industry's financial exposure is a product of how much debt the industry had, measured by the industry's lagged debt to asset ratio $D_{s,2008}/A_{s,2008}$ and how exposed the industry is to SEB ($SEB_{s,2009}$). $SEB_{s,2009}$ is the industry-average of the firm-level exposures. Firm-level exposure to SEB is defined as the ratio of the number of SEB branches to all bank branches in the municipality where the firm's headquarter is located. For example, an industry has 2 firms and an exposure of 0.3. Firm 1's exposure to SEB is 0.2 and that of Firm 2 is 0.4 because they are in different municipalities. In this composite instrument, I view the crisis in the Baltic countries as an exogenous shock and $SEB_{s,2009}$ and $D_{s,2008}/A_{s,2008}$ as heterogeneous treatment or shift-shares.

There are two reasons why the geographic distribution of banks may matter for corporate borrowing. One is that corporate loans and credit lines normally have to be approved and renegotiated in person, especially in the 2000's when digitalization had not been fully realized. This implies that there is a shoe-leather cost associated with obtaining financing, which firms may want to minimize. Second, Degryse and Ongega (2005) show evidence that loan rates decrease with the distance between the firm and the lending bank. Such spacial price discrimination in bank lending suggests that distance matters and that firms can reduce their costs by getting better rates if they chose the bank closest to them.

5.2.3 Instrumental variable regression

The IV regression is a cross-sectional regression that examines the effect of industry exit on firm-level annual price index changes between 2008-2009:

$$\Delta \ln \mathrm{P}_{i,s,2009} = \alpha_1 + \beta_1 \mathrm{RExit}_{s,2009} + \gamma_k + \epsilon_{1,i,s,2009}. \tag{37}$$

The dependent variable $\Delta\ln\mathrm{P}_{i,s,2009}$ is at the firm level and the explanatory variable is at the 5-digit industry level. In the baseline regression, $\mathrm{RExit}_{s,2009}$ is measured by REexit(share), the relative industry market share of exiting firms between 2008-2009, and it is instrumented by $Z_{s,2009} \equiv \frac{\mathrm{D}_{s,2008}}{\mathrm{A}_{s,2008}} \times \mathrm{SEB}_{s,2009}$. γ_k are 2-digit industry fixed effects.

The first-stage regression is given by

$$\mathrm{RExit}_{s,2009} = \alpha_2 + \beta_2 \left(\frac{\mathrm{D}_{s,2008}}{\mathrm{A}_{s,2008}} \times \mathrm{SEB}_{s,2009} \right) + \gamma_k + \epsilon_{2,s,2009}. \tag{38}$$

5.2.4 Relevance, exogeneity and validity of the instrument

Pre- and post trends Figure 3 shows that industry exit is one percent larger in 2009 for industries that are above the median SEB exposure than for industries that are below the median SEB exposure. Examining pre- and post trends highlights that SEB-exposure is a relevant instrument for exit only in 2009.

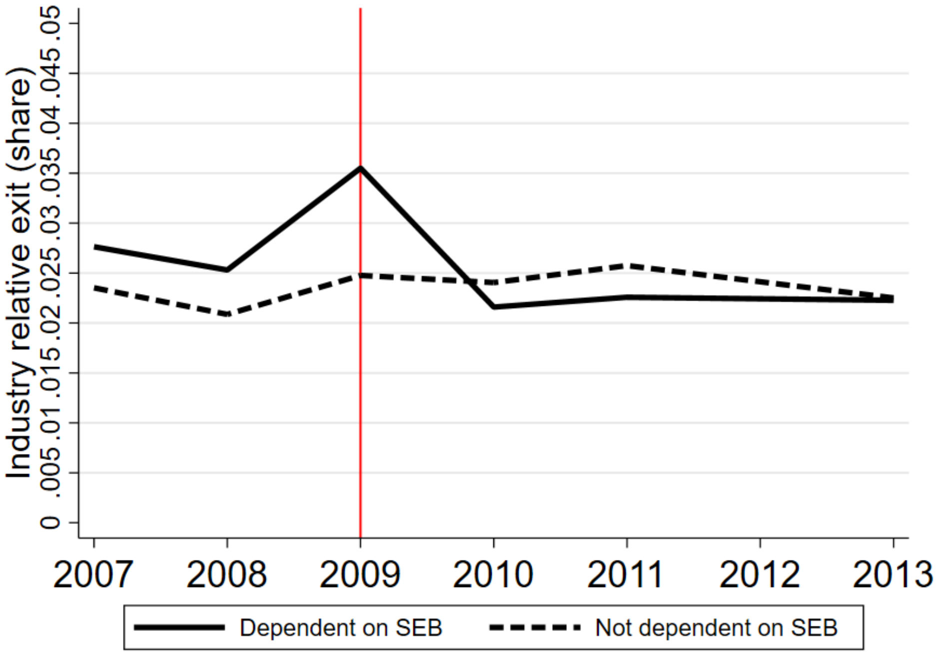

Figure 3: Industry relative exit across two groups of industries

The relevance of the instrument is examined in more detail in Appendix A.7. Specifically, Appendix A.7 shows that both parts of the firm-level variable $Z_{s,2009} \equiv \frac{\mathrm{D}_{s,2008}}{\mathrm{A}_{s,2008}} \times \mathrm{SEB}_{s,2009}$ affect the probability of individual firm exit. In addition, Appendix A.8 shows that firms and industries with a high degree of dependence on SEB did not face a higher probability of firm closure prior to 2009.

Selection to SEB Exogeneity of the instrument requires that underlying firm characteristics are not correlated with bank relations. To investigate selection between firms and SEB, Table 4 reports the normalized difference between SEB-exposed and not SEB-exposed firms in 2008. SEB-exposed firms are those above the median SEB-exposure within their industries. I follow Imbens and Rubin (2015) by constructing normalized differences as measures of the covariate distribution overlap. Imbens and Rubin (2015) argue that their experimental data shows an 'excellent' covariate balance (up to a value) of 0.3. When the covariate distributions are compared in the last column of Table 4, the normalized differences indicate only small differences in covariates between SEB-exposed firms and not SEB-exposed firms. These statistics suggest that firms that are more exposed to SEB have similar characteristics to firms that are less exposed to SEB.

Table 4: Normalized difference between SEB-exposed and not SEB-exposed firms in 2009

	SEB-dependent		Not SEB-dependent		
Firm characteristics in 2008	Mean	SD	Mean	SD	Normalized Difference
Market Share	0.011	0.055	0.007	0.036	0.091
Export/Sales	0.031	0.226	0.030	0.726	0.001
Cash/Assets	0.185	3.155	0.195	0.227	-0.005
Intangible Assets/Assets	0.017	0.079	0.012	0.065	0.067
Inventories/Assets	0.159	0.956	0.174	0.225	-0.021
Receivables/Sales	0.099	0.501	0.091	0.129	0.022
Payables/Assets	0.878	37.829	0.849	58.563	0.001
Observations		41505		40937	

Notes: The normalized difference is calculated as $\bar{X}_{tr} - \bar{X}_{co}/[(S_{tr}^2 + S_{co}^2)/2^{1/2}]$, where $\bar{X}$ is the mean, S is the standard deviation, and subindices tr and co denote treated firms and control firms within 5-digit industries, respectively. The normalized differences in the last column compare covariate outcomes for treated firms with those of nontreated firms.

Selection to SEB and the likelihood of exit To examine whether there is a spurious correlation between exit and SEB dependence because of an underlying characteristic of firms, Tables 19 and 20 in Appendix A.8 present logistic regressions which estimate the probability of exit in 2009 conditional on various observable characteristics and the SEB-dependence of firms in 2008. The tables suggest that there is selection into exit because smaller, cash poor and highly indebted firms are more likely to exit, but the regressions suggest that the correlation between the various balance sheet variables and exit are similar between firms with higher and lower SEB dependence.

Exclusion restriction The exclusion restriction is satisfied as long as exposure to SEB in a firm's industry only affects the firm via exit and does not have a direct effect on the firm's prices. The main threat here is a potential effect via a financial cost channel which would occur if SEB-dependent remaining firms changed their prices more or less because their financial costs changed more relative to firms with other bank relations. In other words, SEB-exposure may be a confounding variable between industry exit and firm-level costs. If so, the instrument should be directly included in the regression and the exclusion restriction would be violated.

Using firm-level data has the advantage that the firm-level variable $Z_{i,t} \equiv \frac{\mathrm{D}_{i,2008}}{\mathrm{A}_{i,2008}} \times \mathrm{SEB}_{i,2009}$ can be directly included in the IV regression as a control variable. Conditioning on the firm's own financial exposure to SEB, the regression specification becomes

$$\Delta \ln \mathrm{P}_{i,s,t,t-1} = \alpha_1 + \beta_1 \mathrm{RExit}_{s,t,t-1} + \beta_2 Z_{i,t} + \gamma_k + \epsilon_{1,i,s,t}. \tag{39}$$

With this specification, it is possible to take account of the direct effect via costs and to elicit whether the remaining firms' financial costs and the industry-level instrument are correlated.

