BACKGROUND PAPER

DISTRESSED BANKS, DISTORTED DECISIONS?

GARETH ANDERSON, REBECCA RILEY AND GARRY YOUNG

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Distressed Banks, Distorted Decisions? *

Gareth Anderson[†] Rebecca Riley[‡§] Garry Young[‡§]

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Abstract

Exploiting variation in credit constraints induced by pre-crisis banking relationships in the UK, we present evidence to suggest that restricted credit availability following the financial crisis increased the probability of business failure. But rather than "cleansing" the economy by accelerating the exit of less productive businesses, we find that credit constraints may have resulted in some businesses failing despite being more productive than their surviving competitors.

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[†]University of Oxford

[‡]NIESR

[§]Centre for Macroeconomics

1 Introduction

The "cleansing" view of recessions suggests that the exit of inefficient businesses is accelerated during economic downturns, to the benefit of aggregate productivity. But following the Global Financial Crisis, the UK has experienced dismal productivity growth. We investigate whether restricted credit availability following the crisis affected the exit rates of UK businesses and, in particular, whether it distorted the difference in exit rates between high productivity and low productivity firms.

We identify the impact of restricted credit availability on firm exit rates by exploiting exogenous variation in credit availability induced by the contrasting effects which the crisis had on UK banks, distinguishing between banks which needed state support in order to survive (*Distressed Banks*) from those that did not (*Non Distressed Banks*). We divide companies into *Treatment* and *Control* groups based on banking relationships they established prior to the crisis. Specifically, we gauge the importance of tight credit conditions on company performance by adopting a quasi-experimental approach, comparing whether the probability of exit for firms which, prior to the financial crisis, had relationships with banks which later became distressed differed from those which had relationships with banks which did not become distressed.

To preview our results, we find that following the financial crisis, firms which had established relationships with *Distressed Banks* prior to the crisis had a higher probability of going out of business than firms which had relationships solely with *Non Distressed Banks*. Furthermore, the impact of being attached to *Distressed Banks* did not have a uniform impact across the distribution of firm productivity. The probability of exit for firms in the lower tail of the productivity distribution was not adversely affected by having a relationship with *Distressed Banks*. But for relatively more productive firms, the probability of exit was adversely affected by being with *Distressed Banks*. This suggests that the credit constraints associated with having a relationship with *Distressed Banks* may have distorted the "cleansing" effect of the recession.

The layout of the paper is as follows. Section 2 describes the existing literature on financial crises and productivity dynamics and sets out a theoretical framework for considering how credit constraints may affect exit dynamics. Section 3 describes our classification of *Treatment* and *Control* groups and describes the UK banking system in the context of the financial crisis, highlighting the very different performance of the largest four banks. Section 4 provides a description of our dataset and presents descriptive statistics. Section 5 presents our empirical framework, with results and robustness tests reported in Section 6. Section 7 concludes.

2 Literature Review and Model

The global financial crisis has provided researchers with a natural experiment for studying the impact of tight credit conditions on firm activity. Using the crisis as an unanticipated, exogenous shock to credit conditions, a number of studies have investigated its impact on investment and employment. For example, Duchin et al. (2010) show that the financial crisis had a greater impact on investment for U.S. firms which were financially constrained prior to the onset of the crisis. Bentolila et al. (2013) show that concerns about the solvency of Spanish banks during the financial crisis negatively impacted on firm employment.

A separate literature exists exploring the implications of firm specific distortions in models of heterogeneous firm productivity (see, for example, Restuccia and Rogerson (2008); Hsieh and Klenow (2009)), although the literature on how credit market distortions in particular affect exit and entry dynamics is more limited. In the absence of distortions, typical models of firm dynamics suggest that firms with the lowest productivity are most likely to exit a given industry (e.g. Hopenhayn (1992); Melitz (2003)). But there are contrasting views on how crises and credit constraints affect the nature of firm entry and exit. It has been argued that recessions can have "cleansing" effects on economies, whereby the process of inefficient methods

of production being forced out of the market is accelerated, freeing resources to be used more productively (Schumpeter (1934); Caballero and Hammour (1994)). Crises may increase the minimum level of productivity required for firms to be able to survive, thereby forcing the most inefficient incumbents to exit. But if frictions associated with crises force relatively more productive firms to exit, they may not be "cleansing". Barlevy (2003) argues that credit market frictions may reverse the "cleansing" effect of recessions if highly productive firms are forced to exit as a result of not being able to access finance. Consistent with this view, Haldane (2017) argues that for the UK economy there exist a large number of high productivity, high debt firms (labelled as "gazelles", in contrast to low productivity, high debt "zombies") which would suffer if credit conditions tightened. In section 3 we present a workhorse closed economy model of firms with heterogeneous productivity levels and credit demands, building on Melitz (2003), as a framework for considering the impact of a tightening of credit constraints on firm exit.

An additional channel through which financial crises may dampen the "cleansing" process of recessions is through increased forbearance by banks. Weak banks may be unwilling to realise losses on loans to low productivity firms and may have incentives to continue funding these "zombies" (see, for example, Peek and Rosengren (2003) and Caballero et al. (2008)). For the UK, Arrowsmith et al. (2013) present evidence to suggest that major banks engaged in some loan forbearance in the aftermath of the financial crisis. By continuing to lend to low productivity firms as a result of forbearance, finance may be less readily available to more productive firms, potentially forcing them to exit the market.

Recent empirical studies have found some support for the view that credit constraints can weaken the "cleansing" effect of recessions, in line with the view posited by Barlevy (2003). Eslava et al. (2010) investigate the exit dynamics of Colombian manufacturing establishments over the business cycle and find evidence to suggest that highly productive, credit constrained firms can be forced to exit during recessions. Hallward-Driemeier and Rijkers (2013) find evidence of an attenuation in the negative relationship between productivity and the probability of firm exit for Indonesian manufacturing firms during the East Asian Crisis, although the attenuation does not appear to be primarily due to a change in credit market conditions. Foster et al. (2016) find that during the Great Recession in the US, the impact which a firm's productivity has on its probability of exit was weaker, although they do not explicitly link this finding to the impact of a specific distortion. In a similar study on the UK economy, Harris and Moffat (2016) find that since the Great Recession the negative relationship which usually exists between Total Factor Productivity (TFP) and plant closure has weakened. Focussing instead on UK firms which survived the crisis, Riley et al. (2015) find that during the initial downturn in 2008-2009, there was a weakening of the positive correlation between employment growth and firms' relative productivity, particularly in sectors with small and bank-dependent firms.

Our paper takes a similar approach to Eslava et al. (2010), investigating whether the exit margin of firms is distorted specifically by credit constraints. Our innovation is that rather than only using proxies to identify credit constraints, we instead exploit an exogenous source of credit constraints faced by UK firms, induced by the banking relationships they maintained on the eve of the financial crisis. In using pre-crisis relationships, we follow a similar approach to that pioneered by Bentolila et al. (2013) and Chodorow-Reich (2014), comparing outcomes for firms which had relationships with banks that became more distressed during the crisis with outcomes for firms which had pre-crisis relationships with banks that were less distressed. Franklin et al. (2015) also use pre-crisis banking relationships to identify credit supply shocks faced by UK firms, although they do not group banks according to whether they became distressed or not and instead use a two stage least squares approach. As far as we are aware, ours is the first study to explore the effect of credit constraints on firm exit during the financial crisis by comparing outcomes for firms which borrowed from more distressed banks to those which borrowed from less distressed banks. Furthermore, our study is the first to explore how the productivity distribution of exiting firms in the UK was impacted by such constraints.

2.1 Model of Firm Dynamics with Credit Constraints

As a framework for our analysis, in this section we present a model in which firms have heterogeneous productivity levels and credit demands to consider the implications of a tightening of credit conditions on firm exit. We use a closed economy heterogeneous firm model with credit market frictions and liquidity shocks, adapting the open economy models of Melitz (2003), Chaney (2007) and Manova (2013). A short description of the model is provided below, with a more detailed exposition in the Appendix. Our model suggests that if the demand for credit is not exclusively concentrated in the lower end of the productivity distribution, then a worsening of credit market frictions may force some relatively productive firms to exit. This is consistent with the insight of Barlevy (2003) and the behaviour observed by Haldane (2017) that some relatively productive, debt dependent firms may be forced to exit the market following a tightening in credit conditions.

2.1.1 Consumers

Following the closed economy setup of Melitz (2003), we assume a representative consumer with constant elasticity of substitution (CES) preferences over a continuum of goods indexed by ω over Ω:

$$U = \left[\int_{\omega\in\Omega} q(\omega)^{\rho} d\omega\right]^{\frac{1}{\rho}}$$

where the elasticity of substitution between goods is given by $\sigma = \frac{1}{1-\rho} > 1$. The set of varieties can be considered as an aggregate good $Q = U$. If the price of good ω is given by $p(\omega)$, it can be shown that the optimal consumption and expenditure, $q(\omega)$and $r(\omega)$, for different varieties are given by:

$$q(\omega) = Q\left[\frac{p(\omega)}{P}\right]^{-\sigma}$$

$$r(\omega) = p(\omega)q(\omega) = R\left[\frac{p(\omega)}{P}\right]^{1-\sigma}$$

where aggregate nominal expenditure is given by $R = PQ = \int_{\omega\in\Omega} p(\omega)q(\omega)d\omega$ and $P = \left[\int_{\omega\in\Omega} p(\omega)^{1-\sigma} d\omega\right]^{\frac{1}{1-\sigma}}$ is the aggregate price index faced by the consumer.

2.1.2 Producers

Production is undertaken by a continuum of firms, each of which produces a variety ω. We assume that there is a large, unbounded pool of potential entrants each period. Entrants are required to pay a fixed entry cost, f_e, in units of labour before drawing their productivity level, φ , from the probability distribution function $g(\varphi)$, with support $[\varphi_{min},\infty)$. The associated cumulative distribution function is given by $G(\varphi)$.

To produce q units of a variety, a firm uses l units of labour. We normalise the price of labour to 1. The amount of labour used, and so the total operating cost, has a fixed component, f , and a variable component that depends on a firm's productivity, φ :

$$l = \frac{q}{\varphi} + f$$

Our assumptions about the financing of the fixed costs of production closely follow Chaney (2007) and Manova (2013), but applied to a closed economy. We assume that firms have to pay a fraction d_i of the fixed cost of production, f , upfront, where $0 \leq d_i \leq 1$. The remainder of the fixed cost of production, given by $(1 - d_i)f$, can be paid once revenues are realised. We assume that the fraction of the fixed cost to be paid upfront is independent of firm level productivity and can take on two values, $i \in \{L, H\}$, where d_L corresponds to a low upfront fixed cost requirement and d_H corresponds to a high upfront fixed cost requirement, such that $d_L \leq d_H$. The fixed cost requirement is assumed to be low, d_L , with probability χ and high, d_H , with probability $1 - \chi$.

The fraction, d_i , of the fixed cost which has to be financed upfront must be financed by a financial intermediary. The financial contract is such that at the beginning of the period firms make a take-it or leave-it offer to the intermediary to make a repayment F. Once revenues are realised, the intermediary receives a repayment at the end of the period. Contracts are imperfect such that intermediaries only obtain the agreed repayment F with probability $\lambda \leq 1$.[1] With probability $1-\lambda$ the firm defaults and the intermediary does not receive F, but it is able to seize collateral from the firm. Collateral is assumed to be equal to a fraction t of the entry cost, f_e , following the approach of Manova (2013). In the case of default, the firm is able to keep its revenues but needs to replace the collateral which is seized by the financial intermediary, tf_e. We assume that firms are not able to retain earnings across periods to finance their fixed costs and instead all profits are required to be paid as dividends to shareholders at the end of each period.[2]

Upon entry, the firm faces the same problem each period, choosing its price, quantity and repayment to maximise profits subject to three constraints:

$$\max_{p(\varphi),q(\varphi),F(\varphi,d_i)} \pi(\varphi,d_i) = p(\varphi,d_i)q(\varphi,d_i) - \left[\frac{q(\varphi,d_i)}{\varphi} + (1-d_i)f + \lambda F(\varphi,d_i) + (1-\lambda)tf_e\right]$$

subject to

(1) $q(\varphi) = Q\left[\frac{p(\varphi,d_i)}{P}\right]^{-\sigma}$

(2) $F(\varphi,d_i) \leq p(\varphi,d_i)q(\varphi,d_i) - \frac{q(\varphi,d_i)}{\varphi} - (1-d_i)f$

(3) $d_i f \leq \lambda F(\varphi,d_i) + (1-\lambda)tf_e$

The profit expression shows that the firm's profits are equal to its revenue less its variable cost of labour, $\frac{q(\varphi,d_i)}{\varphi}$, the fraction of the fixed cost it finances itself, $(1-d_i)f$, and its expected repayments to the financial intermediary, which equal $F(\varphi,d_i)$ when the contract is not broken and tf_e otherwise.

Constraint (1) shows the demand for a firm's variety. Constraint (2) implies that the repayment offered to the financial intermediary must not be larger than the firm's revenue net of its variable costs and the fraction of its fixed costs which it finances itself. Constraint (3) implies that the expected revenue of the financial intermediary must be at least as large as the fraction of the fixed cost which it finances.