Exogeneity with respect to entry A threat to identification may be if the instrument predicts a decline in entry during the crisis. This would require that existing and new firms have similar bank relations in terms of both firms' locations *and* their debt to asset ratios. Since lagged debt to asset ratios are not available for new firms, I cannot measure whether this is the case. However, Table 16 in Appendix A.4 shows that the SEB-dependence of industries ($SEB_{s,2009}$) is not a statistically significant predictor of industry entry, whilst Table 17 in Appendix A.5 reports that $SEB_{s,2009}$ predicts exit. To implement an additional robustness check with respect to entry, I include the entrants' market share as a control variable in the IV regression in Section 6.4.

Summary statistics Table 5 shows summary statistics for the variables in the IV regression as well as for firms' sales, wage expenses and debt to assets ratios. The annual firm-level percentage price change is between -17 and 12 percent. The average industry relative exit considering RExit(number) is three percent and considering RExit(share) it is two percent. The average industry has an exposure variable $Z_{s,t}$ of 0.81. Note that some firms have large liabilities to assets ratios. Inspecting the balance sheets of all firms in Sweden, it is often the case that firms have liabilities to assets ratios that are larger than one.

Table 5: Summary statistics

	Mean	SD	p5	p50	p95
$\Delta \ln P_{i,t,t-1}$	0	0.12	-0.17	0	0.12
$\text{Sales}_{i,t}$	2207705	7122998	47350	501948	8331202
$\text{Wages}_{i,t}$	235208	726139	8082	67411	815181
$\text{Capital}_{i,t}$	1462607	4429291	23256	313632	6311102
$\text{RExitNumber}_{s,t}$	0.03	0.03	0	0.03	0.07
$\text{RExitShare}_{s,t}$	0.02	0.05	0	0.01	0.10
$\text{SEBshare}_{s,t}$	0.10	0.09	0	0.08	0.25
$\text{Liabilities}_{s,t-1}/\text{Assets}_{s,t-1}$	0.87	4.77	0.21	0.61	1.42
$\text{SEB}_{s,t} \times \frac{D_{s,t-1}}{A_{s,t-1}}$	0.81	5.33	0.03	0.07	0.16

Notes: The number of observations are 602, which are the number of firms in 2009 with log price changes available between $t = 2009$ and $t-1 = 2008$. The statistics for 5-digit industry variables indexed by s are calculated across the 602 firms in the sample. Monetary values are in millions of Swedish Kronor (SEK).

Table 6 shows examples of 5-digit industries in 2009 with the highest, the median and the lowest exit rates measured by the RExit(share) variable. In particular, Table 6 reports the number of firms in the population, the number of firms in the price data sample, the relative number of exiting firms, the industry's SEB ratio, the industry's average lagged debt to asset ratio and the SEB Exposure ratio, which is the previous two multiplied. We can see that in industries with the largest market share reduction, firms with a combined market share of 10-50 percent exited, whereas the fraction of exiting firms (RExit(Number)) was only around 4-5 percent.

Table 6: SEB exposure and exit in selected 5-digit industries in 2009

5-digit industries with the highest Rexit(Share)	**Firm Pop.**	**Firms Sample**	**RExit (Number)**	**RExit (Share)**	**SEB**	**Lagged Debt/Asset**	**SEB Exp.**
Consumer Electronics	19	3	0.05	0.4735	0.09	0.57	0.05
Other Electronic and Electric Wires and Cables	25	2	0.04	0.3465	0.05	0.55	0.03
Casting of Iron	21	2	0.05	0.3039	0.07	1.02	0.07
Wholesale of Perfume and Cosmetics	100	1	0.04	0.2531	0.12	0.63	0.08
Wholesale of Fruit and Vegetables	174	2	0.02	0.1870	0.10	0.72	0.07
Industrial Engineering Activities and Tech. Consultancy	713	1	0.04	0.1535	0.12	0.80	0.10
Stone and Mineral Wool Products	3	1	0.25	0.1203	0.04	0.69	0.03
Kitchen Fittings	74	2	0.06	0.1123	0.09	0.69	0.07
Various Other Non-Metallic Mineral Products	12	2	0.07	0.1060	0.17	0.63	0.11
Wholesale of other food, including fish	231	1	0.05	0.0988	0.14	0.76	0.11
5-digit industries with median Rexit(Share)							
Agents in the Sale of Food, Beverages and Tobacco	58	2	0.06	0.0185	0.13	0.79	0.10
Wholesale of Other Machinery and Equipment	1051	3	0.03	0.0184	0.12	0.67	0.08
Wholesale of Pharmaceutical Goods	383	1	0.04	0.0174	0.13	0.81	0.11
Repair of Machinery	477	7	0.03	0.0173	0.08	0.63	0.05
Fruit and Vegetable Juice	9	1	0.10	0.0169	0.09	0.69	0.06
Condiments and Seasonings	25	3	0.04	0.0161	0.11	0.69	0.07
Locks and Hinges	40	4	0.04	0.0157	0.14	0.53	0.08
Other Plastic Products	251	4	0.04	0.0153	0.11	0.67	0.07
Other Construction Installation	393	4	0.04	0.0147	0.11	0.69	0.07
Installation of Ventilation Equipment	471	1	0.04	0.0140	0.10	0.66	0.07
5-digit industries with the lowest Rexit(Share)							
Forest Management	231	1	0.01	0.0009	0.05	1.55	0.08
Other Products of Wood	98	1	0.01	0.0009	0.09	0.63	0.06
Concrete Products for Construction Purposes	76	3	0.03	0.0008	0.09	0.68	0.06
Communication Equipment	83	4	0.02	0.0007	0.13	3.01	0.38
Other Processing and Preserving of Fruit and Vegetables	43	9	0.03	0.0006	0.08	0.73	0.06
Irradiation, Electromedical and Electrotherapeutic Eq.	23	1	0.04	0.0003	0.15	0.72	0.10
Wholesale of Grain, Tobacco, Seeds and Animal Feeds	75	1	0.01	0.0003	0.11	0.73	0.08
Cocoa and Chocolate Confectionery	25	3	0.04	0.0003	0.09	0.78	0.07
Other Electrical Equipment	56	5	0.02	0.0003	0.11	1.10	0.12
Aluminium Production	24	4	0.04	0.0002	0.09	0.69	0.06

Notes: The table is ordered by Rexit(Share) in 2009. The number of firms in the population and in the sample are listed in the first two columns. SEB is the industry average of firm-level SEB exposures. Lagged Debt/Asset ratio is the industry average of firm-level Debt/Asset in 2008. SEB Exposure is the product of SEB and the Lagged Debt/Asset ratio.

6 Empirical results

6.1 Fixed-effects OLS regression

Table 7 reports OLS panel regressions for the period 2000-2016, relating log price changes to changes in the industry number of firms (column 1), the relative number of exiting firms (column 2) and the exiting firms' market share (column 3). The regressions include year×2-digit industry and firm fixed effects to control for industry-year specific shocks and firm-level unobserved heterogeneity. Column (1) suggests that a one percent increase in the number of firms in the industry reduces prices by 0.0085 percent, but this coefficient is small and not statistically different from zero. Columns (2) and (3) in Table 7 indicate that a one percent increase in industry relative exit increases prices by 0.2 percent. However, 5-digit industry-level demand and cost shocks may remain potential sources of bias in these regressions.

Table 7: OLS estimates of the effects of changes in the number of firms and exit on prices

	(1) $\Delta\text{lnP}_{i,t,t-1}$	(2) $\Delta\text{lnP}_{i,t,t-1}$	(3) $\Delta\text{lnP}_{i,t,t-1}$
$\Delta\text{lnN}_{s,t,t-1}$	-0.0085		
	0.0252		
$\text{RExit}_{s,t,t-1}$(number)		0.21^{+}	
		0.12	
$\text{RExit}_{s,t,t-1}$(share)			0.21^{*}
			0.10
Observations	7643	7643	7643
Year × 2-digit Industry FE	X	X	X
Firm FE	X	X	X

Notes: This table reports estimates from firm OLS panel regressions between 2000-2016 for firms with at least 1 employee. The outcome in all columns is firm ln annual price changes. Year × 2-digit industry and firm fixed effects are included in all regressions. Robust SEs are underneath point estimates. Stars $+p < .1$ $*p < .05$ $**p < .01$ $***p < .001$

6.2 First-stage

Table 8 reports the first-stage coefficients. Column (1) shows that a one unit increase in the instrument increases the fraction of firms that exit by 0.1 percentage units. Column (2) shows that a one unit increase in the instrument induces firms with a combined market share of 0.4 percent to exit. The magnitude of the coefficient in column (2) is in line with Figure 3 which suggested that the difference between industries with the highest and the lowest exposures is approximately one percent. The adjusted R^2 are 20 and 25 percent, respectively, implying that 25 percent of the variance in $\text{RExitShare}_{s,t,t-1}$ is explained by $\text{SEB}_{s,t} \times \frac{D_{s,t-1}}{A_{s,t-1}}$ and the industry fixed effects.

Table 8: First-stage

	(1)	(2)
	$\text{RExitNumber}_{s,2009}$	$\text{RExitShare}_{s,2009}$
$\text{SEB}_{s,2009} \times \frac{D_{s,2008}}{A_{s,2008}}$	0.000936***	0.00381***
	(0.000198)	(0.000361)
2-digit Industry FE	X	X
Observations	602	602
R^2	0.186	0.247

Notes: This table reports estimates from firm OLS cross-section regressions for 2009 for firms with at least 1 employee. Observations are firms. 2-digit industry dummies are included in all regressions. SEs, clustered at the 5-digit industry-level, are underneath point estimates. Stars $+p < .1$ $^{*}p < .05$ $^{**}p < .01$ $^{***}p < .001$.

Instrument strength Multiple weak instrument tests are presented in Appendix A.6. They suggest that the instrument is not weak.

SEB and Debt/Assets ratio Table 17 in Appendix A.5 reports the first-stage OLS regression that investigates the relation between industry exit and $\frac{\text{D}_{s,2008}}{\text{A}_{s,2008}}$ and $\text{SEB}_{s,2009}$ as separate regressors for all industries in 2009. The coefficients indicate that both SEB-dependence and the lagged debt to asset ratio are significant predictors of exit.

6.3 Instrumental variable regression

Table 9 reports the results of the instrumental variable regression. Column (1) shows that one percent exit measured by the number of firms in the firm's industry increases the remaining firm's prices by 1.3 percent. Column (2) shows that when firms with a combined market share of one percent exit, the remaining firms increase their prices by 0.3 percent. A standard deviation, or an average, increase in RExitShare across industries is 5 percent. The results suggest that the exit of firms with a 5 percent combined market share increases prices by 1.6 percent. RExitShare in the median industry is one percent and in the 95th percentile industry it is 10 percent, so the price increase would be 3.2 percent in industries with the largest exit shares.

Table 9: Instrumental variable regression

	(1)	(2)
	Δ $\ln P_{i,s,2009}$	Δ $\ln P_{i,s,2009}$
$\text{RExitNumber}_{s,2009}$	1.302***	
	(0.333)	
$\text{RExitShare}_{s,2009}$		0.320***
		(0.0458)
2-digit Industry FE	X	X
Observations	602	602
R^2	0.068	0.136

Notes: This table reports estimates from 2SLS cross-sectional IV regressions for 2009 for firms with at least 1 employee. Observations are firms. 2-digit industry dummies are included in the regression. SEs, clustered at the 5-digit industry-level, are underneath point estimates. Stars $+p < .1$ $*p < .05$ $**p < .01$ $***p < .001$.

Reduced form The reduced form of the IV regression is reported in Appendix A.9.

6.4 Robustness

The first set of robustness exercises aim to bring evidence against the alternative hypotheses that firm-level cost shocks drive the results. Column (2) in Table 10 includes the firm-level exposure variable as a control to rule out the cost channel via increased financial expenses for the remaining firms. Column (2) shows that the effect via firms' own financial expenses and prices is small and not statistically different from zero. To explain this, a short discussion about the cost channel is included below.

Table 10: Robustness: IV with weights and firm-level controls

	(1)	(2)	(3)	(4)	(5)
	Δ ln$P_{i,s,2009}$	Δ ln$P_{i,s,2009}$	Δ ln$P_{i,s,2009}$	Δ ln$P_{i,s,2009}$	Δ ln$P_{i,s,2009}$
RExitShare$_{s,2009}$	0.320***	0.319***	0.327***	0.295***	0.297***
	(0.0458)	(0.0440)	(0.0514)	(0.0537)	(0.0359)
SEB$_{i,s,2009} \times \frac{D_{i,s,2008}}{A_{i,s,2008}}$		-0.00880	-0.00445	-0.0177	
		(0.0141)	(0.0176)	(0.0321)	
ΔMC$_{i,s,2009}$					0.00378
					(0.0152)
2-digit Industry FE	X	X	X	X	X
Weighted (Ind., Firm)			X	X	
Observations	602	592	592	592	402
R^2	0.136	0.137	0.198	0.501	0.148

Notes: This table reports estimates from 2SLS cross-sectional IV regressions for 2009 for firms with at least 1 employee. Observations are firms. SEs, clustered at the 5-digit industry-level, are underneath point estimates. Firms' marginal costs are measured in the data as: $\Delta \text{MC}_{i,s,t,t-1} = \Delta \ln(\text{TVC}_{i,s,t,t-1}/Y_{i,s,t,t-1})$ with $Y_{i,s,t,t-1} = lnTR_{i,s,t,t-1} - lnP_{i,s,t,t-1}$. 2-digit industry dummies are included in all regressions. Stars $+p < .1$ $*p < .05$ $**p < .01$ $***p < .001$.

In addition, column (3) and column (4) report weighted regressions where the weights are firm and industry market shares, respectively. Column (5) includes a changes in the firm-level marginal cost to rule out the confounding from firm-level cost shocks.[12] Column (5) shows that the coefficient of interest remains robust to including marginal cost changes; however, the coefficient on the marginal cost measure is not statistically significant. This may be due to the fact that the industry fixed effects pick up relevant cost shocks.

Cost channel The robustness checks in column (2) and (5) in Table 10 show that the effect of exit on prices remains unchanged conditional on firm-level financial and marginal costs. Why is it that the remaining firms who were exposed to SEB did not experience a rise in their pre-funding costs? Figure 4 shows that the average lending rates declined during 2009 due to the expansionary policy of the Swedish Central Bank. The reduction in aggregate borrowing costs may explain a negative coefficient on SEB$_{i,s,2009} \times \frac{D_{i,s,2008}}{A_{i,s,2008}}$, suggesting that the remaining firms overall faced lower interest rates during 2009 than

[12] I follow Amiti, Itskhoki and Konings (2019) to calculate the change in the firm's marginal cost as the log change in the firm's average variable cost $\Delta \text{MC}_{i,s,t,t-1} = \Delta \ln(\text{TVC}_{i,s,t,t-1}/Y_{i,s,t,t-1})$ where the total variable costs are the sum of the total material cost and the total wage bill; and the log production quantity $Y_{i,s,t,t-1}$ is the difference between log revenues and the firm-level log price index $Y_{i,s,t,t-1} = lnTR_{i,s,t,t-1} - lnP_{i,s,t,t-1}$.

before.

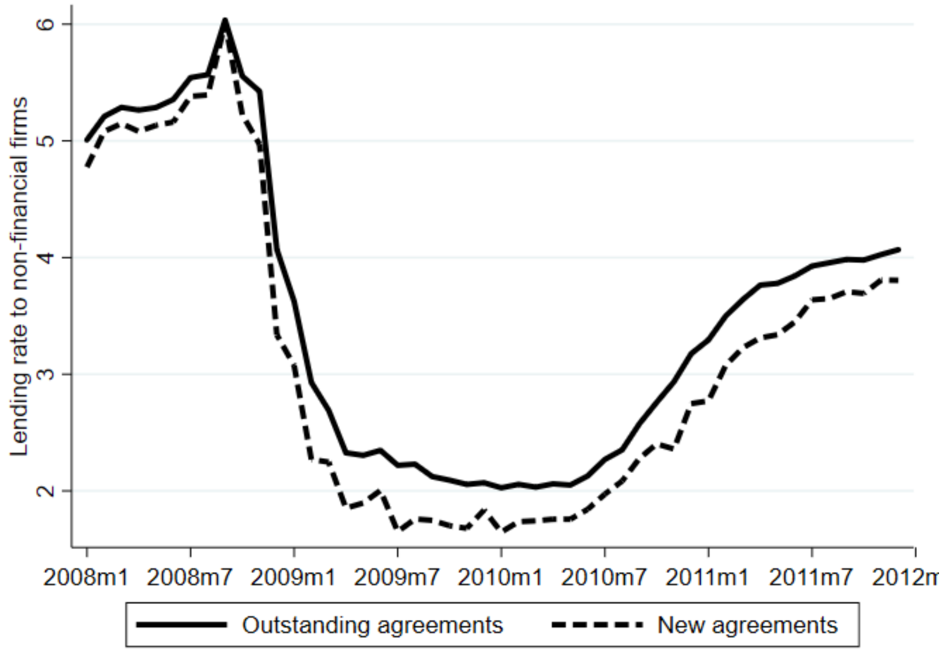

Figure 4: Lending rates on outstanding and new agreements to non-financial companies

To investigate whether lending rates increased more for firms exposed to SEB, I regress log changes of a measure of implicit interest rates (given by the ratio of interest expenses to debt at the firm level) on the SEB exposure variable at the firm level. I find a negative coefficient in Table 22 reported in Appendix A.10. The negative coefficient suggests that firms exposed to SEB faced somewhat lower interest rates than firms that were exposed to other banks during the crisis.

In addition, I examine whether there is a generic financial cost channel via interest rates. Column (5) of Table 22 in Appendix A.10 reports that interest rate and price changes were positively correlated in 2009, meaning that firms increased their prices when their pre-funding costs rose. In light of the negative correlation between firm level SEB-exposure and interest rate changes, the financial cost channel was likely in place for all firms and not specific only to the firms exposed to SEB. Further robustness checks, where I include the log changes of firm and industry-level implicit interest rates as control variables in the IV regression, are presented in Table 22 in Appendix A.10. These regressions show that the IV coefficient on exit does not change; and they suggest that there is no direct positive effect of firm-level SEB-exposure on prices.

Industry marginal cost, international competition and entry Table 11 reports the instrumental variable regression with various control variables at the 5-digit industry level.