We assume perfect competition among financial intermediaries, such that constraint (3) binds with equality. Upon entry, firms will choose to produce providing that their productivity φ, is sufficiently large to ensure that profits are non-negative, $\pi(\varphi,d_i) \geq 0$ and constraint (2) is satisfied. Given the firm must finance d_i of the fixed cost upfront, we can define a productivity threshold for each level of the fixed cost requirement, $\varphi^*_{d_i}$, such that firms which draw productivity levels below the threshold choose not to produce and exit the market. In the standard Melitz (2003) model, the productivity threshold is defined just by the productivity level which ensures profits are non-negative. In this setup, however, if the upfront fixed cost requirement is sufficiently large, constraint (2) will be more stringent than the non-negative profit condition and as a result the productivity threshold will be higher.

2.1.3 Solving the Model

In the Appendix we detail how we solve the model to find the two productivity thresholds, $\varphi^*_{d_L}$ and $\varphi^*_{d_H}$. So that we can illustrate comparative statics, we calibrate the model, closely following the calibration approach of Melitz and Redding (2013), with details also presented in the Appendix. When credit conditions tighten as a result of a fall in λ, the cutoff productivities increase, forcing some firms which are now below their relevant cutoff productivity to choose to not produce anymore and exit immediately. Using our calibrated

[1] Manova (2013) argues that λ can reflect the sophistication/development of financial institutions.

[2] Manova and Yu (2016) motivate this assumption by arguing that dividends have to be paid out as a result of moral hazard concerns.

Figure 1: Impact of Credit Market Frictions on Productivity Cutoffs

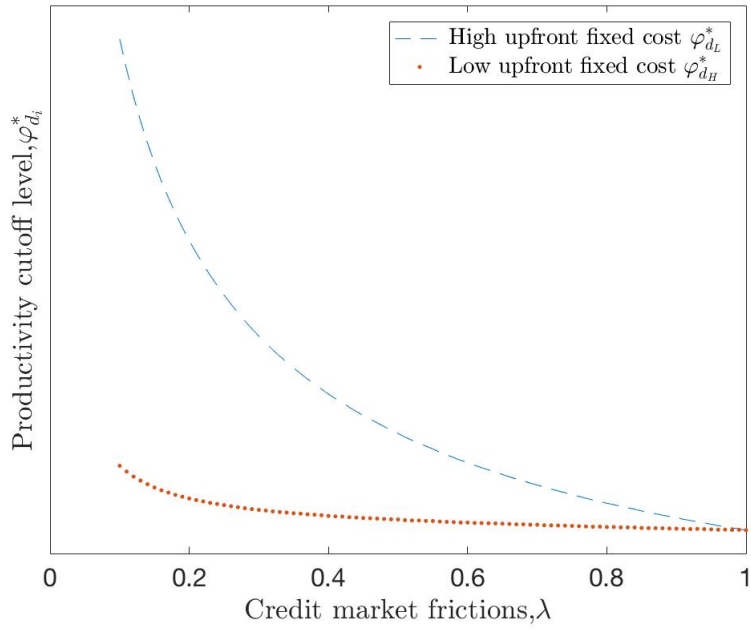


Figure 1 illustrates how the two productivity thresholds, $\varphi^*_{d_L}$ and $\varphi^*_{d_H}$ change as the size of the credit market friction, λ, varies. The calibration of the model is detailed in the Appendix. An increase in λ corresponds to a reduction in credit frictions.

model, we consider the extent to which contract imperfections, given by λ, affect the cutoff productivities of low liquidity and high liquidity firms.

In Figure 1 we show how the implied cutoffs in the model, $\varphi^*_{d_L}$ and $\varphi^*_{d_H}$, vary as we change the degree of contract imperfections. For any given level of credit market frictions, modelled by λ, the cutoff for firms with a low upfront fixed cost requirement, $\varphi^*_{d_L}$, is less than or equal to the cutoff for firms with a high upfront fixed cost requirement, φ^*_H.

When there are no contract imperfections, such that $\lambda = 1$, the implied cutoffs for firms with a low upfront requirement, d_L, and firms with a high upfront requirement, d_H, are the same. Therefore without credit market frictions, high upfront fixed cost firms and low upfront fixed cost firms are equally likely to exit. This is because, as detailed in the Appendix, when $\lambda = 1$, the cutoff condition for all firms reduces to the "zero profit cutoff condition", as in the standard closed-economy Melitz (2003) model.

But when credit frictions exist such that $\lambda<1$, firms with a high upfront cost requirement are more likely to exit, since they require a higher cutoff productivity level in order to survive. As credit frictions increase (λ becomes smaller) the required productivity cutoff for firms which have to pay a high upfront fixed cost increases sharply. Given a lower probability of being repaid, financial intermediaries require a higher repayment from firms and therefore firms require greater revenues. But the productivity cutoff for firms which only have to pay a low upfront fixed cost is relatively insensitive to changes in credit frictions, since these firms are less reliant on obtaining finance from financial intermediaries to cover their fixed cost of production.

In Figure 2, we consider how the cumulative distribution function (cdf) of productivity levels in the economy is affected by a tightening in credit constraints (modelled as a reduction in λ). Figure 2 illustrates that when credit frictions become more severe, the cumulative distribution at very low productivity levels is relatively unchanged. This is because the firms with the lowest productivity are those with a low upfront fixed cost requirement and the productivity level cutoff for these firms, $\varphi^*_{d_L}$, is relatively insensitive to changes in credit frictions, since their reliance on external finance is low. These firms are able to finance most of their fixed costs internally, and so their decision as to whether produce is relatively unaffected by the tightening

Figure 2: Impact of Credit Market Frictions on the Productivity Distribution

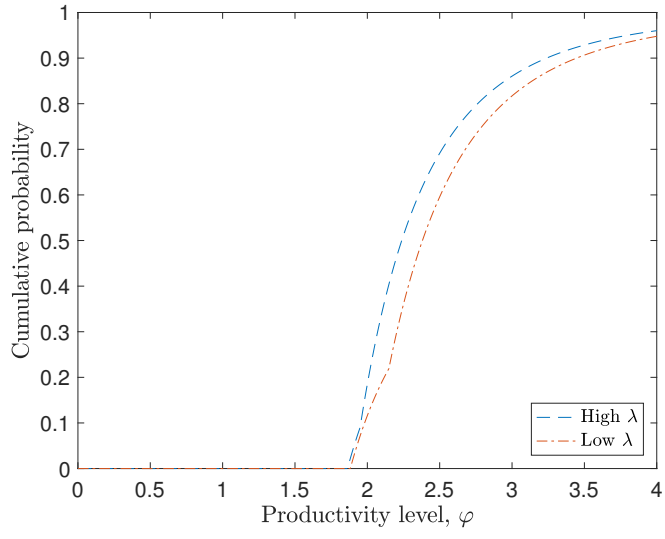


Figure 2 shows the cumulative distribution function of productivity levels for a high value of λ and a low value of λ. The calibration of the model is detailed in the Appendix. In this Figure, the high value of λ is equal to 0.7 and the low value of λ is equal to 0.5.

in credit conditions. The increase in credit frictions affects firms which have to pay high upfront fixed costs more severely, leading to a much larger change in their productivity level cutoff, $\varphi^*_{d_H}$.

In short, the model suggests that if the structure of the economy changes such that credit constraints tighten, it will lead to the immediate exit of some firms which are dependent on external finance to pay upfront fixed costs. If the demand for external finance is not concentrated in the lower end of the productivity distribution, as assumed here, then a tightening of credit conditions may force some relatively productive firms to exit. In our example, if credit constraints are already present to some degree, firms with the very lowest productivity levels are relatively unaffected by a further tightening in credit constraints, as these firms are able to exist in the economy by virtue of not being dependent upon financial intermediaries to finance their fixed costs. Firms with the highest productivity levels will also be unaffected, as these firms are productive enough to survive regardless of whether they have low or high upfront costs to pay. The tightening of credit constraints will affect those firms with intermediate productivity levels which have high upfront costs to pay and so are dependent upon financial intermediaries.

While the model presented above is simplistic in a number of its assumptions, it illustrates how augmenting a workhorse heterogenous firm productivity model with a friction which is experienced not solely by the least productive firms can result in a distortion in the productivity distribution. Relatively productive firms which are dependent on external finance may be forced to exit in response to a tightening in credit conditions, while relatively unproductive firms which are less dependent on external finance may be able to survive.

3 Treatment and Control Groups

Following the approach used by Bentolila et al. (2013) and Chodorow-Reich (2014), we use the sticky nature of relationships between firms and banks to obtain variation in the exposure of firms to the tightening of credit supply following the financial crisis. We define *Distressed Banks* as those which obtained state funding between 2008 and 2009 or required a takeover in order to survive and *Non Distressed Banks* as those which did not receive state funding and did not require a takeover in order to survive. We divide our sample of firms into *Treatment* and *Control* groups based on which banks they had relationships with in

2008, at the onset of the financial crisis in the UK.

In our analysis, our *Treatment* group consists of firms which have relationships with just *Distressed Banks*. Our control group consists of firms which have relationships with just *Non Distressed Banks*. We exclude from our sample firms which have relationships with a combination of both *Distressed Banks* and *Non Distressed Banks*. We also exclude firms which do not have any identifiable relationships with banks. We do so because firms without any identifiable banking relationship are likely to be considerably different in their characteristics than those firms which are reliant on bank finance, as discussed in more detail below.

In the UK, four banking groups account for the vast majority of loans to businesses: Barclays Bank, HSBC, Lloyds Banking Group (LBG)[3]and the Royal Bank of Scotland Group (RBS). These four banking groups account for around 80% of business current accounts.[4] The group of *Distressed Banks* includes banks belonging to LBG and RBS and a number of other smaller banks.[5] The group of *Non Distressed Banks* includes banks belonging to Barclays Bank and HSBC and a number of other smaller banks.[6]

Our focus is on whether contractions in the supply of credit by *Distressed Banks* affected the exit behaviour of our *Treatment* group which had pre-crisis relationships exclusively with those banks relative to our *Control* group which had pre-crisis relationships exclusively with *Non Distressed Banks*.

3.1 The UK Financial Crisis and Bank Lending to Businesses, 2008-2012

Of particular importance for our identification strategy is that credit supply conditions tightened by more for firms which had pre-crisis relationships with *Distressed Banks* than for others.

In this section we document how the elevated level of funding costs and 'near-death' experiences which *Distressed Banks* suffered during the crisis would suggest that they might have tightened credit supply conditions by more than other lenders. While some of the *Distressed Banks* did make lending commitments in return for public sector support, there is little evidence that this influenced their lending behaviour.

3.1.1 Drivers of the Credit Crunch

It is noteworthy that our *Treatment* group is based on an outcome which is realized ex-post, following the financial crisis. Our identification strategy would be undermined if, prior to the crisis, firms anticipated which banks would become *Distressed Banks* or if the reason banks became distressed was because they had established relationships with poorly performing firms.

However, the credit crunch in the UK was driven by factors that were largely independent of the pre-crisis state of the corporate loan books of the major lenders (see, for example, Broadbent (2012)). The global financial crisis was triggered by emerging losses in the US sub-prime mortgage market. Widespread nervousness about the true liquidity and capital positions of banks in general meant that the funding costs of lenders in the United Kingdom rose markedly relative to Bank Rate, making it more expensive to fund new loans as well as the loans and facilities to which they were already committed.

Moreover, there is little evidence to suggest that the fate of UK banks was anticipated prior to the crisis. As noted by Harimohan et al. (2016), prior to the financial crisis, funding costs for major UK banks

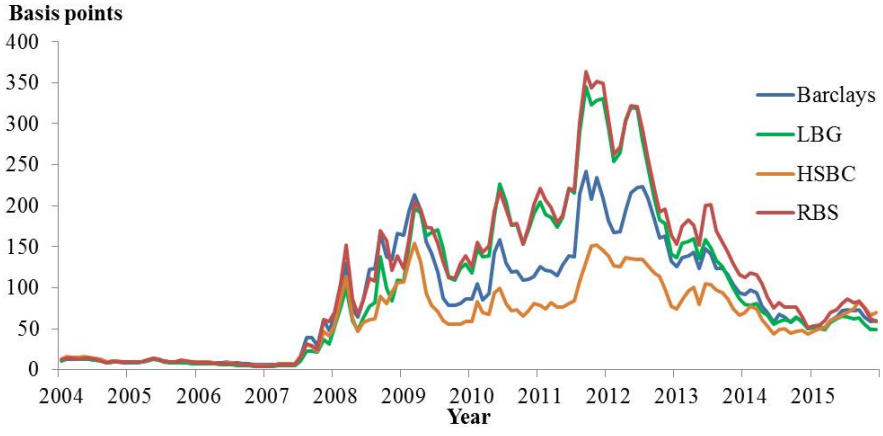
[3]Lloyds Banking Group was the entity which eventually resulted from Lloyds TSB's acquisition of Halifax Bank of Scotland (HBOS) in January 2009.

[4]See "CMA Retail banking market investigation: Provisional findings report" (2015), Department for Business, Innovation and Skills.

[5]We also include Allied Irish Bank, Alliance and Leicester, Anglo Irish Bank, Bank of Ireland, Bradford and Bingley, Capital Home Loans, First Trust Bank, Mortgage Express and Northern Rock. In November 2007, Alliance and Leicester was offered a 3 billion collateral swap by the Bank of England. It was subsequently taken over by Santander in April 2008. Northern Rock was taken into public ownership in February 2008. In September 2008, Bradford and Bingley's retail deposit business was sold to Santander, with the remainder of the business taken into public ownership. Mortgage Express was a specialist mortgage lender acquired by Bradford and Bingley in 1997.