Table 11: Robustness: IV with 5-digit industry controls

	(1)	(2)	(3)	(4)	(5)
	Δ $\ln P_{i,s,t,t-1}$	Δ $\ln P_{i,s,t,t-1}$	Δ $\ln P_{i,s,t,t-1}$	Δ $\ln P_{i,s,t,t-1}$	Δ $\ln P_{i,s,t,t-1}$
$\text{RExitShare}_{s,t,t-1}$	0.302***	0.374***	0.314***	0.254**	0.257**
	(0.0551)	(0.0396)	(0.0464)	(0.0785)	(0.0789)
$\Delta\text{MC}_{s,t,t-1}$	0.00031				
	(0.0022)				
$\Delta R_{s,t,t-1}$		-0.0135^{+}			
		(0.00709)			
$\text{EntrantsShare}_{s,t,t-1}$			0.0293		
			(0.0461)		
$\Delta\text{ImportVolume}_{s,t,t-1}$				0.00423	
				(0.0202)	
$\Delta\text{ExportVolume}_{s,t,t-1}$				-0.0166	-0.0142
				(0.0188)	(0.0164)
2-digit Industry FE	X	X	X	X	X
Observations	602	602	430	602	602
R^2	0.131	0.136	0.125	0.148	0.147

Notes: This table reports estimates from IV 2SLS cross-sectional regressions for 2009 for firms with at least 1 employee. Observations are firms. Industry marginal costs are measured in the data as: $\Delta\text{MC}_{s,t,t-1} = \Delta\ln(\text{TVC}_{s,t,t-1}/Y_{s,t,t-1})$ with $Y_{s,t,t-1} = \sum_i Y_{i,s,t,t-1}$. Industry interest rates R_s are the industry average of the firm-level (implicit) interest rates calculated as the ratio of the firm's interest payments to debt. $\text{EntrantsShare}_{s,t,t-1}$ is measured analogous to the exiting firms' market share by summing over entrant firms' industry market shares. Import and export volumes of industries are based on firm-level trade statistics, and calculated by summing over firms' imports (exports) in industry s from foreign industry s^*. 2-digit industry dummies are included in all regressions. SEs, clustered at the 5-digit industry-level, are underneath point estimates. Stars $+p < .1$ $*p < .05$ $**p < .01$ $***p < .001$.

The impact of a one percent increase in relative exit on prices remains around 0.3 percent across specifications, suggesting that the instrument's effect on prices via exit is invariant to conditioning on these control variables. Column (1) and (2) include control variables for 5-digit industry marginal cost and interest rate changes, respectively. The regressions with controls of industry cost changes aim to provide evidence that the estimated impact of exit on firm-level price changes is not correlated with industry-level marginal and financial cost shocks. Column (3) controls for entering firms' industry market share in order to examine whether the reduction in industry entry affects prices and correlates with the instrument for exit. Columns (4) and (5) include control variables for changes in international competition. In particular, column (4) conditions on the change in industry s's imports and exports from industry s^* in a foreign country. Column (5) only considers the change in exports in order to examine whether the decline in Swedish firms' exports, due to the financial crisis, is correlated with the instrument and there is a possibility for reverse causality.

In summary, the results seem to be robust to these alternative specifications, so it is likely that the IV estimate captures the impact of exit on prices and not the price effect via another channel.

7 Discussion

The aggregate effect The instrumental variable regression shows that when firms with a combined market share of one percent exit, the remaining firms increase their prices by 0.3 percent. This estimate is based on firms representing 30-40 percent of the Swedish economy, according to the 5-digit industries in the sample that are from the manufacturing, wholesale, retail, construction and services sectors. This supports the hypothesis that there is a non-negligible increase in producer prices when competitive pressures decline. Prices would have decreased more during the financial crisis absent the reduction in competition via exit. The exit channel provides an alternative mechanism that may help understand the missing disinflation puzzle during the financial crisis investigated by Gilchrist, Schoenle, Sim and Zakrajsek (2017).

Figure 5 shows that there was a 3 percent drop in Sweden's GDP and a 1.5 percent drop in the number of operating firms during the financial crisis.

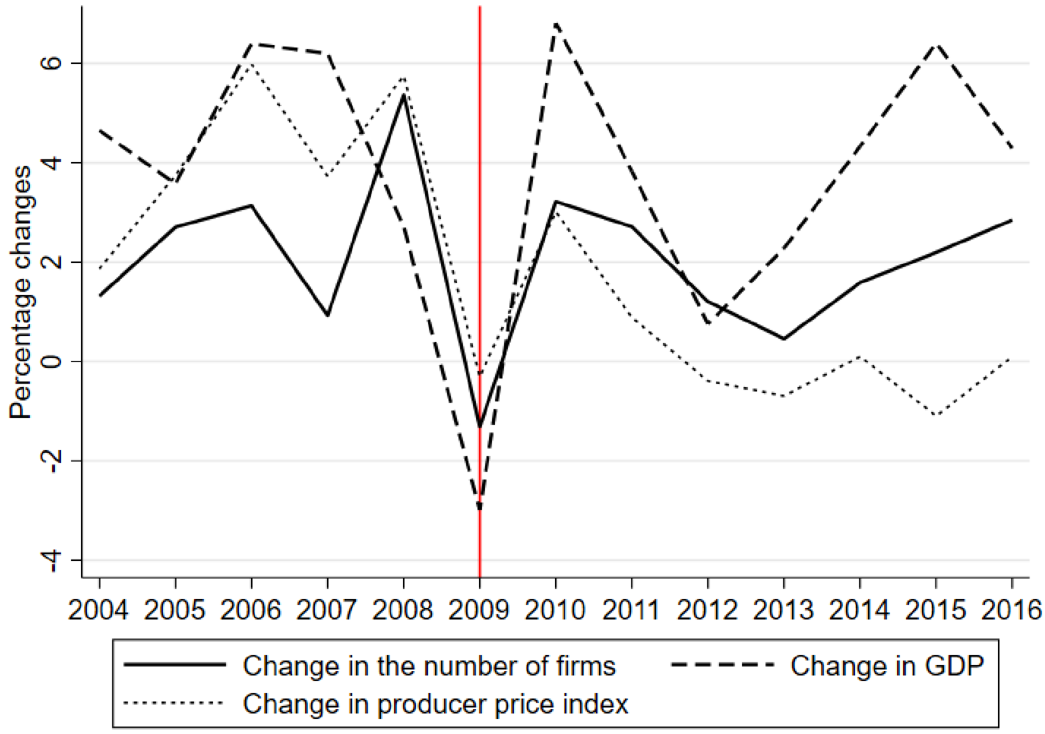

Figure 5: Percentage change in the number of firms, GDP and the producer price index (PPI)

At the same time, the producer price index remained unchanged, even though the Swedish Central Bank had forecasted a drop in prices similar to the two percent decline in GDP (Riksbank, 2009).

Using the coefficient estimate of RExit(number), the average price increase in the economy upon 1.5 percent exit of firms would amount to 1.95 percent. By this measure, the price effect of increased concentration could explain 1.95 percent of the 2 percent forecasted deflation that were not realized.

Discrepancy between the model and the data The empirical results do not align well with the model predictions. The model predicts a near zero price increase when one percent of firms exit. This is because an oligopolistic competition model with industries that have more than a few dozen firms cannot generate large changes in the average markup when firms exit. The intuition can be explained using Figure 6. The green histogram depicts the market share distribution of Swedish firms. Almost all firms are located where the convex curve that relates market shares to markups is flat, so that firm exit only has small effects on the markups.

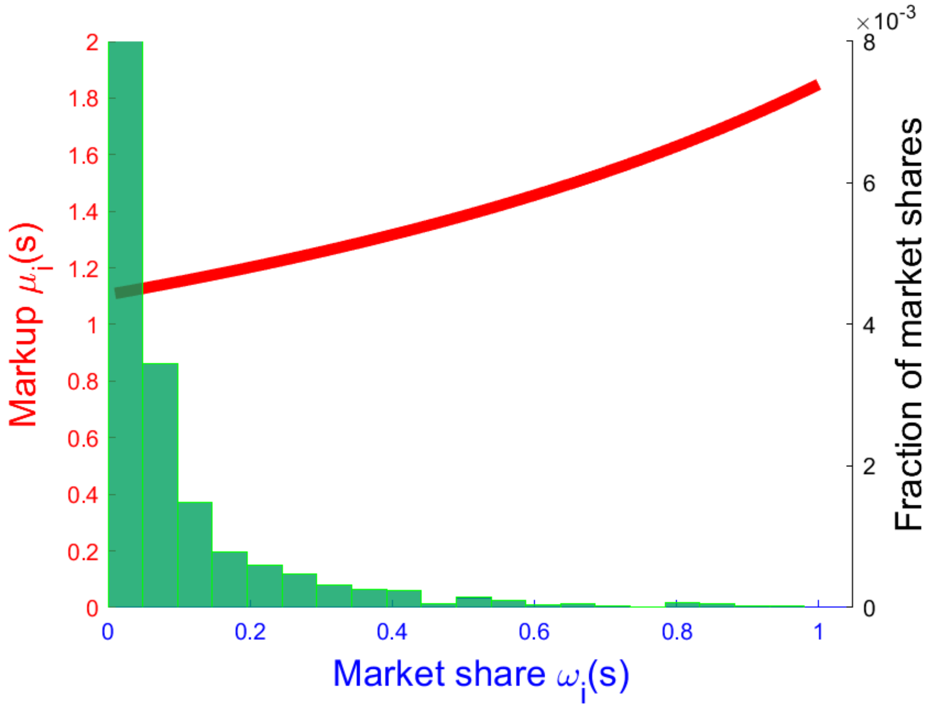

Figure 6: Market share distribution in 2008

Reconciling the model and the data The industrial organization (IO) literature has long argued that industrial classifications fail to reflect well-defined economic markets. In a thorough review of the literature on estimating markups, Berry, Gaynor and Scott (2019) argue that markets cannot be observed in the data. They give the example of "software" which is often registered as a single industry but it is less clear how to divide it into separate markets. Another problem identified by Berry, Gaynor and Scott (2019) is with respect to geography. An extreme example of how geography segments industries is given by Syverson's (2008) discussion on the ready-mixed concrete industry.

Competition agencies and the IO literature have developed formal processes to define markets. An example of this is the hypothetical monopolist test (or SSNIP test). This test asks whether a hypothetical monopolist could raise the prices of all products in a market by at least 5 % for at least one year. If so, the products are in the same market, if not, then they are not.

Studies like Edmond, Midrigan and Xu (2015) and Amiti, Itskhoki and Konings (2019) consider 8-digit product-groups which are more disaggregated than the 5-digit industry data in this study.[13] However, it is difficult to argue that most products even at the

[13]The median number of firms in Edmond, Midrigan and Xu (2015) is 10 in the data and 16 in the model.

8-digit product-group level would pass the hypothetical monopolist test because most products face different levels of competition according to geography. For example, while bread[14] can be transported across borders, it is also a product that people prefer to buy at a local shop. This argument may apply to most perishable goods. Other heavy products, like concrete, soil or wood and services such as tax consultants may also not pass the hypothetical monopolist test.

In Table 12, I consider specific examples of 5-digit industries in Sweden for which location plays a crucial role. For instance, there are 28 ready-mixed concrete producers in total, but the median number of firms at the county-level is two. At most four ready-mixed concrete producers are located in the same county. Another example is the prepared meal producers which have 2-4 producers per county. The last line shows that as many as 823 companies produce fresh bread and bakery products. However, when looking at municipalities, e.g. Stockholm city or Solna, there are only 2-4 places on average where people can buy fresh bread.

Table 12: Number of producers in selected industries by location

	p10	p25	p50	p75	p90	Total
By county						
Ready-mix concrete	1	1	2	4	4	28
Prepared meals	1	1	2	3	3	36
By municipality						
Fresh bread and pastry	1	2	2	4	4	823

To investigate how sensitive the simulated results are to the definition of a market, I consider a case where the median market is built up of 5 firms, which is a tenth of the number of firms in the 5-digit industry in the data and half of what Edmond, Midrigan and Xu (2015) find in the 8-digit product-level data.[15] The calibration to the finer market structure is presented in Table 13.

[14]With common nomenclature code: 1905 90 30 "Bread, not containing added honey, eggs, cheese or fruit, and containing by weight in the dry matter state not more than 5 % of sugars and not more than 5 % of fat".

[15]Having smaller markets in the model, inspired by segmentation due to quality and location, makes an implicit assumption about the substitutability of goods across markets. Smaller markets in the model may imply that the elasticity of substitution between free-range eggs, not free-range eggs and the different types of wine is equal, or, alternatively, that bakery producers across different locations face the same across market elasticity of substitution.

Table 13: Calibration to markets

Moments	Model		Model
Markets	500	Coefficients in regression of	
p10 number producers	2	labor share on market share	
p50 number producers	5	Ratio of coefficients b1 / b0	-1.15
p90 number producers	7		
		Mean gross interest rate within	
Concentration measures		firm market share percentiles	
Mean inverse HH	3.4	p0-p10	1.0717
p10 inverse HH	1.7	p10-p20	1.0691
Median inverse HH	3.2	p20-p30	1.0667
p90 inverse HH	5.4	p30-p40	1.064
		p40-p50	1.0611
Distribution of firm market shares		p50-p60	1.0581
Mean share	0.22	p60-p70	1.0548
Median share	0.16	p70-p80	1.0512
p75 share	0.28	p80-p90	1.0463
p95 share	0.6	p90-p100	1.0383
p99 share	0.84		
SD share	0.17		
Parameter values			
gamma	10.5		
theta	2.17		
productivity Pareto tail	5.2		
fixed cost tau	0.002		
R distribution mean	1.06		
R distribution sd	0.01		
R distribution skew	-0.6		
R distribution kurt	2.6		

Notes: The HH index measures market concentration $HHI_s = \sum_i \omega_i^2$ and the inverse HH index is $1/HH$, which equals $N(s)$ with symmetric firms.

In this case, eliminating one percent of the smallest firms from the economy leads to a 0.2 percent increase in the weighted-average markup. The reason why the model generates a larger response with segmented markets is because the mass of the market share distribution is not positioned at the flattest part of the convex curve mapping market shares to markups (in Figure 6) but rather toward the middle where the markup function has more curvature.

To give an example, consider an industry that is made up of three markets. In each of these markets, five firms operate and each has a market share of 0.20. If one out of five firms exits in one market, the remaining firms increase their market share to 0.25 which means that their markup will change from 1.20 to 1.23, i.e. a 2.5 percent increase in the markup of each firm.[16] Assuming that the size of all markets within the industry is equally large, the change in one market implies an increase of 0.83 percent in the industry's average markup. If instead 15 firms operate in one market with equal market shares and one firm exits, the markups increase by 0.2 percent. In comparison, the exit of one firm in an industry with 50 firms, which is the median number of firms in the baseline calibration, yields an increase in the average markup of only 0.017 percent.

Model implied non-linearities in the data In the data, I find that larger firms expand their market shares more when their competitors exit. Figure 7 shows the log change in firms' market shares when their competitors with a combined market share of one percent exit.

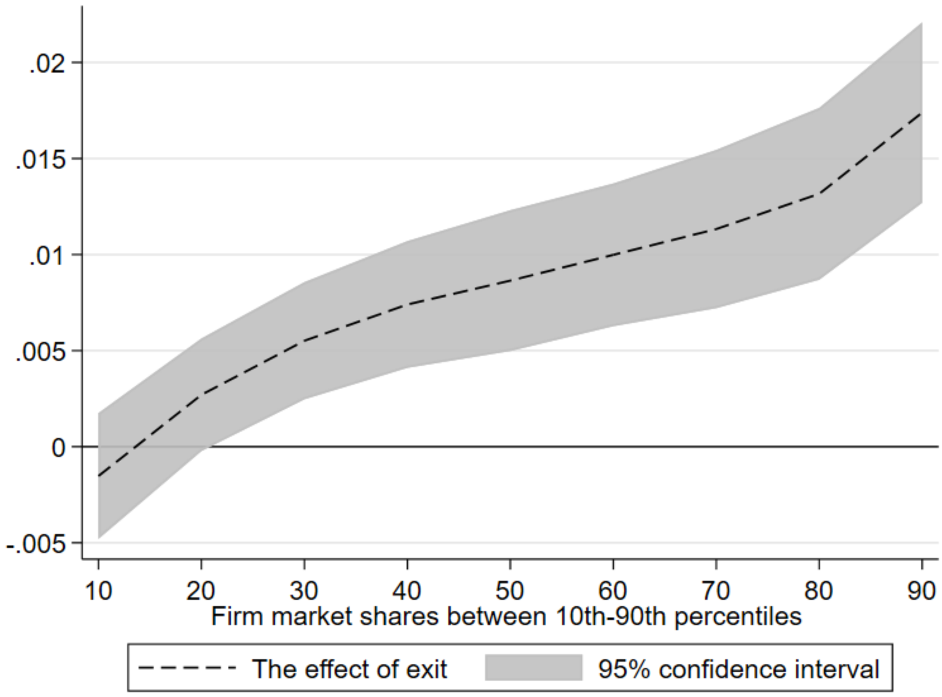

Figure 7: Log changes in the remaining firms' market shares by size after the exit of firms with a combined market share of one percent.
Notes: The x-axis shows the percentiles of the firms' market share distribution between the 10^{th} and 90^{th} percentiles. The y-axis depicts the effect of a one percent increase in RExit(Share) on log changes in market shares.

The regression specification, corresponding to Figure 7, is an OLS panel regression

[16] I use $\theta = 2.17$, $\gamma = 10.5$ and the formula in equation (15) to calculate the changes.

with industry and firm fixed effects for the period 2000-2016:

$$\Delta ln(MShare_{i,s,t,t-1}) = \alpha_i \ + \ \beta^q \ \text{RExitShare}_{s,t,t-1} \times \mathbb{1}_{size=q} \ + \gamma_{k,t} \ + \ \epsilon_{s,t}.$$

This regression estimates q coefficients for q groups of the market share distribution. The first group consists of the smallest firms with market shares in the 0th-10th percentile of the industry market share distribution, the second group consists of firms with market shares in the 10th-20th percentile of the industry market share distribution and so on. The corresponding results table is presented in Appendix A.11.

Figure 7 depicts that the smallest firms, between the 10th-30th percentiles of the market share distribution, increase their market shares by 0.5 percent (for example, from 10 percent to 10.05 percent), whereas the largest firms, between the 80th-90th percentiles of the market share distribution, increase their market shares by almost 2 percent (for example, from 50 percent to 51 percent).

Firms operate differently in the model. Smaller firms expand their market shares when their competitors exit because small firms face a higher elasticity of demand and more elastic consumers. Larger firms face less elastic consumers and they have less ability to increase their market shares further. Thus, in the model, the increase in small firms' market share upon exit is larger than it is for bigger firms. Since the data suggests the opposite effect, it is difficult for the model with a reversed mechanism to estimate the impact of exit and entry.