[6]The other banks classed as *Non Distressed* are Clydesdale Bank, Yorkshire Bank, Co-operative Bank, Santander, Abbey National, Nationwide, Mortgage Works, Paragon Mortgages, Mortgage Trust, Coutts, Close Brothers, Skipton Building Society, Norwich Union, Bibby Financial Services, Venture Finance, Griffin Credit Services, Royal Trust Corporation of Canada and Svenska Handelsbanken.

Figure 3: CDS Premiums of Major UK Banks



The chart shows the five-year senior CDS premia of selected UK banks. The chart plots monthly averages of daily data over the period 2004-2015.

were almost identical. One indicator of the intensity of the crisis was the cost of insuring the unsecured debt of banks against the risk of default as given by Credit Default Swap (CDS) premiums. As Figure 3 shows, prior to the crisis, the CDS premiums of the major UK banks had been similar and close to zero, consistent with bank default being considered a very low probability event by market participants. Given that private firms are unlikely to have more information at their disposal about the health of banks than financial market participants, it appears unlikely that firms anticipated that some UK banks would become distressed following the financial crisis.

The prospect of bank default triggered by the crisis meant that bank wholesale funding costs rose sharply for all banks, but with especially severe consequences for those banks that were reliant on wholesale funding. Differences in capital positions and exposures meant that funding costs varied markedly across the different banks. Figure 3 shows that the increase in CDS spreads during the crisis was particularly pronounced for RBS and LBG.

3.1.2 Public Sector Support for Weak Banks

The financial crisis threatened the survival of a number of UK lenders and required substantial recapitalisation or takeovers for them to continue to function. Some recapitalisation was achieved by raising further equity from private investors. But two of the major lenders, RBS and LBG, received substantial capital injections from the public sector. The first stage of this was the Bank Recapitalisation Scheme in October 2008 whereby the government made Tier 1 capital available to UK banks to strengthen their balance sheets. As part of the scheme, the government invested £20 billion in RBS and £17 billion in LBG. The other two major commercial lenders, Barclays and HSBC, did not participate in the scheme. In October 2008 Barclays announced plans to raise £7.3 billion from private investors and in 2009 HSBC announced plans to raise £12.5 billion in a rights issue.

Subsequent to this, further deterioration in confidence surrounding the banking system in 2009 led the government to establish an asset protection scheme (APS) that would put a floor to participating banks' exposure to losses associated with impaired assets. When RBS signed up to the APS in November 2009, the government injected £25 billion into RBS, taking its overall capital injection to £45 billion. Rather than joining the APS, in November 2009 LBG was able to raise equity from its existing shareholders by a rights issue. As a major shareholder in the group, the UK government took up its rights taking its ultimate stake in the group up to £20.3 billion. This stake has subsequently been reduced since the government began the disposal of its stake in September 2013.

3.1.3 Lending Commitments

The injection of public sector capital into the major UK banks was intended to support lending in the UK economy. But despite substantial injections of public sector capital and clear directives that lending to UK businesses should be supported, lending by the *Distressed Banks* fell and was generally negative in the years following the financial crisis.

The UK government sought to obtain commitments from the banks participating in its support schemes that they would continue to support lending to the UK economy. Participants of the 2008 Bank Recapitalisation Scheme committed to maintaining, over the following three years, 'the availability and active marketing of competitively-priced lending to homeowners and to small businesses at 2007 levels'. This agreement was superseded by formal lending commitments agreed between the government and LBG and RBS on acceptance of public sector capital. The agreements committed RBS to lend an additional £16 billion to businesses in the 12 months from March 2009 and LBG an additional £11 billion over the same period. The lending was to be on commercial terms and subject to market demand, with further agreements made for the subsequent year.

But lending to businesses by *Distressed Banks* fell short of the net lending levels set out in the commitments. Net lending by LBG and RBS fell between March 2009 and February 2011 as debt repayments exceeded gross business lending. Further lending commitments were made in February 2011 when the largest five UK lenders (Barclays, HSBC, LBG, RBS and Santander) signed up to Project Merlin, an accord between the UK government and the major banks. This committed them to making £190 billion of new credit facilities available to businesses in 2011. In total, £214.9 billion facilities were made available to UK businesses in 2011, 13% higher than the commitment of £190 billion. But gross lending to businesses by the Merlin banks totalled £99.9 billion, significantly less than the size of lending facilities made available, and net lending by these banks amounted to -£9.6 billion. So, while the lenders met the targets they had agreed for funds made available to businesses, the stock of actual lending to businesses continued to fall. Furthermore, there were contrasting lending performances between the *Distressed Banks* and *Non Distressed Banks*. The RBS Independent Lending Review (2013) reports that RBS's share of gross new lending to all sectors excluding commercial real estate fell from 35% in 2009 to 23% in 2011. In contrast, HSBC, reported that net lending to UK businesses increased by 6% in 2011, despite an overall market contraction, while Barclays reported that net lending increased by 3% to UK companies in 2011. [7]

3.2 Summary

The evidence presented suggests that the shift in corporate credit supply conditions was not uniform across the various lenders and that *Distressed Banks* tightened credit supply conditions by more than other lenders. While the *Distressed Banks* had made lending commitments in return for public sector support, there is little evidence that this influenced their lending behaviour.

Having a pre-crisis relationship with a *Distressed Bank* would not have hindered firms in the post-crisis period if they were easily able to switch lenders to obtain finance. But the relationship banking literature argues that by acquiring information about borrowers through building banking relationships, banks are able to overcome the problems of adverse selection and moral hazard inherent in lending contracts. Such informational frictions suggest that it may be difficult for firms to switch banks. In practice, and as detailed in the description of our data below, banking relationships do tend to be very sticky (see also Franklin et al. (2015) for the UK and Chodorow-Reich (2014) for the US for further evidence on the stickiness of banking relationships).

Therefore, given the stickiness in banking relationships and the evidence to suggest that the contraction in credit supply by *Distressed Banks* following the crisis was greater than that of *Non Distressed Banks*, we

[7] See HSBC Bank plc Annual Report and Accounts 2011, Barclays PLC Full Year 2011 Results Presentation.

use pre-crisis banking relationships as an exogenous source of credit supply constraints facing firms following the financial crisis.

4 Data

4.1 Firm Level Data

In the UK, all limited and public limited companies are required to report accounts to Companies House. All companies are required to report basic balance sheet information, but Companies House reporting requirements vary by company size.

A company can be classified as "small", "medium" or "large" depending upon whether it satisfies certain size criteria. As detailed in Table 1, over the sample period considered, small companies were not required to report profit and loss accounts and could choose to report abbreviated balance sheets. Medium-sized companies could choose to report abbreviated profit and loss accounts.

Table 1: Minimum Reporting Requirements of Firms

	Balance Sheet,	Profit & Loss Account	Turnover
Small	Abbreviated	Not required	Not required
Medium	Full	Abbreviated	Not required prior to 2008
Large	Full	Full	Required

Notes: The Table reports the minimum reporting requirements by company size for our sample period, 2004-2012. The size of a company is determined on the basis of thresholds for annual turnover, balance sheet total and number of employees. Details of the thresholds can be found at www.gov.uk/government/organisations/companies-house

We use the FAME dataset provided by Bureau van Dijk, which extracts information from accounts filed by UK firms at Companies House. Since only incorporated companies are required to file accounts with Companies House, the FAME dataset is not representative of sole-proprietorships and partnerships.

As well as providing information on company accounts, the FAME dataset also includes a Credit Score for UK firms, known as the "Quiscore". The Quiscore is produced by CRIF Decision Solutions Limited using a proprietary model and is designed to reflect the likelihood that the company will fail in the following 12 months. Each firm is assigned a value between 0 and 100, with a larger value indicating a lower probability of failure. The scores can be broadly categorised into 5 bands: 0-20 "high risk", 21-40 "caution", 41-60 "normal", 61-80 "stable" and 81-100 "secure".

To obtain an accurate picture of the corporate landscape in the UK, we have combined snapshots of the FAME database at an annual frequency over the period 2002-2012. This is necessary since, at any point in time, the FAME dataset only provides a live snapshot of the information stored at Companies House. This means that information on variables such as company structure and director information is only accurate at the time the database is accessed and also means that a given snapshot provides a biased picture of the historical population of companies, because many, but not all, inactive companies are removed from the database.[8]

Using these data, we consider companies which file accounts at an annual frequency at Companies House. We focus on market sector companies and we exclude the agriculture, financial and real estate industries from our sample.[9] We exclude very small companies which report total assets of less than £10,000.

[8]For a discussion of these issues using the global equivalent of the FAME dataset, see Kalemli-Ozcan et al. (2015) "How to construct nationally representative firm level data from the ORBIS global database", CEPR Discussion Paper No. 10829.

[9]We identify the industry a company operates in using the 2-digit SIC 2007 code. We exclude companies operating in agriculture, forestry and fisheries industries (SIC codes 01-03), veterinary activities (SIC code 75), mining and quarrying industries (SIC codes 05-09), public sector and related industries and households (SIC codes 84-88, 91, 94, 97-99), the real estate industry (SIC code 68) and the banking and insurance industries (SIC codes 64-66).

4.2 Banking Relationships

In the UK, registered companies are also required to report charges/mortgages (hereafter 'charges') to Companies House within 21 days of their creation date. A charge is the security which companies are required to provide for a loan.[10] When registering a charge, companies are required to report the date on which the charge was created and the name of the chargeholder. We use a textual algorithm to search for the names of registered UK lenders within the list of chargeholders for each company within the FAME dataset.

Having identified the names of UK lenders within the list of chargeholders, we use this as a proxy for banking relationships. Evidence suggests this is likely to be a good proxy for banking relationships. As part of its 2013 investigation into SME forbearance (Arrowsmith et al. (2013)), the Bank of England was able to confirm for one bank that of 4,500 identified in this way, 99.8% were current or past customers of the bank, though 14% no longer had borrowing facilities.

In our sample, a firm is considered to have an active relationship with a given bank if it has an outstanding charge with that bank. The length of the relationship is proxied by the length of time between the oldest outstanding charge a firm has with a bank and the date of the most recent financial accounts. Table 2 reports the number of firms we identify in each year as having a relationship with either *Distressed Banks* or *Non Distressed Banks* and a breakdown of the percentage of our sample belonging to each of the four major banking groups. Just over half of firms in the sample in any given year have relationships with *Distressed Banks* and, of those firms, the majority have relationships with either LBG or RBS. Of the firms attached to *Non Distressed Banks*, the majority have relationships with either Barclays or HSBC.

Table 2: Firms with Active Bank Relationships, by Banking Group

	2004	2005	2006	2007	2008
Distressed					
LBG	17%	16%	16%	16%	16%
RBS	31%	31%	31%	32%	33%
Distressed Other	1%	1%	1%	2%	2%
Distressed Mix	3%	3%	3%	3%	3%
Total % Distressed	52%	52%	52%	53%	54%
Non Distressed					
Barclays	18%	17%	17%	16%	15%
HSBC	23%	24%	23%	23%	22%
Non Distressed Other	4%	4%	4%	4%	4%
Non Distressed Mix	4%	4%	4%	5%	5%
Total % Non-Distressed	48%	48%	48%	47%	46%
Observations	153,534	166,965	171,812	173,775	173,348

Notes: The Table reports the number of firm observations for the years 2004-2008 which have relationships with either *Distressed Banks* or *Non Distressed Banks*. We exclude from our sample firms which do not have a registered charge with a lender and firms which have charges with both *Distressed Banks* or *Non Distressed Banks*. For firms which had a relationship with only *Distressed Banks*, the Table provides a breakdown of the percentage of firms which had exclusive relationships with RBS, LBG, other distressed banks (*Distressed Other*) or a combination of different distressed banks (*Distressed Mix*). For firms which had a relationship with only *Non Distressed Banks*, the Table provides a breakdown of the percentage of firms which had exclusive relationships with Barclays, HSBC, other non-distressed banks (*Non Distressed Other*) or a combination of different non-distressed banks (*Non Distressed Mix*).

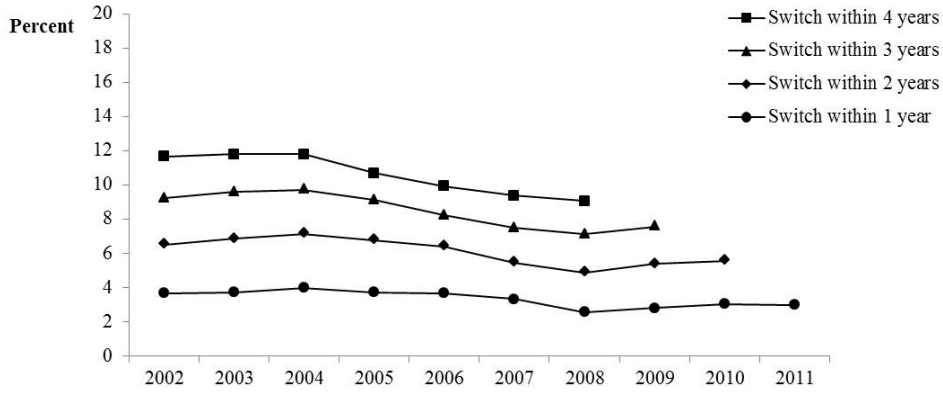
Figure 4 presents evidence on the sticky nature of banking relationships. It shows the proportion of firms which are initially attached solely to a bank or collection of banks belonging to the group of *Distressed Banks* that subsequently form a relationship with another lender that is not part of this group. Over the period 2002-2011, the average switching rate at the 1 year horizon was around 3%[11] and the switching rate at the 4

[10] A mortgage differs from a charge in that it passes property to the person whom the mortgage is given.

[11] The percentage of firms switching at the 1 year horizon is consistent with a survey undertaken for the Department for

year horizon was just 9%, implying relationships tend to be very sticky. From Figure 4, there is no evidence of a large increase in switching by firms attached to *Distressed Banks* around the financial crisis. It shows that the proportion of firms switching lenders has shown little variation over time.

Figure 4: Switching Rates for Firms with Distressed Banks



Notes: The Figure considers firm observations over the period 2002-2012 for firms which had exclusive relationships with *Distressed Banks*. The Figure shows, for each year, the proportion of firms which initially had exclusive relationships with *Distressed Banks* and then formed a relationship with another lender (either a bank or non-bank not part of the *Distressed Banks* gorup) after 1 year, 2 years, 3 years and 4 years. At each horizon we focus only on firms which survive to that horizon and have charges outstanding with lenders. For example, at the four year horizon we focus only on the subset of firms which initially have relationships with *Distressed Banks* and survive for at least four years and have charges outstanding after four years.

4.3 Descriptive Statistics

We begin by describing how the exit rates of firms which banked with *Distressed Banks* and *Non Distressed Banks* evolved in the pre-crisis and post-crisis period.

We consider firms which report annual accounts and have all of their outstanding charges with either *Distressed Banks* or *Non Distressed Banks*. For any given year, t, we consider firms which file accounts between April of that year and March of the following year, in line with the financial year in the UK. For example, a firm's annual accounts are associated with the year 2008 if it files its accounts between April 2008 and March 2009. A firm is deemed to exit the sample in year t if the final accounts which the firm files are associated with year $t-1$. It is important to note that firms may exit for a variety of reasons, some of which may not be related to credit constraints and financial distress. For example, a firm may exit voluntarily due to the directors of the business retiring. Alternatively, a firm may exit if it is acquired by another firm.[12]

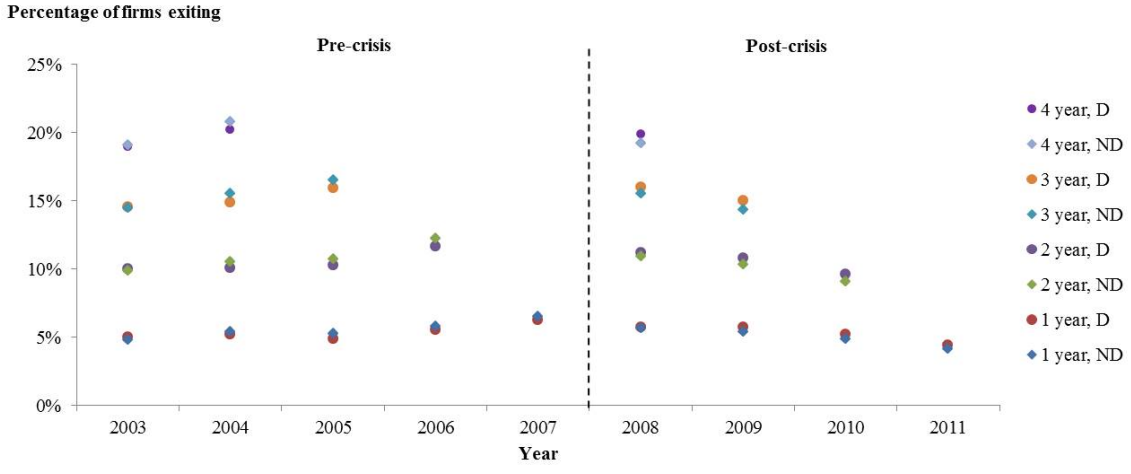
Figure 5 plots the share of firms which exited within 1 year, 2 years, 3 years and 4 years over the period 2003-2011, split by whether the firm had exclusive relationships with *Distressed Banks* or *Non Distressed Banks*. The chart excludes observations for which the exit horizon spans both the Pre-crisis and Post-crisis period (e.g. the percentage of firms in 2005 which exited within 4 years).

Figure 5 shows that in the pre-crisis period, the exit rate at all horizons was slightly higher for firms with *Non Distressed Banks* than for firms attached to *Distressed Banks*. After the financial crisis, exit rates were similar for firms with *Non Distressed Banks* and firms with *Distressed Banks*. It is also notable that after the financial crisis, exit rates were slightly lower. This is consistent with evidence presented by Harris and Moffat (2016) which uses plant-level data from the Annual Business Survey (ABS) conducted by the Office for National Statistics (ONS) and finds that there has been a fall in the probability of plant closure since 2008 in all sectors other than retailing.

Business Innovation & Skills in 2013 on Small and Medium-Sized Enterprise (SME) finance and with a report by the House of Commons Business, Energy and Industrial Strategy Committee in 2016. See "Small and Medium Sized Enterprise (SME) Journey Towards Raising External Finance, A report by BMG Research, October 2013" and "Access to Finance, First Report of Session 2016-17. House of Commons Business, Energy and Industrial Strategy Committee, 2016".

[12]Note that acquisitions do not necessarily result in firm exit.

Figure 5: Exit Rates, by Banking Relationship

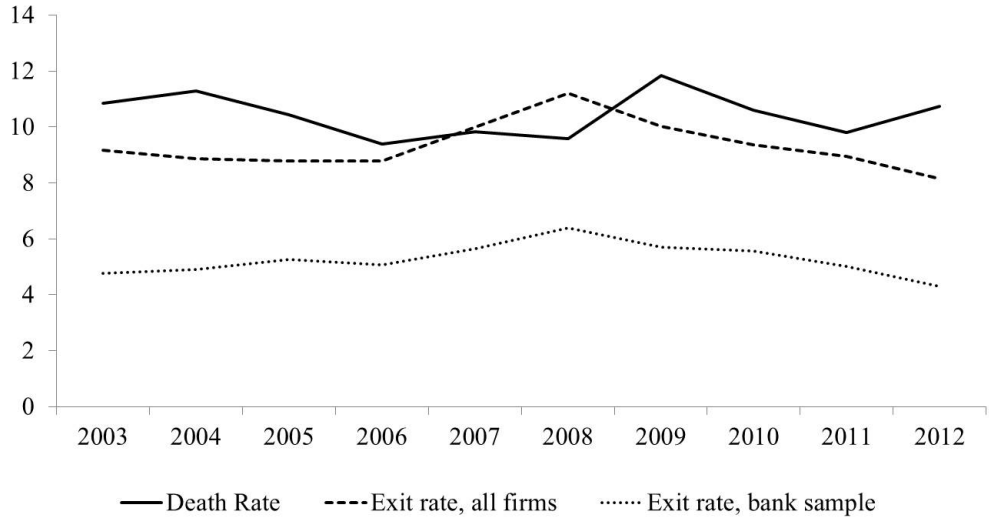


The figure plots the percentage of firms which exit the sample at the 1 year, 2 year, 3 year and 4 year horizon, split by firms which have a relationship with *Distressed Banks* (D) and *Non Distressed Banks* (ND). The chart is split by the Pre-crisis (before 2008) and Post-crisis period. The chart excludes observations for which the exit horizon spans both the Pre-crisis and Post-crisis period.

In Figure 6 we plot the percentage of firm deaths between 2003 and 2012 reported by the Office for National Statistics (ONS), based on the Inter-Departmental Business Register (IDBR). We also plot the 1 year exit rate for firms in our full FAME sample and our FAME sample which is restricted just to firms which had relationships with either *Distressed Banks* or *Non Distressed Banks*. For comparability with the ONS firm death data, for our FAME samples we plot the lagged exit rate (since, for example, the 1 year exit rate in 2010 reflects firms which were present in 2010 but exited in 2011).

Figure 6 shows that the death rate reported by the ONS tends to be slightly higher than the proportion of firms exiting the FAME sample. This likely reflects the greater coverage of smaller businesses in the IDBR, in particular the inclusion of sole-proprietorships and partnerships which are not captured in the FAME sample. To the extent that smaller businesses face a higher probability of failure, it is not surprising that the level of death rates reported by the ONS exceeds the exit rates in our FAME sample. The exit rate using our full FAME sample is higher than the exit rate using our sample of firms which have a relationship with either *Distressed Banks* or *Non Distressed* banks, which is also likely to reflect the greater prevalence of smaller firms in the full FAME sample. Comparing the profile of the ONS firm death series and our FAME exit rates, it is notable again that firm death rates and exit rates did not increase substantially following the financial crisis. In the ONS firm death series, there was a modest pick-up in 2009 which has since receded. In our FAME sample exit rates increase modestly in 2008 before receding.

Figure 6: ONS firm death rate



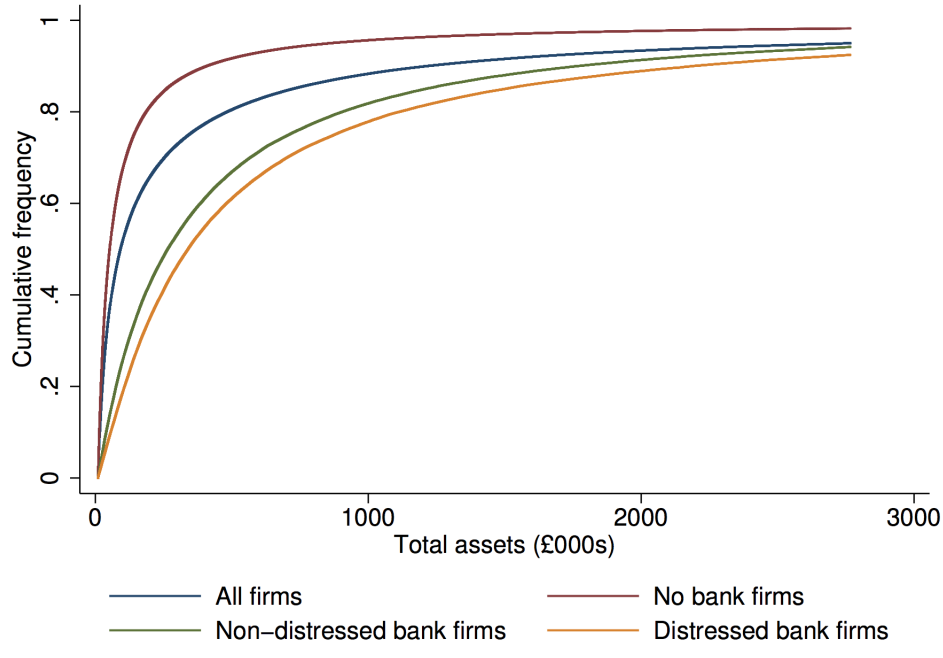
The figure plots the percentage of firm deaths in a given year reported by the ONS using the IDBR. For comparison we plot the one year exit rate of firms in the FAME sample. For comparability with the ONS firm death data, for our FAME samples in year x we plot the 1 year exit rate in year $x-1$.

In Table 3, we compare the profile of firms in our sample in 2004, 2006 and 2008 which had relationships exclusively with *Non Distressed Banks* or *Distressed Banks*. For comparison, we also include firms which do not have any bank charges. The year 2008 is selected to coincide with the onset of the financial crisis. The top two rows of Table 3 show what is illustrated in Figure 5: that the proportion of firms in 2004 and 2006 which subsequently exited within 2 or 4 years was slightly higher for firms which had exclusive relationships with *Non Distressed Banks*, but in 2008 there is no discernible difference. Table 3 also compares the credit rating of firms with *Non Distressed Banks* and firms with *Distressed Banks*. The table suggests that there was little difference between the credit profile of firms with *Non Distressed Banks* and *Distressed Banks*. In each year considered, the proportion of firms with a 'High Risk' or 'Caution' credit rating was very similar for the group of firms attached to *Non Distressed Banks* and the group of firms attached to *Distressed Banks*.

The number of firms which have relationships with either *Non Distressed Banks* or *Distressed Banks* is small in comparison to the number of firms which do not have any bank charges. Table 3 shows that those firms without any bank charges are considerably different in nature than firms with bank charges. In particular, firms without any charges are smaller and younger on average, are considered to be higher risk and have considerably higher exit rates than firms which have relationships with *Non Distressed Banks* or *Distressed Banks*. Figure 7 plots the cumulative frequency distribution of firm size, given by total assets, for firms which have relationships with *Non Distressed Banks* or *Distressed Banks* and for firms which do not have any bank charges in the year 2006. It illustrates that for the firms with no bank charges, a much larger proportion of those firms are very small in size relative to firms which have banking relationships with either *Non Distressed Banks* or *Distressed Banks*. Because of their lack of similarity to firms with banking relationships, we exclude firms which do not have any bank charges from our subsequent analysis.

It is also worth noting that there appears to be a change in methodology in the calculation of the credit rating in 2006. In particular, a larger proportion of firms with banking relationships are considered to have a "Normal" credit rating, and a smaller proportion have a "High risk", "Caution" or "Secure" rating. However these changes are common across firms attached to *Non Distressed Banks* and firms attached to *Distressed Banks*.

Figure 7: Size Distribution of Firms in 2006, by Banking Relationship



The figure plots the cumulative distribution function of firms' total assets in the year 2006 for four groups of firms: the whole sample of firms in our FAME dataset, firms which have no bank charges ("No bank firms") and firms which have relationships either just with *Non Distressed Banks* or just with *Distressed Banks*. We exclude firms with total assets less than £10,000.