8 Conclusion

This paper examines the price effect of exit and asks three questions. How strong is the effect of exit on prices? Did increased exit contribute to higher inflation during the financial crisis - a phenomenon recently termed as missing disinflation? Is the estimated price effect of exit consistent with the prediction from a heterogeneous firm model with oligopolistic competition and variable markups?

The answers to these questions are the following: (i) the IV regression identifies a 0.3 percent increase in the prices of the remaining firms when one percent of the firms in the industry exits. (ii) the estimated price effect of exit is economically non-negligible and thus, it supports the hypothesis that the reduction in competition following exit during the financial crisis was part of the reason why prices did not fall as expected. This finding has further implications for monetary policy as New Keynesian models without firm exit may overestimate the price fall during recessions. Since exit is countercyclical and market power increases in recessions, exit dampens the price fall. (iii) quantitative models that feature oligopolistic competition predict a smaller estimated effect from exit. This may be overcome under the assumption of smaller, more segmented markets that are typically assumed when models are calibrated in the micro literature.

More segmented markets imply that firms become locally large in their markets, or "granular" and shocks to "locally large" firms may average into a non-negligible increase at the aggregate-level. This reasoning relates to the work on granular firms by Gabaix (2011) and Baqaee and Farhi (2019) who argue that large firms can be a possible source of aggregate volatility. Shocks to granular firms in the economy do not cancel out with shocks to much smaller firms, and may lead to aggregate fluctuations. In the case of the Swedish economy and the above model, many medium sized firms may be locally large and own their local markets, even if the aggregate firm-size distribution seems fat-tailed and most firms are not very large relative to GDP.

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A Appendix

A.1 Markups under Bertrand competition

The demand elasticity of the firm under Bertrand competition can be written as

$$\epsilon_i^B = \omega_i \theta + (1 - \omega_i)\gamma. \tag{40}$$

Therefore, the markup of the firm is

$$\mu_i = \frac{\gamma + (\theta - \gamma)\omega_i}{\gamma + (\theta - \gamma)\omega_i - 1}. \tag{41}$$

The elasticity of the markup with respect to the firm's market share is

$$\varepsilon_{\mu,\omega}^B = \frac{\partial \mu_i}{\partial \omega_i}\frac{\omega_i}{\mu_i} = \frac{-(\theta - \gamma)\omega_i}{(\gamma - 1 + (\theta - \gamma)\omega_i)^2 \mu_i} \tag{42}$$

$\varepsilon_{\mu,\omega}^B$ is positive and increasing in the firm's market share.

A.2 Description of the financial crisis

Main Effects The main effects of the financial crisis on Sweden were the fall in exports and Swedish banks' exposure to the Baltic countries which were severely hit by the financial crisis. The financial crisis was manifested in a 3 percent drop in the country's GDP and a 1.5 percent drop in the number of operating firms. These processes are depicted in figure 5. In contrast to a contraction in GDP and the number of producers, the producer price index remained unchanged, despite the fact that the Swedish central bank forecasted a drop in prices similar to the drop in GDP (Riksbank (2009)).

Closures and Bankruptcies Figure 8 shows that the number of firm closures significantly increased in 2009 and went up proportionately more for larger firms.

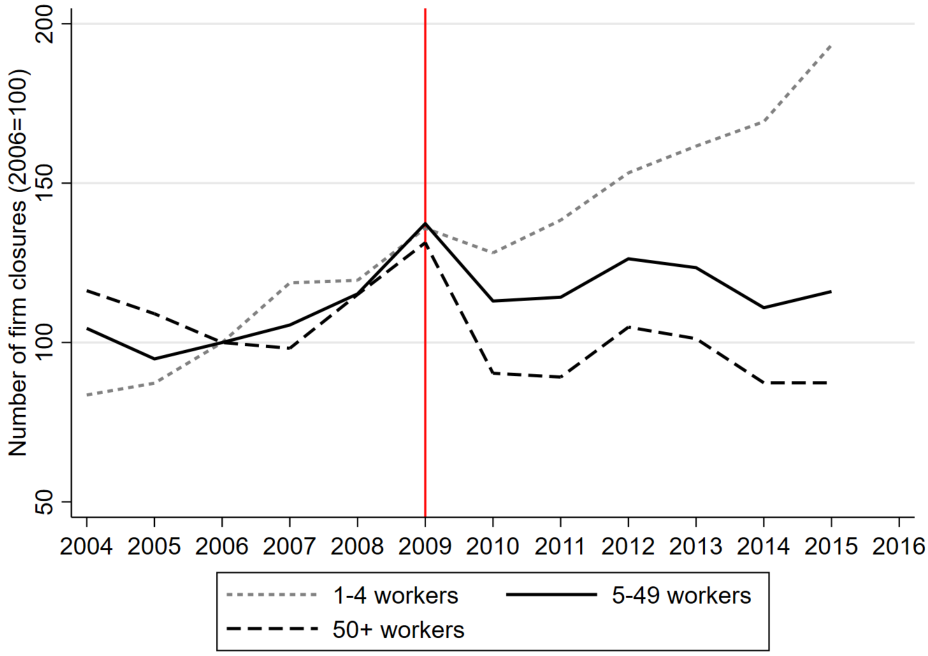


Figure 8: Number of closed firms by firm size groups

Figure 9 shows that the largest firms with more than 50 employees were relatively more prone to go bankrupt in 2009. Thus, these figures indicate that not only small firms exited during this crisis.

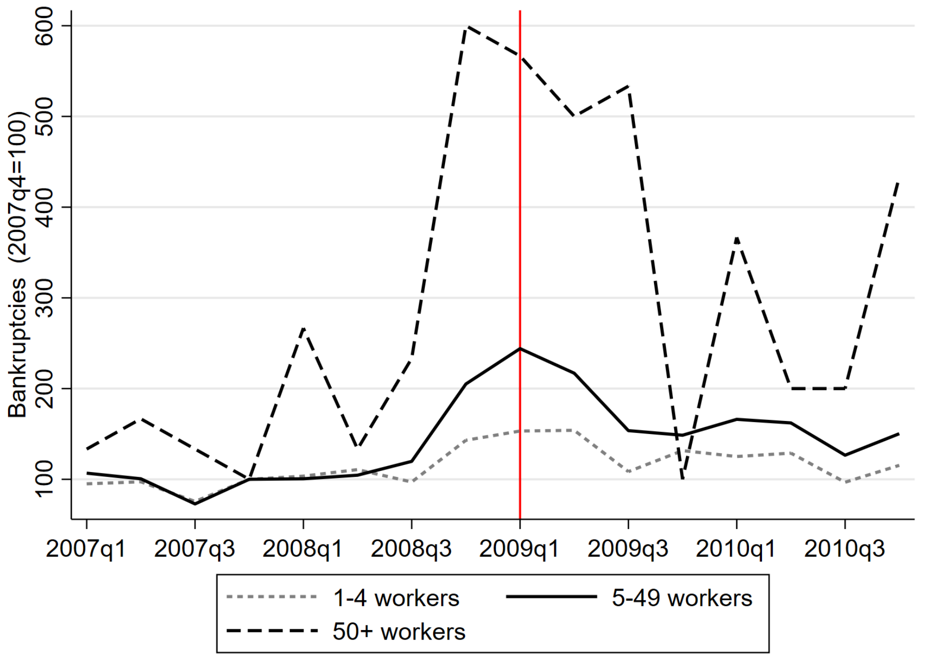


Figure 9: Number of bankruptcies by firm size groups

Access to Financing and Lending Rates The Riksbank (2010) reports that 40-50 percent of companies felt that it was more difficult than normal to fund their operations in 2009. According to Figure 2 the total loan volume issued for non-financial companies decreased significantly during 2009. In addition, there was a drop in lending rates, leading to lower interest rates for companies that managed to obtain loans. The drop in lending rates is depicted in Figure 4.

A.3 Alternative calibration and predictions

Table 14: Model calibrated to moments of the firm size distribution and industry concentration measures in 2008 in Sweden.

Moments	Data	Model		Data	Model
5-digit industries	208	208	Coefficients in regression of		
p10 number producers	9	188	labor share on market share		
p50 number producers	50	352	Ratio of coefficients b1 /b0	-1.15	
p90 number producers	485	485			
			Mean gross interest rate within		
Concentration measures			firm market share percentiles		
Mean inverse hh	16.7	17.5	p0-p10	1.078	1.0718
p10 inverse hh	1.5	3.7	p10-p20	1.069	1.0689
Median inverse hh	5.47	14.1	p20-p30	1.065	1.0663
p90 inverse hh	36.1	36.1	p30-p40	1.062	1.0636
			p40-p50	1.060	1.0609
Distribution of firm market shares			p50-p60	1.057	1.0579
Mean share	0.004	0.003	p60-p70	1.053	1.0546
Median share	0.0001	0.0005	p70-p80	1.048	1.0508
p75 share	0.001	0.001	p80-p90	1.044	1.0462
p95 share	0.008	0.008	p90-p100	1.038	1.0382
p99 share	0.06	0.05			
SD share	0.03	0.02			
Parameter values					
γ	10.5				
θ	2.17				
productivity Pareto tail ξ	7.6				
fixed cost τ	0.00001				
R distribution mean	1.06				
R distribution sd	0.01				
R distribution skew	-0.6				
R distribution kurt	2.6				

Notes: The HH index measures market concentration $HHI_s = \sum_i \omega_i^2$ and the inverse HH index is $1/HH$, which equals $N(s)$ with symmetric firms. In the data, I measure gross interest rates as the ratio of interest expenses to debt at the firm-level.