Table 3: Summary Statistics, by Banking Relationship

	2004			2006			2008		
	ND	D	No Bank	ND	D	No Bank	ND	D	No Bank
Exit in 2 years	11%	10%	13%	12%	12%	15%	11%	11%	14%
Exit in 4 years	21%	20%	26%	22%	21%	27%	19%	20%	25%
Start-Up	14%	13%	33%	8%	8%	22%	6%	8%	24%
Young	34%	33%	58%	33%	32%	60%	26%	28%	56%
Foreign Owned	2%	3%	3%	2%	2%	2%	2%	3%	2%
Exporter	1%	2%	1%	1%	1%	1%	2%	1%	1%
Median Assets (£000)	288	359	51	266	341	53	288	359	51
Median Leverage Ratio	0.74	0.76	0.72	0.74	0.74	0.68	0.74	0.76	0.72
Credit Rating									
High Risk	13%	13%	11%	5%	6%	8%	3%	4%	6%
Caution	27%	28%	18%	20%	19%	34%	21%	21%	39%
Normal	22%	22%	22%	47%	47%	46%	50%	50%	46%
Stable	17%	17%	18%	15%	15%	6%	15%	14%	5%
Secure	17%	17%	29%	9%	11%	3%	8%	10%	2%
Observations	66334	70695	403407	73468	78866	474952	70400	81237	546880

Notes: The Table reports summary statistics for firms which had relationships exclusively with *Distressed Banks* (D) or *Non Distressed Banks* (ND), as well as firms which have no identified bank relationship in 2004, 2006 and 2008. We exclude firms with total assets of less than £10,000. "Exit in 2 years" describes the percentage of firms which appear in the sample in year t, but subsequently drop out of the sample in year $t+1$ or $t+2$. "Exit in 4 years" is the percentage of firms which appear in the sample in year t, but subsequently drop out of the sample in year $t+1$,$t+2$, $t+3$ or $t+4$. A firm is defined as a "Start-up" if it is aged between 0 and 2 years and "Young" if it is aged between 0 and 5 years. A firm is defined as an "Exporter" is they report overseas turnover. The Credit Rating of each firm is based on the "Quiscore" assigned to a firm. The Quiscore is a number in the range 0-100 measuring the likelihood that a firm will fail in the next 12 months. Broadly the Quiscore can be split into 5 bands: 1-18 "High Risk", 19-36 "Caution", 37-56 "Normal", 57-81 "Stable", 82-99 "Secure" .

5 Exit Dynamics- Empirical Specification

In our baseline empirical framework, we seek to explore how the probability of firm exit is affected by credit constraints, controlling for industry and firm characteristics. Our key identifying assumption is that trends in exit probabilities are the same among firms which have relationships with $Distressed\,Banks$ as firms which have relationships with $Non\,Distressed\,Banks$ in the absence of changes in the supply of credit following the financial crisis.

In our baseline specification, we use a linear probability model to investigate whether having a relationship with a $Distressed\,Bank$ at time t affects the likelihood of exit in the subsequent period for firm i in industry j:

$$\begin{aligned} Y_{i,t} &= \gamma_j + X_{i,t}\kappa + \beta_1 \times Distressed\,Bank_{i,t} + \beta_2 \times Post\,Crisis_t \\ &\quad + \beta_3 \times Distressed\,Bank_{i,t} \times Post\,Crisis_t + \varepsilon_{i,t} \end{aligned} \tag{1}$$

where

$Y_{i,t}$	is an indicator variable equal to 1 if firm i subsequently exits in the specified time frame and 0 otherwise
γ_j	are industry fixed effects
$X_{i,t}$	is a matrix of controls for firm i at time t
$Distressed\,Bank_{i,t}$	is an indicator variable equal to one if all of the outstanding charges for firm i at time t are with a bank which became distressed during the financial crisis and 0 otherwise.
$Post\,Crisis_t$	is an indicator variable equal to 0 prior to 2008 and 1 otherwise.
$\varepsilon_{i,t}$	is an i.i.d. error term

We compare the difference in exit rates after the financial crisis between firms with $Distressed\,Banks$ and firms with $Non\,Distressed\,Banks$ with the difference in exit rates prior to the financial crisis. The coefficient of interest in Equation 1 is β_3 , which captures the change in the exit rate between the pre-crisis and post-crisis period for firms which had relationships with $Distressed\,Banks$ relative to the change experienced by firms which had relationships with $Non\,Distressed\,Banks$. A positive coefficient on β_3 would imply that the change in exit rates for firms which had relationships with $Distressed\,Banks$ between the pre-crisis and post-crisis period was higher than the change for firms which had relationships with $Non\,Distressed\,Banks$.

In using banking relationships which existed on the eve of the financial crisis as an exogenous source of credit constraints, we differ from the existing literature on the implications of credit constraints on firm exit. Eslava et al. (2010), for example, use a proxy for firm credit constraints, calculated by interacting a measure of the financial external dependence of an industry with a proxy for a firm's ability to access credit.

We consider how credit constraints impacted on the 2 year, 3 year and 4 year exit rates. We compare exit rates in a window prior to the crisis with exit rates at the same horizon following the crisis. Specifically, we compare the two year exit rate in 2006 (firms which are present in 2006 but exited between 2007-2008) with the two year exit rate in 2008 (firms which were present in 2008 but exited between 2009-2010).[13] We

[13]Given the way in which we assign firm accounts to years, detailed above, firms present in 2006 will include all firms filing

also compare the three year exit rate in 2005 (firms present in 2005 but exited between 2006-2008) with the three year exit rate in 2008 (firms present in 2008 but exited between 2009-2011) and the four year exit rate in 2004 (firms present in 2004 but exited between 2005-2008) with the four year exit rate in 2008 (firms present in 2008 but exited between 2009-2012).

The estimates from our difference in difference specification will be biased if we do not account for time-varying differences between firms with $Distressed\,Banks$ and firms with $Non\,Distressed\,Banks$ that are unrelated to the tightening in credit conditions. To overcome this concern, we control for a number of firm characteristics, given by $X_{i,t}$ in our specification. In our baseline analysis, we control for the age of the firm, the length of a firm's banking relationship, whether a firm is foreign owned, whether a firm is an exporter, the credit score grouping of the firm, whether the firm has had any county court judgements in the past two years, the size of the firm given by the quintile of the asset distribution it is in and the type of accounts the firm files.

6 Results

6.1 Baseline Results

The results from estimating our baseline specification are presented in Table 4. The first row of Table 4 reports estimates of β_1 and suggests that prior to the financial crisis, the probability of exit for firms which had relationships with $Distressed\,Banks$ was not significantly higher than the probability of exit for firms which had relationships with $Non\,Distressed\,Banks$. The second row reports estimates of β_2 and suggests that for firms which had relationships with $Non\,Distressed\,Banks$, the 3 year and 4 year exit probability was significantly higher following the financial crisis. The final row reports estimates of the coefficient of interest, β_3 , showing the change in exit probability following the financial crisis for firms attached to $Distressed\,Banks$ relative to the change for $Non\,Distressed\,Banks$. The change in the probability of exit at all three horizons is significantly higher for firms with $Distressed\,Banks$ following the crisis than for firms attached to $Non\,Distressed\,Banks$. The estimates suggest that the change in the probability of exit at the 2 year and 3 year horizon was around 0.6 percentage points higher for firms which had a relationship with $Distressed\,Banks$ relative to firms with $Non\,Distressed, Banks$ and the probability of exit within 4 years was around 0.8 percentage points higher. These effects on the probability of exit are modest but non-negligible. To provide some context for the magnitude of these effects, Table 3 shows that the average exit rate is around 10% at the 2 year horizon and 20% at the 4 year horizon.

6.2 Exit Dynamics and Financially Constrained Firms

Firms which were not highly leveraged may have been less susceptible to the tightening in credit conditions by banks following the financial crisis, while highly indebted firms may have been more constrained. To explore this, in Table 5 we consider whether the adverse impact of being attached to $Distressed\,Banks$ on the probability of firm exit differed depending on firm leverage.

We measure firm leverage as the ratio of total liabilities (current and non-current) to total assets[14]:

$$Leverage_{i,t} = \frac{Total\,Liabilities_{i,t}}{Total\,Assets_{i,t}}$$

We use our measure of firm leverage, $Leverage_{i,t}$, to divide our sample into quintiles. We then estimate our baseline specification, given by equation 1, allowing the key coefficients of interest β_1, β_2 and β_3 to differ

accounts between April 2006 and March 2007 and these firms are deemed to have exited within two years if they do not file accounts from April 2009 onwards. We address the concern that the tightening of credit conditions associated with the financial crisis may have already been experienced by some firms before April 2009 in our robustness tests.

[14]We use total liabilities to calculate our measure of leverage because it is well reported across the size distribution of firms in our sample. However total liabilities will include liabilities which do not directly arise from financing activities, for example deferred taxes and pension liabilities, and are therefore less relevant when considering whether a firm is financially constrained.

Table 4: Effect of a Distressed Bank Relationship on Firm Exit

	(1)	(2)	(3)
	2 Year Exit	3 Year Exit	4 Year Exit
Distressed	-0.001	0.001	0.001
	(0.001)	(0.002)	(0.002)
Post-Crisis	-0.001	0.012***	0.026***
	(0.002)	(0.005)	(0.006)
Distressed * Post-Crisis	0.006***	0.006***	0.008***
	(0.001)	(0.002)	(0.002)
Industry Fixed Effects	Yes	Yes	Yes
Firm Controls	Yes	Yes	Yes
R-Squared	0.143	0.112	0.117
Observations	303953	300244	288648

Notes: The Table reports the empirical link between the probability of a firm exiting an industry and the banking relationships a firm has. In Column 1 we consider the probability of exit within two years for firms present in 2006 and 2008. The dependent variable in Column 1 is a dummy variable equal to one if the firm subsequently exits in the following 2 years. In Column 2 we consider the probability of exit within three years for firms present in 2005 and 2008. The dependent variable in Column 2 is a dummy variable equal to one if the firm subsequently exits in the following 3 years. In Column 3 we consider the probability of exit within four years for firms present in 2004 and 2008. The dependent variable in Column 3 is a dummy variable equal to one if the firm subsequently exits in the following 4 years. $Distressed$ is an indicator variable equal to one if a firm has all of its relationships with banks which became distressed during the financial crisis and zero otherwise. $Post-crisis$ is an indicator variable equal to one if the observation year is 2008 and zero otherwise. Both specifications include industry fixed effects and firm controls. Industry fixed effects at the 2-digit SIC code level. The firm controls included are $firm\,size$, (measured by the quintile in the distribution of total assets), $credit\,score$ (measured by the normal "Quiscore"), $county\,court\,judgements$ (measured by the number of county court judgments in the previous 2 years), whether a firm is a $recent\,start\,up$ (measured by whether a firm is aged between 0 and 2 years) and whether a firm is $young$ (measured by whether a firm is aged between 0 and 5 years). Robust standard errors, clustered at the industry level, in parentheses, where ***, **, * shows significance at the 1%, 5% and 10% significance levels respectively.

depending upon the quintile of the firm leverage distribution a firm is in. Our specification is given by:

$$
\begin{aligned}
Y_{i,t,} = \gamma_j + X_{i,t}\kappa + & \sum_{k=1}^{5} \beta_{1,k}(Distressed\,Bank_i \times Lev_{i,k,t}) \\
& + \sum_{k=1}^{5} \beta_{2,k}(Post\,Crisis_t \times Lev_{i,k,t}) \\
& + \sum_{k=1}^{5} \beta_{3,k}(Distressed\,Bank_i \times Post\,Crisis_t \times Lev_{i,k,t}) + \varepsilon_{i,t}
\end{aligned} \tag{2}
$$

where

$Lev_{i,k,t}$ is an indicator variable equal to 1 if the leverage of firm i at time t is in quintile k of the leverage distribution and 0 otherwise.

The results suggest that the adverse effect of being attached to $Distressed\,Banks$ is predominantly felt by firms with high leverage. For firms in the lowest leverage quintile, the change in the exit probability following the crisis is not significantly different for firms attached to $Distressed\,Banks$ relative to the change for firms attached to $Non\,Distressed\,Banks$. In contrast, for firms in the highest leverage quintile, the change in the probability of exit following the crisis is significantly higher for firms attached to $Distressed\,Banks$ at all three horizons.

Table 5: Effect of a Distressed Bank Relationship on Firm Exit, by Leverage Quintile

	(1)	(2)	(3)
	2 Year Exit	3 Year Exit	4 Year Exit
Lowest Leverage Quintile 1			
Distressed	0.001	0.001	0.001
	(0.002)	(0.004)	(0.004)
Post-crisis	-0.009***	-0.025***	-0.044***
	(0.003)	(0.004)	(0.005)
Distressed * Post-Crisis	0.003	0.007	0.006
	(0.003)	(0.004)	(0.005)
Leverage Quintile 2			
Distressed	-0.002	0.001	0.004
	(0.003)	(0.003)	(0.003)
Post-Crisis	0.000	-0.007*	-0.012**
	(0.003)	(0.004)	(0.006)
Distressed * Post-Crisis	0.005**	0.003	0.003
	(0.003)	(0.005)	(0.004)
Leverage Quintile 3			
Distressed	0.002	0.006	0.004
	(0.003)	(0.004)	(0.005)
Post-Crisis	0.006*	0.015**	0.027***
	(0.003)	(0.006)	(0.008)
Distressed * Post-Crisis	0.003	0.000	0.003
	(0.003)	(0.003)	(0.005)
Leverage Quintile 4			
Distressed	0.000	-0.003	-0.009
	(0.005)	(0.006)	(0.006)
Post-Crisis	0.007	0.028***	0.047***
	(0.005)	(0.008)	(0.010)
Distressed * Post-Crisis	0.001	0.004	0.015**
	(0.005)	(0.006)	(0.006)
Highest Leverage Quintile 5			
Distressed	-0.008**	-0.003	0.004
	(0.004)	(0.006)	(0.006)
Post-Crisis	-0.011***	0.038***	0.096***
	(0.004)	(0.007)	(0.008)
Distressed * Post-Crisis	0.015**	0.015***	0.013**
	(0.006)	(0.005)	(0.006)
Industry Fixed effects	Yes	Yes	Yes
Firm Controls	Yes	Yes	Yes
R-Squared	0.245	0.257	0.298
Observations	303953	300244	288648

The Table reports estimates of Equation 1, allowing the key coefficients of interest β_1, β_2 and β_3 to differ depending upon the quintile of the firm leverage distribution a firm is in. In Column 1 we consider the probability of exit within two years for firms present in 2006 and 2008. The dependent variable in Column 1 is a dummy variable equal to one if the firm subsequently exits in the following 2 years. In Column 2 we consider the probability of exit within three years for firms present in 2005 and 2008. In Column 3 we consider the probability of exit within four years for firms present in 2004 and 2008. *Distressed* is an indicator variable equal to one if a firm has all of its relationships with banks which became distressed during the financial crisis and zero otherwise. $Post - Crisis$ is an indicator variable equal to one if the observation year is 2008 and zero otherwise. All specifications include industry fixed effects and firm controls. Robust standard errors, clustered at the industry level, in parentheses, where ***, **, * shows significance at the 1%,5% and 10% significance levels respectively.

6.3 Exit Dynamics and Productivity

Standard models of firm dynamics suggest that in the absence of distortions, firms with a lower level of productivity should face a higher probability of exit (see, for example, Hopenhayn (1992) and the model presented in Section 2.1 without credit constraints). Furthermore, the "cleansing" view suggests that the

"weeding out" of inefficient firms is accentuated during recessions. Therefore, according to the "cleansing" view, the effect which being a low productivity firm has on the probability of firm exit should be magnified during recessions.

As discussed in our model of firm dynamics, if there are credit market frictions associated with recessions which are not limited to just the lowest productivity firms, then the "cleansing" effect may be weakened. If, for example, the most productive firms in an economy are also highly leveraged and susceptible to a tightening in credit conditions during a recession, then the "cleansing" effect may be distorted. In this section, we extend our baseline specification to consider how the results vary across the productivity distribution. We then consider whether variation in our results across the productivity distribution is the result of variation in the leverage of firms. We split the observations into productivity quintiles, based on a proxy for gross value added productivity given by:

$$Productivity_{i,t} = \frac{GVA_{i,t}}{Employees_{i,t}}$$

where $GVA_{i,t}$ is a proxy of gross value added in real terms given by the sum of a firm's reported $Profits$ and the $Cost\,Of\,Employees$, deflated by industry deflators. We use GVA deflators, published by the ONS at the two-digit and three-digit SIC code level. In requiring that firms report $Profits$, $Cost\,Of\,Employees$, and $Employees$ to calculate our measure of $Productivity$, the sample size in our productivity sample is considerably smaller than that considered in our baseline specification.

In Table 6, we present summary statistics for the firms in our productivity sample, split by whether they had exclusive relationships with $Distressed\,Banks$ or $Non\,Distressed\,Banks$. In the productivity sample, there is little difference between the credit profile and average size of firms with $Distressed\,Banks$ and firms with $Non\,Distressed\,Banks$. Relative to the full sample, summarised in Table 3, firms in the productivity sample on average are older, larger, have lower leverage ratios and are less likely to exit. This reflects the fact that the productivity sample is composed only of firms which report $Profits$, $Cost\,Of\,Employees$, and $Employees$ in their accounts. Smaller firms face less stringent reporting requirements (Table 1) and therefore are excluded from the sample.

In Figure 8 we compare the productivity distribution of exiting firms in the pre-crisis period with the post-crisis period. Figure 8 considers only firms which had outstanding bank charges and plots the productivity distribution, by quintile, of those firms which exited in the four years following 2004 and the four years following 2008. A slightly greater proportion of firms exiting in the four years after 2004 were in the lowest quintile of the productivity distribution than in the four years after 2008.

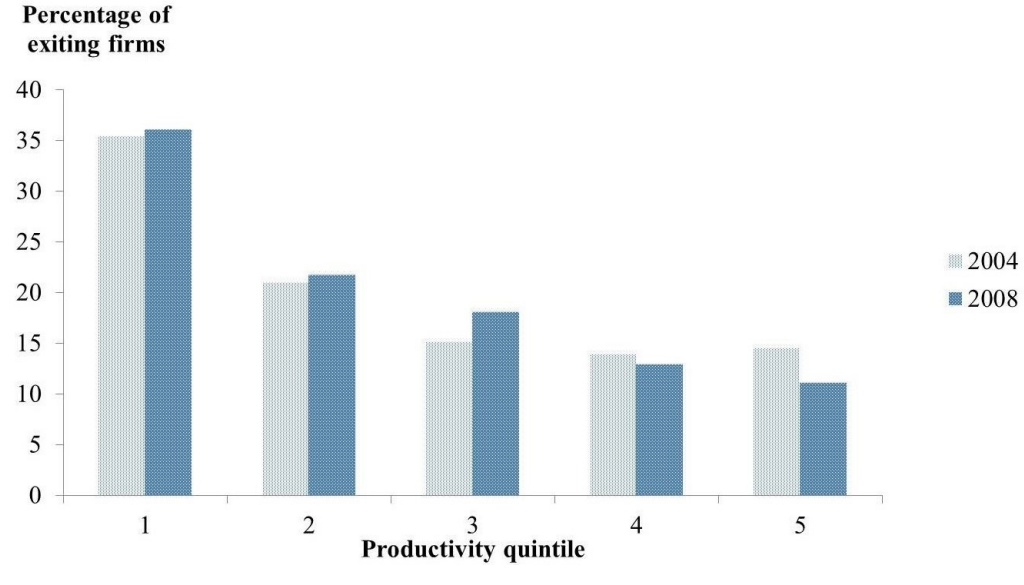
In Figures 9 and 10, we look separately at the productivity distribution of exiting firms for $Non\,Distressed\,Banks$ and $Distressed\,Banks$. For $Non\,Distressed\,Banks$, the percentage of firms exiting from the lowest productivity quintile was higher in the years following the financial crisis than in the years following 2004, consistent with the "cleansing view". In contrast, for $Distressed\,Banks$, the percentage of exiting firms which were in the lowest quintile was lower following the financial crisis.

Table 6: Summary Statistics for Productivity Sample, by Banking Relationship

	2004		2006		2008	
	ND	D	ND	D	ND	D
Exit in 2 Years	5%	5%	7%	7%	5%	5%
Exit in 4 years	12%	12%	13%	12%	10%	10%
Start-Up	6%	6%	4%	5%	4%	5%
Young	18%	19%	15%	16%	14%	15%
Foreign Owned	15%	14%	16%	15%	18%	17%
Exporter	19%	19%	19%	18%	21%	18%
Median Assets (£000)	3063	3245	3888	3974	4580	4646
Median Leverage Ratio	0.63	0.65	0.63	0.64	0.60	0.64
Credit Rating						
High Risk	7%	7%	1%	1%	1%	1%
Caution	20%	22%	3%	3%	2%	2%
Normal	26%	27%	10%	9%	7%	7%
Stable	23%	21%	15%	15%	15%	14%
Secure	22%	21%	68%	70%	74%	75%
Observations	4544	5602	4125	5289	3761	5110

Notes: The Table reports summary statistics for firms which had relationships exclusively with *Distressed Banks* (D) or *Non Distressed Banks* (ND) in our productivity sample. We exclude firms with total assets of less than £10,000 and firms which do not have exclusive banking relationships with *Distressed Banks* (D) or *Non Distressed Banks* (ND) . "Exit in 2 years" describes the percentage of firms which appear in the sample in year t, but subsequently drop out of the sample in year $t+1$ or $t+2$. "Exit in 4 years" is the percentage of firms which appear in the sample in year t, but subsequently drop out of the sample in year $t+1$,$t+2$, $t+3$ or $t+4$. A firm is defined as a "Start-up" if it is aged between 0 and 2 years and "Young" if it is aged between 0 and 5 years. A firm is defined as an "Exporter" is they report overseas turnover. The Credit Rating of each firm is based on the "Quiscore" assigned to a firm. The Quiscore is a number in the range 0-100 measuring the likelihood that a firm will fail in the next 12 months. Broadly the Quiscore can be split into 5 bands: 1-18 "High Risk", 19-36 "Caution", 37-56 "Normal", 57-81 "Stable", 82-99 "Secure" .

Figure 8: Productivity Distribution of Exiting Firms, by Productivity Quintile



The chart shows the distribution of exiting firms in the four years after 2004 and 2008, across the productivity distribution. The sum of the bars in any given year is 100%. We consider only those firms which had outstanding bank charges in either 2004 or 2008. The productivity distribution is split into quintiles, with "1" equal to the lowest quintile of the distribution in a given year and "5" equal to the highest quintile.

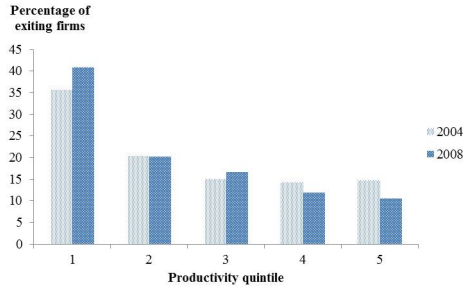


Figure 9: Firms which Exited and Banked with "Non-Distressed" Banks

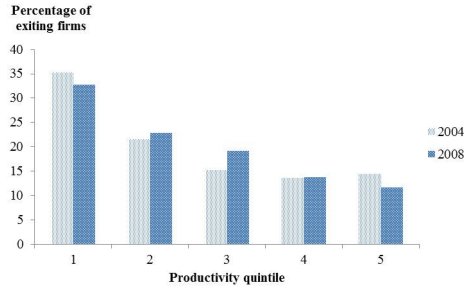


Figure 10: Firms which Exited and Banked with "Distressed" Banks

To explore empirically the impact of restricted credit availability on firms in our productivity sample, we first estimate our baseline specification, given by Equation 1, for just our productivity sample. The results, presented in Table 7, suggest that, for the productivity sample of firms, on average having a relationship with *Distressed Banks* did not significantly increase the probability of exit relative to firms with *Non Distressed Banks*. The coefficient on the interaction term between *Distresed Banks* and *Post Crisis* remains positive, but is not statistically significant. This contrasts with the baseline results presented for our larger sample in Table 4 which suggest that relationships with *Distressed Banks* significantly increased the probability of exit following the crisis. The lack of significance for the smaller productivity sample may reflect the fact that the sample is composed of firms which report $Profits$, $Cost Of Employees$, and $Employees$ and therefore on average tend to be larger in size and more established than firms in the baseline sample. As a result of being larger and more established, these firms may be less susceptible to a tightening in bank credit conditions. Alternatively, the reduced sample size of the productivity sample means the precision with which we can determine the coefficients of our model is less than for the full sample.

Table 7: Effect of a distressed bank relationship on firm exit, productivity sample

	(1)	(2)	(3)
	2 Year Exit	3 Year Exit	4 Year Exit
Distressed	-0.002	-0.002	-0.007
	(0.004)	(0.005)	(0.007)
Post-Crisis	-0.010**	0.013*	0.034***
	(0.004)	(0.006)	(0.009)
Distressed * Post-Crisis	0.008	0.003	0.011
	(0.007)	(0.008)	(0.011)
Industry Fixed Effects	Yes	Yes	Yes
Firm Controls	Yes	Yes	Yes
R-Squared	0.175	0.086	0.099
Observations	18284	18638	19016

Notes: The Table reports the empirical link between the probability of a firm exiting an industry and the banking relationships a firm has. In Column 1 we consider the probability of exit within two years for firms present in 2006 and 2008. The dependent variable in Column 1 is a dummy variable equal to one if the firm subsequently exits in the following 2 years. In Column 2 we consider the probability of exit within three years for firms present in 2005 and 2008. The dependent variable in Column 2 is a dummy variable equal to one if the firm subsequently exits in the following 3 years. In Column 3 we consider the probability of exit within four years for firms present in 2004 and 2008. The dependent variable in Column 3 is a dummy variable equal to one if the firm subsequently exits in the following 4 years. *Distressed* is an indicator variable equal to one if a firm has all of its relationships with banks which became distressed during the financial crisis and zero otherwise. $Post - crisis$ is an indicator variable equal to one if the observation year is 2008 and zero otherwise. Both specifications include industry fixed effects and firm controls. Industry fixed effects at the 2-digit SIC code level. The firm controls included are $firm\ size$, (measured by the quintile in the distribution of total assets), $credit\ score$ (measured by the normal "Quiscore"), $county\ court\ judgements$ (measured by the number of county court judgments in the previous 2 years), whether a firm is a $recent\ start\ up$ (measured by whether a firm is aged between 0 and 2 years) and whether a firm is $young$ (measured by whether a firm is aged between 0 and 5 years). Robust standard errors, clustered at the industry level, in parentheses, where ***, **, * shows significance at the 1%, 5% and 10% significance levels respectively.