Table 15: Percentage change in firm-level markups when one percent of the smallest, median or largest industry competitors exits.

	(1) Avg. % change in markups	(2) Weighted % change in markups
Experiment 1 (small)	0.0001%	0.0008%
Experiment 2 (medium)	0.0001%	0.0036%
Experiment 3 (large)	0.0360%	0.3895%

Notes: A one percent increase in the markup is, for example, from 1.1 to 1.111. The simple average percentage change in markups is the arithmetic average of the percentage changes in the markups of firms that are present in both periods. The percentage change in the economy weighted-average markup is calculated according to equation (29) only using the markup of firms that are present in both periods such that the weights in both periods are the firms' market shares after the shock.

A.4 SEB-dependence and entry

Table 16: OLS regression estimating the relation between SEB-dependence and entry

	Entrant(Share)$_{s,2009}$
SEB$_{s,2009}$	-0.113
	(0.124)
2-digit Industry FE	X
Observations	734
R^2	0.186

Notes: This table reports estimates from OLS cross-section regressions for 2009 for all 5-digit industries with firms that have at least 1 employee. Entrant(Share)$_{s,2009}$ is measured as the entering firms' sales relative to industry sales in 2008, analogous to RExit(Share)$_{s,2009}$. 2-digit industry dummies are included in all regressions. SEs, clustered at the 5-digit industry-level, are underneath point estimates. Stars $+p < .1$ $*p < .05$ $**p < .01$ $***p < .001$.

A.5 Industry exit, SEB-dependence and debt to asset ratio

Table 17: The relation between industry exit, SEB-dependence and Debt/Asset in 2009

	(1)	(2)
	$\text{RExit(Number)}_{s,2009}$	$\text{RExit(Share)}_{s,2009}$
$\text{SEB}_{s,2009}$	0.192***	0.201*
	(0.0552)	(0.0849)
$\text{Debt/Asset}_{s,2008}$	0.0000760***	0.000429***
	(0.0000225)	(0.0000881)
2-digit Industry FE	X	X
R^2	0.377	0.202

Notes: This table reports estimates from OLS cross-section regressions for 2009 for 5-digit industry averages with firms that have at least 1 employee. 2-digit industry dummies are included in all regressions. SEs, clustered at the 5-digit industry-level, are underneath point estimates. Stars $+p < .1$ $*p < .05$ $**p < .01$ $***p < .001$.

A.6 Weak instrument test

I test the null hypothesis that the instrument is weak. Stock and Yogo (2005) discuss two issues with respect to weak instruments. On the one hand, weak instruments cause IV estimators to be biased and, on the other, hypothesis tests of parameters estimated by IV estimators may suffer from size distortions. The robust F statistic for the first stage is 111.51, which is higher than the critical value (with Prob > F = 0.000) and I can conclude that the instrument is not weak. Stock, Wright, and Yogo (2002) suggest that the F statistic should exceed 10 for inference based on the 2SLS estimator to be reliable when there is only one endogenous regressor. The F statistic also satisfies this criterion. The minimum eigenvalue statistic of 51.8 exceeds the critical value of 16.38 which means that I am willing to tolerate (less than) a 10% relative bias and, based on this additional test, I conclude that the instrument is not weak.

A.7 Probability of exit and firm-level exposure

Which part of the firm-level variable $\frac{\text{D}_{i,t-1}}{\text{A}_{i,t-1}} \times \text{SEB}_{i,t-1}$ increases the probability of firm exit? Table 18 presents firm-level logistic regressions for the period 2000-2009 where the outcome variable is 1 if the firm exits and 0 if it remains in operation. Note that $\text{SEB}_{i,t}$

is not available for firms that exit so I instead use the lagged variable. Columns (1)-(2) show that firms with a higher lagged debt to asset ratio and a higher ratio for lagged SEB-dependence are more likely to exit in 2009 (cr=1). In other years (cr=0), neither of these variables predict a higher probability of firm exit. Column (3) indicates that $\frac{\mathrm{D}_{i,t-1}}{\mathrm{A}_{i,t-1}} \times \mathrm{SEB}_{i,t-1}$ increases the likelihood of exit among cash-poor firms in 2009. Cash holdings are measured by the firm's cash to asset ratio in $t-1$. Firms with high cash holdings are those above the industry median cash to asset ratio, denoted by "$\mathrm{highcash}_{i,t-1}$=1".

Table 18: Determinants of firm exit in 2009 versus before 2009

	(1)	(2)	(3)
	Firm closure$_{i,t}$	Firm closure$_{i,t}$	Firm closure$_{i,t}$
cr=0 × $\frac{D_{i,t-1}}{A_{i,t-1}}$ × SEB$_{i,t-1}$	-1.91E-09		
	1.17e-09		
cr=1 × $\frac{D_{i,t-1}}{A_{i,t-1}}$ × SEB$_{i,t-1}$	5.26e-09***		
	1.06e-09		
cr=0 × $\frac{D_{i,t-1}}{A_{i,t-1}}$		-2.64e-10+	
		1.46e-10	
cr=1 × $\frac{D_{i,t-1}}{A_{i,t-1}}$		8.26e-10***	
		1.29e-10	
cr=0 × SEB$_{i,t-1}$		0.000553	
		0.00333	
cr=1 × SEB$_{i,t-1}$		0.00744+	
		0.00428	
cr=0 × highcash$_{i,t-1}$=0 × $\frac{D_{i,t-1}}{A_{i,t-1}}$ × SEB$_{i,s,t-1}$			-1.15e-09*
			4.57e-10
cr=0 × highcash$_{i,t-1}$=1 × $\frac{D_{i,t-1}}{A_{i,t-1}}$ × SEB$_{i,s,t-1}$			-3.71e-08*
			1.78e-08
cr=1 × highcash$_{i,t-1}$=0 × $\frac{D_{i,t-1}}{A_{i,t-1}}$ × SEB$_{i,t-1}$			5.78e-09***
			6.49e-10
cr=1 × highcash$_{i,t-1}$=1 × $\frac{D_{i,t-1}}{A_{i,t-1}}$ × SEB$_{i,t-1}$			-1.31e-09***
			3.67e-10
Constant	0.0366***	0.0364***	0.0366***
	(0.000105)	(0.000396)	(0.000105)
Industry×Year FE	X	X	X
Firm FE	X	X	X
Observations	2688489	2688489	2688489

Notes: This table reports coefficients from logistic regressions for the period 2000-2009 for all firms in the population with at least 1 employee. The outcome variable is 1 if the firm exits and 0 if it remains in operation. cr=0 refers to years before the crisis and cr=1 is 2009. Cash holdings are measured by the firm's cash to asset ratio in $t-1$. Firms with high cash holdings are those above the industry median cash to asset ratio, denoted by "highcash$_{i,t-1}$=1". 5-digit industry × year fixed effects and firm fixed effects are included in all regressions. SEs, clustered at the 5-digit industry-level, are underneath point estimates. Stars $+p < .1$ $*p < .05$ $**p < .01$ $***p < .001$.

A.8 Drivers of firm exit

To further investigate which firm characteristics increase the probability of exit, the logistic regression in Table 19 examines whether the firm's market share, debt-to-asset ratio, cash-to-asset ratio, receivables to sales ratio and inventories to assets ratio in 2008 are correlated with firm exit in 2009.

Table 19: Determinants of firm exit in 2009

	Firm closure$_{i,2009}$
mshare$_{i,2008}$	-3.909**
	(1.492)
debttoassets$_{i,2008}$	0.0397***
	(0.00495)
cashtoasset$_{i,2008}$	-0.411*
	(0.177)
receivablestosales$_{i,2008}$	-1.763*
	(0.771)
inventoriestoassets$_{i,2008}$	0.202
	(0.264)
5-digit Industry FE	X
Observations	144118

Notes: This table reports estimates from firm-level logit regressions for 2009 for firms with at least 1 employee. The outcome variable is 1 if the firm exits in 2009 and 0 if it remains in operation. 5-digit industry fixed effects are included in the regression. SEs, clustered at the 5-digit industry-level, are underneath point estimates. Stars $+p < .1$ $*p < .05$ $**p < .01$ $***p < .001$.