To investigate whether restricted credit availability following the crisis distorted the difference in exit rates between high productivity and low productivity firms in our productivity sample, we interact the three key variables of interest in our baseline specification ($Distressed\,Bank$, $Post\,Crisis$ and $Post\,Crisis \times Distressed\,Bank$) with indicator variables for the productivity quintile a firm is in. We also continue to include industry fixed effects and firm specific controls.[15] Our specification is therefore given by:

$$\begin{aligned} Y_{i,t,} = \gamma_j + X_{i,t}\kappa + & \sum_{k=1}^{5} \beta_{1,k}(Distressed\,Bank_i \times Prod_{i,k,t}) \\ & + \sum_{k=1}^{5} \beta_{2,k}(Post\,Crisis_t \times Prod_{i,k,t}) \\ & + \sum_{k=1}^{5} \beta_{3,k}(Distressed\,Bank_i \times Post\,Crisis_t \times Prod_{i,k,t}) + \varepsilon_{i,t} \end{aligned} \tag{3}$$

where

$Prod_{i,k,t}$ is an indicator variable equal to 1 if the productivity of firm i at time t is in quintile k of the productivity distribution and 0 otherwise.

Table 8 reports the results from estimating equation 3, showing estimates of the coefficient of interest, $\beta_{3,k}$, for each productivity quintile k. We consider the impact of having a relationship with $Distressed\,Banks$ on the probability of exit at the 2 year (Column 1), 3 year (Column 2) and 4 year (Column 3) horizon.

The results reported in Table 8 suggest that the probability of exit for low productivity firms with $Distressed\,Banks$ was not adversely affected following the financial crisis relative to low productivity firms which were attached to $Non\,Distressed\,Banks$. For firms in the lowest productivity quintile, at the two year and three year horizon the change in exit probability was significantly lower for firms attached to $Distressed\,Banks$ relative to the change for firms attached to $Non\,Distressed\,Banks$. At both the two year and three year horizon, the change in exit probability was around 3-4 percentage points lower for firms attached to $Distressed\,Banks$.

[15] We also consider estimating the baseline specification separately for each productivity quintile, allowing for industry fixed effects which vary across quintile. This produces results which are qualitatively similar.

Table 8: Effect of a Distressed Bank Relationship on Firm Exit, by Productivity Quintile

	(1)	(2)	(3)
	2 Year Exit	3 Year Exit	4 Year Exit
Lowest Productivity Quintile			
Distressed	0.032**	0.023	0.012
	(0.012)	(0.014)	(0.017)
Post-Crisis	0.011	0.029*	0.052**
	(0.013)	(0.015)	(0.023)
Distressed * Post-Crisis	-0.036*	-0.033*	-0.020
	(0.018)	(0.018)	(0.032)
Productivity Quintile 2			
Distressed	-0.002	-0.009	-0.008
	(0.009)	(0.014)	(0.016)
Post-Crisis	-0.013	-0.003	0.031*
	(0.009)	(0.015)	(0.017)
Distressed * Post-Crisis	0.011	0.022	0.022
	(0.016)	(0.020)	(0.021)
Productivity Quintile 3			
Distressed	-0.019**	-0.002	-0.010
	(0.008)	(0.011)	(0.013)
Post-Crisis	-0.022***	0.015	0.035*
	(0.008)	(0.011)	(0.020)
Distressed * Post-Crisis	0.031***	0.017	0.025
	(0.011)	(0.016)	(0.017)
Productivity Quintile 4			
Distressed	-0.008	-0.009	-0.018*
	(0.009)	(0.009)	(0.009)
Post-Crisis	-0.011	0.007	0.019*
	(0.011)	(0.009)	(0.011)
Distressed * Post-Crisis	0.012	0.003	0.018
	(0.010)	(0.012)	(0.016)
Highest Productivity Quintile			
Distressed	-0.011	-0.010	-0.010
	(0.007)	(0.008)	(0.010)
Post-Crisis	-0.016**	-0.005	0.001
	(0.007)	(0.009)	(0.012)
Distressed * Post-Crisis	0.019*	0.011	0.014
	(0.010)	(0.010)	(0.014)
Industry Fixed Effects	Yes	Yes	Yes
Firm Controls	Yes	Yes	Yes
R-Squared	0.227	0.168	0.204
Observations	18284	18638	19016

The Table reports estimates of Equation 3. In Column 1 we consider the probability of exit within two years for firms present in 2006 and 2008. The dependent variable in Column 1 is a dummy variable equal to one if the firm subsequently exits in the following 2 years. In Column 2 we consider the probability of exit within three years for firms present in 2005 and 2008. In Column 3 we consider the probability of exit within four years for firms present in 2004 and 2008. *Distressed* is an indicator variable equal to one if a firm has all of its relationships with banks which became distressed during the financial crisis and zero otherwise. $Post - Crisis$ is an indicator variable equal to one if the observation year is 2008 and zero otherwise. All specifications include industry fixed effects and firm controls. Robust standard errors, clustered at the industry level, in parentheses, where ***, **, * shows significance at the 1%,5% and 10% significance levels respectively.

In contrast, there is evidence to suggest that at the two year horizon, relatively more productive firms were adversely affected by having relationships with *Distressed Banks*. For firms in the higher productivity quintiles (quintile 3 and quintile 5), the change in the probability of exit at the two year horizon following the financial crisis was significantly higher for firms attached to *Distressed Banks* than for firms attached to *Non Distressed Banks*. For example, for firms in the third quintile of the productivity distribution, the

change in the probability of exit within 2 years was around 3 percentage points higher for firms which had a relationship with *Distressed Banks* relative to firms with *Non Distressed, Banks*.

Overall, the results presented in Table 8 suggest that having a relationship with *Distressed Bank*s may have distorted the "cleansing" process of the financial crisis, particularly at the two year exit horizon, increasing the probability of exit for relatively more productive firms rather than for the least productive firms.

One possible explanation for this result, consistent with the model presented in Section 2.1, is that firms at the bottom of the productivity distribution are less reliant on external finance and so are not adversely affected by a tightening of credit conditions. If the most productive firms are those which typically are most reliant on external finance, as suggested by Barlevy (2003), we would expect a tightening of credit conditions to adversely affect the top end of the productivity distribution. An alternative explanation is one which is consistent with forbearance by banks on loans to less productive, "zombie" companies. If banks are unwilling to write-off bad loans to unproductive firms, these firms may not be susceptible to a tightening of credit constraints, whereas more productive firms may suffer.

To explore the hypothesis that our productivity results are driven by variation in the demand for external finance across productivity quintiles, we seek to control for the demand for external finance by comparing firms with similar leverage ratios. We split our sample by leverage ratio into three groups (terciles) and then reestimate our productivity specification for each leverage tercile. If our productivity results are driven by variation in the demand for external finance, we would not expect the adverse impact of being with *Distressed Banks* to be greater for more productive firms when we compare firms within the same leverage ratio tercile.

In Table 9 we estimate the probability of exit at the 2 year exit horizon and 4 year exit horizon across the productivity distribution for each of our three leverage terciles. For the lowest leverage tercile, firms with relationships with *Distressed Banks* do not face a significantly higher change in the probability of exit at the 2 year or 4 year horizon following the crisis than firms with *Non Distressed Banks* in any of the productivity quintiles. But at the two year horizon for the middle and highest leverage tercile, there is still evidence that having a relationship with *Distressed Banks* increased the probability of exit for firms in the middle of the productivity distribution. Furthermore, in the middle leverage tercile the results also suggest having a relationship with *Distressed Banks* increased the probability of exit at both horizons for relatively more productive firms.

Therefore while the productivity results in Table 8 may in part be explained by more productive firms being more dependent on external finance and therefore more vulnerable to a tightening in credit conditions, there is still evidence of a distortion in the "cleansing" process when we compare firms with similar leverage ratios. According to the "cleansing view", we would expect the probability of exit to be significantly higher for the least productive firms, independent of their leverage, however this is not observed.

Table 9: Effect of a Distressed Bank Relationship on Firm Exit, by Leverage and Productivity

	(1)	(2)	(3)	(4)	(5)	(6)
	Lowest Leverage Tercile		Middle Leverage Tercile		Highest Leverage Tercile	
	2 Year Exit	4 Year Exit	2 Year Exit	4 Year Exit	2 Year Exit	4 Year Exit
Lowest Productivity Quintile						
Distressed * Post-Crisis	0.008	-0.003	-0.032	0.015	-0.081**	-0.049
	(0.029)	(0.041)	(0.034)	(0.047)	(0.034)	(0.058)
Productivity Quintile 2						
Distressed * Post-Crisis	0.026	0.024	-0.014	0.012	0.019	0.018
	(0.024)	(0.025)	(0.023)	(0.031)	(0.040)	(0.040)
Productivity Quintile 3						
Distressed * Post-Crisis	0.005	-0.007	0.020	0.044*	0.069**	0.010
	(0.016)	(0.033)	(0.017)	(0.025)	(0.030)	(0.035)
Productivity Quintile 4						
Distressed * Post-Crisis	0.008	-0.008	0.026*	0.030	0.006	0.012
	(0.016)	(0.017)	(0.015)	(0.025)	(0.023)	(0.036)
Highest Productivity Quintile						
Distressed * Post-Crisis	0.011	-0.010	-0.006	0.005	0.054	0.044
	(0.015)	(0.022)	(0.022)	(0.024)	(0.035)	(0.041)
Industry Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes
Firm Controls	Yes	Yes	Yes	Yes	Yes	Yes
R-Squared	0.191	0.162	0.145	0.145	0.295	0.278
Observations	6032	6274	6034	6275	6218	6467

The Table reports estimates of Equation 3for each tercile of the leverage ratio distribution. In Columns 1 and 2 we consider the probability of exit within two years and four years for firms present in the lowest leverage tercile. In Columns 3 and 4 we consider the probability of exit within two years and four years for firms present in the middle leverage tercile. In Columns 5 and 6 we consider the probability of exit within two years and four years for firms present in the highest leverage tercile. *Distressed* is an indicator variable equal to one if a firm has all of its relationships with banks which became distressed during the financial crisis and zero otherwise. $Post - Crisis$ is an indicator variable equal to one if the observation year is 2008 and zero otherwise. All specifications include industry fixed effects and firm controls. Robust standard errors, clustered at the industry level, in parentheses, where ***, **, * shows significance at the 1%,5% and 10% significance levels respectively.

6.4 Robustness Checks

6.4.1 Non-linear Model

Our baseline analysis uses a linear probability model to consider the impact of a tightening in credit availability following the financial crisis. As a robustness check, we estimate a probit model, including the same controls as in our baseline specification in Equation (1).

In Table 10 , we report the marginal effect of interest, found by computing the cross differences of the expected probability of exit with respect to the treatment indicator and the post-crisis indicator.[16] The marginal effects are evaluated at the mean values of the other control variables. The results are significant and similar in magnitude to those presented in our baseline analysis, suggesting that the change in the probability of exit was significantly higher for firms with $Distressed\,Banks$ following the crisis than for firms attached to $Non\,Distressed\,Banks$.

6.4.2 Placebo Crises

Our difference in difference specification relies on the assumption of parallel pre-crisis trends in exit rates for firms which had relationships with $Distressed\,Banks$ and firms which had relationships with $Non\,Distressed\,Banks$. To provide evidence of parallel pre-crisis trends, we undertake placebo tests where we consider alternative placebo "crisis" periods. We explore the impact of having relationships with $Distressed\,Banks$ on the two year exit probability for two placebo "crises": 2004 and 2006, with the results presented in Table 11. We also

[16] See Ai and Norton (2003) for a discussion of interpreting interaction terms in probit models.

Table 10: Probit Model, Marginal Effects

	(1)	(2)	(3)
	2 year exit	3 year exit	4 year exit
Distressed * Post-crisis	0.006***	0.006***	0.008***
	[0.002]	[0.002]	[0.003]
Observations	302883	299213	288645

Notes: The Table reports the marginal effects from the probit representation of Equation (1) . The marginal effects are evaluated at the mean of the control variables. In Column 1 we consider the probability of exit within two years for firms present in 2006 and 2008. The dependent variable in Column 1 is a dummy variable equal to one if the firm subsequently exits in the following 2 years. In Column 2 we consider the probability of exit within three years for firms present in 2005 and 2008. The dependent variable in Column 2 is a dummy variable equal to one if the firm subsequently exits in the following 3 years. In Column 3 we consider the probability of exit within four years for firms present in 2004 and 2008. All specifications include industry fixed effects and firm controls. Industry fixed effects at the 2-digit SIC code level. The firm controls included are $firm\,size$, (measured by the quintile in the distribution of total assets), $credit\,score$ (measured by the normal "Quiscore"), $county\,court\,judgements$ (measured by the number of county court judgments in the previous 2 years), whether a firm is a $recent\,start\,up$ (measured by whether a firm is aged between 0 and 2 years) and whether a firm is *young* (measured by whether a firm is aged between 0 and 5 years). Robust standard errors, clustered at the industry level, in parentheses, where ***, **, * shows significance at the 1%, 5% and 10% significance levels respectively.

explore the impact on the three year exit rate, using 2005 as a placebo "crisis", with the results presented in Table 12.

In Table 11 we consider placebo "crises" for the two year exit probability. In column 1 we report the results from estimating the baseline specification for the two year exit probability, with 2002 as the control period and 2004 as the placebo "crisis" period. In column 2, we use 2004 as our control period and 2006 as our placebo "crisis" period. Finally, for comparison, in column 3 we reproduce our baseline result, in which the control period is 2006 and the true crisis period is 2008. We report the estimates for the coefficient on the interaction between having a relationship with $Distressed\,Banks$ and the placebo "crisis" period (β_3 in Equation 1). The results suggest that for the two placebo "crises" considered, having a relationship with $Distressed\,Banks$ did not significantly affect the probability of exit at the two year horizon. This contrasts with the true crisis period in which the results suggest that having a relationship with $Distressed\,Banks$ increased the probability of exit by around 0.6 percentage points.