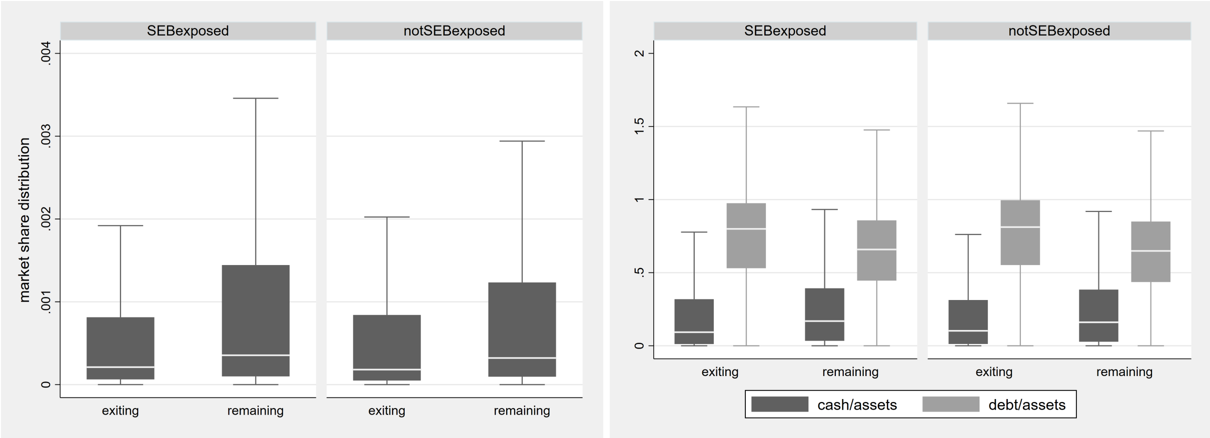
Table 20 examines the determinants of firm exit across more and less SEB-dependent firms. SEB$_{i,2008}$=1 indicates if the firm is located in a municipality where the ratio of SEB bank branches to other bank branches is above the median value in the economy. The logistic regression shows that, for example, a unit increase in the debt to asset ratio increases the probability of firm exit by a similar magnitude for firms that are more dependent on SEB based on location as for firms that are less dependent on SEB.

Table 20: Determinants of firm exit across more and less SEB-dependent firms

	Firm closure$_{i,2009}$
SEB$_{i,2008}$=0 × mshare$_{i,2008}$	-2.787
	(1.906)
SEB$_{i,2008}$=1 × mshare$_{i,2008}$	-3.987^{+}
	(2.158)
SEB$_{i,2008}$=0 × cashtoasset$_{i,2008}$	-0.445*
	(0.226)
SEB$_{i,2008}$=1 × cashtoasset$_{i,2008}$	-0.367*
	(0.156)
SEB$_{i,2008}$=0 × debttoassets$_{i,2008}$	0.0491***
	(0.00958)
SEB$_{i,2008}$=1 × debttoassets$_{i,2008}$	0.0381***
	(0.00495)
SEB$_{i,2008}$=0 × receivablestosales$_{i,2008}$	-1.587^{+}
	(0.934)
SEB$_{i,2008}$=1 × receivablestosales$_{i,2008}$	-1.572*
	(0.682)
SEB$_{i,2008}$=0 × inventoriestoassets$_{i,2008}$	0.116
	(0.305)
SEB$_{i,2008}$=1 × inventoriestoassets$_{i,2008}$	0.306
	(0.237)
5-digit Industry FE	X
Observations	144118

Notes: This table reports estimates from firm-level logit regressions for 2009 for firms with at least 1 employee. The outcome variable is 1 if the firm exits in 2009 and 0 if it remains in operation. SEB$_{i,2008}$=1 indicate if the firm is located in a municipality where the ratio of SEB bank branches to other bank branches is above the median value in the economy. 5-digit industry fixed effects are included in the regression. SEs, clustered at the 5-digit industry-level, are underneath point estimates. Stars $+p < .1$ $^{*}p < .05$ $^{**}p < .01$ $^{***}p < .001$.

Figure 10 provides a visual overview of firm characteristics of the exiting and renaming firms based on their level of SEB-dependence.



(a) Market share distribution

(b) Cash/Assets and Debt/Assets

Figure 10: Exiting and remaining firm characteristics by SEB exposure groups. SEBexposed firms are those above the median SEB exposure within their industries. The graphs are based on 144118 firms in the register with at least 1 employee in 2009.

Figure 10a shows that exiting firms' market shares are generally smaller than the market shares of firms that remain in operation. However, the market shares of SEB-dependent firms that exit are not necessarily smaller than the market shares of those firms which are less likely to be exposed to SEB. Figure 10b depicts a similar distribution across firms' cash to asset and debt to asset ratios between exposed and less exposed groups of firms. This graph suggests that there is no obvious sorting between firms and banks; and SEB-dependence and exit.

A.9 Reduced form

Table 21 shows the reduced form results.

Table 21: Reduced form

	Δ ln$\text{P}_{i,s,t,t-1}$
$\text{SEB}_{s,t} \times \frac{D_{s,t-1}}{A_{s,t-1}}$	0.00122***
	(0.0000663)
2-digit Industry FE	X
Observations	602
R^2	0.169

Notes: This table reports the coefficient from firm OLS cross-section regressions for 2009 for firms with at least 1 employee. Observations are firms. 2-digit industry dummies are included as controls. SEs, clustered at the 5-digit industry-level, are underneath point estimates. Stars $+p < .1$ $^{*}p < .05$ $^{**}p < .01$ $^{***}p < .001$.

A.10 Cost channel

I measure firm-level implicit interest rates as the firm's interest expense to debt ratio. In columns (1)-(2) in Table 22, I investigate whether implicit interest rate increases are correlated with SEB-dependence. In columns (3)-(6), I examine the effects of interest rate changes on prices.

Table 22: The effect of implicit interest rate changes

	(1) $\Delta R_{i,t,t-1}$	(2) $\Delta R_{s,t,t-1}$	(3) Δ $\ln P_{i,s,t,t-1}$	(4) Δ $\ln P_{i,s,t,t-1}$	(5) Δ $\ln P_{i,s,t,t-1}$	(6) Δ $\ln P_{i,s,t,t-1}$
cr=0 $\times$ $SEB_{i,s,t}$	-0.0206					
	(0.0831)					
cr=1 $\times$ $SEB_{i,s,t}$	-0.0396					
	(0.134)					
cr=0 $\times$ $SEB_{s,t}$		0.650				
		(1.445)				
cr=1 $\times$ $SEB_{s,t}$		0.426				
		(2.218)				
cr=0 $\times$ $\Delta R_{i,t,t-1}$ $\times$ $SEB_{i,s,t}$			-0.0251			
			(0.0196)			
cr=1 $\times$ $\Delta R_{i,t,t-1}$ $\times$ $SEB_{i,s,t}$			0.0334			
			(0.0563)			
cr=0 $\times$ $\Delta R_{s,t,t-1}$ $\times$ $SEB_{s,t}$				-0.0114		
				(0.0398)		
cr=1 $\times$ $\Delta R_{s,t,t-1}$ $\times$ $SEB_{s,t}$				-0.132		
				(0.0941)		
$\text{RExitShare}_{s,t,t-1}$					0.304***	0.374***
					(0.0149)	(0.0396)
$\Delta R_{i,t,t-1}$					0.00305	
					(0.00323)	
$\Delta R_{s,t,t-1}$						-0.0135+
						(0.00709)
Panel 2005-2009	X	X	X	X		
Cross-section IV 2009					X	X
5dInd $\times$ Year + Firm FE	X		X	X		
2dInd $\times$ Year FE		X				
2-digit Industry FE					X	X
Observations	318776	2452	1699	936	481	592
R^2	0.171	0.183	0.560	0.203	0.172	0.136

Notes: Columns (1)-(4) report coefficients from OLS panel regressions for the period 2005-2009 for all firms in the population with at least 1 employee. cr=0 refers to years before the crisis and cr=1 is 2009. The outcome variable in column (1) is the log change in firm-level implicit interest rates measured as the firm's interest expense to debt ratio. The outcome variable in column (2) is the log change in the industry-level implicit interest rates, which is the simple average of the firm-level $\Delta R_{i,t,t-1}$. Columns (3) and (4) aim to elicit whether interest rates increased the prices of firms that are more exposed to SEB during the financial crisis. Columns (5) and (6) are robustness checks. They report the price effect of exit for the main cross-sectional IV specification controlling for firm-level and industry-level interest rate changes. SEs, clustered at the 5-digit industry-level, are underneath point estimates. Stars $+p < .1$ $*p < .05$ $**p < .01$ $***p < .001$.

A.11 Changes in market shares

Table 23: Changes in market shares after one percent exit from the industry across the firm size distribution

	Δ ln(Mshare$_{i,s,t,t-1}$)
q=0 × RExitShare$_{s,t,t-1}$	-0.0187***
	(0.00412)
q=10 × RExitShare$_{s,t,t-1}$	-0.00152
	(0.00167)
q=20 × RExitShare$_{s,t,t-1}$	0.00270+
	(0.00149)
q=30 × RExitShare$_{s,t,t-1}$	0.00552***
	(0.00155)
q=40 × RExitShare$_{s,t,t-1}$	0.00740***
	(0.00168)
q=50 × RExitShare$_{s,t,t-1}$	0.00865***
	(0.00187)
q=60 × RExitShare$_{s,t,t-1}$	0.00999***
	(0.00189)
q=70 × RExitShare$_{s,t,t-1}$	0.0113***
	(0.00210)
q=80 × RExitShare$_{s,t,t-1}$	0.0132***
	(0.00228)
q=90 × RExitShare$_{s,t,t-1}$	0.0174***
	(0.00239)
2-digit Industry × Year FE	X
Firm FE	X
Observations	1089822
Adjusted R^2	0.086

Notes: This table reports estimates from an OLS panel regression for the period 2000-2016 for firms with at least 1 employee. q refers to groups of firms according to q percentiles. q=10 is the group of firms between the 10th and the 20th percentiles. 2-digit industry × year fixed effects and firm fixed effects are included in all regressions. SEs, clustered at the 5-digit industry-level, are underneath point estimates. Stars $+p < .1$ $*p < .05$ $**p < .01$ $***p < .001$.