In Table 12 we consider a placebo "crisis" for the three year exit probability. In column 1 we report the results from estimating the baseline specification with 2002 as the control period and 2005 as the crisis period. The results suggest that for the placebo "crisis", having a relationship with $Distressed\,Banks$ did not significantly increase the three year exit rate. In column 2 we reproduce our baseline result for the three year exit rate, in which the control period is 2005 and the true crisis period is 2008. In this case, having a relationship with $Distressed\,Banks$ significantly increased the probability of exit by around 0.6 percentage points.

Table 11: Placebo Crises, 2 Year Exit Rate

	(1) Placebo "Crisis"=2004	(2) Placebo "Crisis"=2006	(3) Actual Crisis=2008
Distressed * Placebo Crisis	-0.003	-0.003	0.006***
	(0.003)	(0.002)	(0.001)
Industry Fixed Effects	Yes	Yes	Yes
Firm Controls	Yes	Yes	Yes
R-Squared	0.088	0.113	0.143
Observations	267902	289347	303953

Notes: The Table reports the empirical link between the probability of a firm exiting an industry within 2 years and the banking relationships a firm has. In each specification, the dependent variable is a dummy variable equal to one if the firm subsequently exits in the following 2 years. In Column 1 we consider the probability of exit within two years for firms present in 2002 and 2004, where the placebo "crisis" is defined as 2004. In Column 2 we consider the probability of exit within two years for firms present in 2004 and 2006, where the placebo "crisis" is defined as 2006. In Column 3 we consider the probability of exit within two years for firms present in 2006 and 2008, where the actual crisis is defined as 2008, consistent with our baseline analysis. *Distressed* is an indicator variable equal to one if a firm has all of its relationships with banks which became distressed during the financial crisis and zero otherwise. "*Crisis*" is an indicator variable equal to one if the observation year is the "crisis" year and zero otherwise. All specifications include industry fixed effects and firm controls. Standard errors in parentheses, where ***, **, * shows significance at the 1%,5% and 10% significance levels respectively.

Table 12: Placebo crises, 3 year exit rate

	(1) Placebo "Crisis"=2005	(2) Actual Crisis=2008
Distressed * Placebo Crisis	-0.004	0.006***
	(0.004)	(0.002)
Industry Fixed Effects	Yes	Yes
Firm Controls	Yes	Yes
R-Squared	0.090	0.112
Observations	410379	300244

Notes: The Table reports the empirical link between the probability of a firm exiting an industry within 3 years and the banking relationships a firm has. In each specification, the dependent variable is a dummy variable equal to one if the firm subsequently exits in the following 3 years. In Column 1 we consider the probability of exit within two years for firms present in 2002 and 2005, where the "crisis" is defined as 2005. In Column 2 we consider the probability of exit within three years for firms present in 2005 and 2008, where the "crisis" is defined as 2008. *Distressed* is an indicator variable equal to one if a firm has all of its relationships with banks which became distressed during the financial crisis and zero otherwise. "*Crisis*" is an indicator variable equal to one if the observation year is the "crisis" year and zero otherwise. All specifications include industry fixed effects and firm controls.Standard errors in parentheses, where ***, **, * shows significance at the 1%, 5% and 10% significance levels respectively.

6.4.3 Definition of Treatment Group

In our baseline analysis, we divide our sample of firms into *Treatment* and *Control* groups based on which banks they had relationships with in 2008. We identify banking relationships using the annual accounts which firms file and we associate a firm's annual accounts with year t if it files its accounts between April of year t and March of year $t+1$, in line with the financial year in the UK. Therefore *Treatment* and *Control* groups are assigned using accounts filed between April 2008 and March 2009.

Given that the Bank Recapitalisation Scheme was announced in October 2008, it is possible that firms filing accounts after this time may have already adjusted to the distress experienced by some UK banks. For example, firms which were able to readily switch banking relationships may have switched away from the *Distressed Banks*. For robustness, we therefore repeat our analysis using lagged banking relationships to establish *Treatment* and *Control* groups. Our *Treatment* group now consists of firms which reported having relationships with just *Distressed Banks* in their accounts associated with the previous year (year $t-1$) . Our

control group consists of firms which reported having relationships with just *Non Distressed Banks* in their accounts from the previous year. We exclude from our sample firms which report having relationships with a combination of both *Distressed Banks* and *Non Distressed Banks* in their accounts from the previous year and we also exclude firms which do not have any identifiable relationships with banks.

In Table 13 we report the results from estimating our baseline specification using this new definition of our *Treatment* and *Control* groups. The change in the probability of exit remains significantly higher for firms with *Distressed Banks* following the crisis than for firms attached to *Non Distressed Banks* at all three horizons.

In Table 14 we report the results from estimating our productivity specification using our new definition of our *Treatment* and *Control* groups. Consistent with our main analysis, the results suggest that the probability of exit for low productivity firms which had a relationship with *Distressed Banks* was not adversely affected following the financial crisis relative to those firms which were attached to *Non Distressed Banks*. At the two and three year horizon, the change in the probability of exit following the crisis is significantly lower for firms in the lowest productivity quintile attached to *Distressed Banks*. In contrast, for firms in the highest productivity quintile the change in the probability of exit at the two year and three year horizon following the financial crisis was significantly higher for firms attached to *Distressed Banks* than for firms attached to *Non Distressed Banks*. At the four year horizon, the change in probability of exit was significantly higher for firms in the third and fourth quintiles which were attached to *Distressed Banks*.

Table 13: Effect of a Distressed Bank Relationship on Firm Exit, Alternative *Treatment* Group Definition.

	(1)	(2)	(3)
	2 Year Exit	3 Year Exit	4 Year Exit
Distressed	0.000	0.001	-0.000
	(0.002)	(0.003)	(0.002)
Post-Crisis	0.002	0.014***	0.024***
	(0.002)	(0.005)	(0.006)
Distressed * Post-Crisis	0.003*	0.006**	0.009***
	(0.002)	(0.002)	(0.003)
Industry Fixed Effects	Yes	Yes	Yes
Firm Controls	Yes	Yes	Yes
R-Squared	0.136	0.106	0.111
Observations	259413	249364	241088

Notes: The Table reports the empirical link between the probability of a firm exiting an industry and the banking relationships a firm has. In Column 1 we consider the probability of exit within two years for firms present in 2006 and 2008. The dependent variable in Column 1 is a dummy variable equal to one if the firm subsequently exits in the following 2 years. In Column 2 we consider the probability of exit within three years for firms present in 2005 and 2008. The dependent variable in Column 2 is a dummy variable equal to one if the firm subsequently exits in the following 3 years. In Column 3 we consider the probability of exit within four years for firms present in 2004 and 2008. The dependent variable in Column 3 is a dummy variable equal to one if the firm subsequently exits in the following 4 years. *Distressed* is an indicator variable equal to one if in the previous period (year $t-1$) the firm has all of its relationships with banks which became distressed during the financial crisis and zero otherwise. $Post-crisis$ is an indicator variable equal to one if the observation year is 2008 and zero otherwise. Both specifications include industry fixed effects and firm controls. Industry fixed effects at the 2-digit SIC code level. Robust standard errors, clustered at the industry level, in parentheses, where ***, **, * shows significance at the 1%, 5% and 10% significance levels respectively.

6.4.4 Weighted Regression

As noted above, one drawback of our productivity sample is that is limited to firms with banking relationships which report $Profits$, *Employees* and $Cost\,Of\,Employees$ in their annual statements. As a result, the sample is not representative of the population of firms which have banking relationships. In particular, the sample under-represents smaller firms which are not required to report detailed accounts.

To address this concern, we assign re-sampling weights to each firm-year observation which are based on the number of firms in each industry-size-bank group-year cell, following a similar procedure to Gal (2013).

Table 14: Effect of a Distressed Bank Relationship on Firm Exit, by Productivity Quintile. Alternative *Treatment* Group Definition

	(1)	(2)	(3)
	2 Year Exit	3 Year Exit	4 Year Exit
Lowest Productivity Quintile			
Distressed	0.033**	0.025	-0.002
	(0.013)	(0.017)	(0.021)
Post-Crisis	0.004	0.028	0.025
	(0.011)	(0.018)	(0.028)
Distressed * Post-Crisis	-0.033*	-0.039*	-0.002
	(0.017)	(0.021)	(0.039)
Productivity Quintile 2			
Distressed	-0.005	-0.009	-0.004
	(0.010)	(0.018)	(0.017)
Post-Crisis	-0.009	-0.001	0.032**
	(0.011)	(0.016)	(0.013)
Distressed * Post-Crisis	0.017	0.026	0.021
	(0.017)	(0.023)	(0.022)
Productivity Quintile 3			
Distressed	-0.007	-0.005	-0.015
	(0.010)	(0.011)	(0.014)
Post-Crisis	-0.017**	0.003	0.020
	(0.008)	(0.010)	(0.016)
Distressed * Post-Crisis	0.019	0.023	0.032**
	(0.015)	(0.017)	(0.015)
Productivity Quintile 4			
Distressed	-0.006	-0.009	-0.027***
	(0.010)	(0.009)	(0.009)
Post-Crisis	-0.016	-0.007	0.005
	(0.011)	(0.008)	(0.010)
Distressed * Post-Crisis	0.013	0.013	0.035*
	(0.010)	(0.010)	(0.018)
Highest Productivity Quintile			
Distressed	-0.015	-0.013	-0.010
	(0.009)	(0.011)	(0.013)
Post-Crisis	-0.022***	-0.020**	-0.005
	(0.008)	(0.010)	(0.014)
Distressed * Post-Crisis	0.027**	0.022*	0.018
	(0.012)	(0.012)	(0.017)
Industry Fixed Effects	Yes	Yes	Yes
Firm Controls	Yes	Yes	Yes
R-Squared	0.203	0.150	0.186
Observations	15183	15247	15668

The Table reports estimates of Equation 3. In Column 1 we consider the probability of exit within two years for firms present in 2006 and 2008. The dependent variable in Column 1 is a dummy variable equal to one if the firm subsequently exits in the following 2 years. In Column 2 we consider the probability of exit within three years for firms present in 2005 and 2008. In Column 3 we consider the probability of exit within four years for firms present in 2004 and 2008. *Distressed* is an indicator variable equal to one if in the previous period (year $t-1$) the firm has all of its relationships with banks which became distressed during the financial crisis and zero otherwise. $Post-crisis$ is an indicator variable equal to one if the observation year is 2008 and zero otherwise. Both specifications include industry fixed effects and firm controls. Robust standard errors, clustered at the industry level, in parentheses, where ***, **, * shows significance at the 1%,5% and 10% significance levels respectively.

The weights scale up the observations in the productivity sample so that they match the number of firms in each industry-size-bank group-year cell in our baseline sample of firms.[17] The implicit assumption made is that firms in the productivity sample within a given industry-size-bank group-year cell are representative of the population within that cell. Using these weights, we then estimate our productivity specification, given by Equation 3.

Consistent with the unweighted results, the weighted results reported in Table 15 suggest that for the lowest productivity firms there was no adverse impact of having a relationship with *Distressed Banks* following the financial crisis. In contrast, at the two year horizon, for firms in the middle quintile of the productivity distribution the probability of exit was adversely affected for firms with *Distressed Banks* relative to firms with *Non Distressed Banks*. At the three year horizon, the probability of exit was also adversely affected for the most productive firms (quintile 5) with *Distressed Banks* relative to *Non Distressed Banks* .

The results therefore reinforce the qualitative conclusion from the unweighted analysis that having a relationship with *Distressed Bank*s did not adversely affect the probability of exit for the least productive firms, but for relatively more productive firms relationships with *Distressed Banks* increased the probability of exit .

[17] We assume that our baseline sample is representative of the population of UK firms with banking relationships. We take our baseline sample and divide it into cells which count the number of firms by year, industry (using 1 digit SIC codes), three size groups (using terciles of the distribution of total assets) and bank group (using *Distressed Banks* and *Non Distressed Banks*). We also divide our productivity sample into the same cells and calculate re-sampling weights using the number of firms in each cell for the baseline sample relative to the productivity sample. Given the relatively low number of observations in some 1 digit SIC code groups, we group SIC codes 1,2, 3 and 4 together and group SIC codes 5 and 6 together.

Table 15: Weighted regression. Effect of a distressed bank relationship on firm exit, by productivity quintile

	(1)	(2)	(3)
	2 year exit	3 year exit	4 year exit
Lowest Productivity Quintile			
Distressed	0.017	-0.038	-0.022
	(0.016)	(0.029)	(0.025)
Post-crisis	-0.006	0.027	0.040
	(0.025)	(0.034)	(0.040)
Distressed * Post-crisis	-0.003	0.028	0.024
	(0.031)	(0.043)	(0.054)
Productivity Quintile 2			
Distressed	-0.003	0.015	-0.032
	(0.024)	(0.029)	(0.030)
Post-crisis	-0.026	0.015	0.017
	(0.032)	(0.041)	(0.034)
Distressed * Post-crisis	0.016	-0.020	0.038
	(0.041)	(0.056)	(0.042)
Productivity Quintile 3			
Distressed	-0.015	-0.005	0.028
	(0.017)	(0.025)	(0.026)
Post-crisis	-0.027	-0.007	0.036
	(0.025)	(0.032)	(0.042)
Distressed * Post-crisis	0.058**	0.031	0.001
	(0.027)	(0.031)	(0.044)
Productivity Quintile 4			
Distressed	-0.003	0.008	-0.024
	(0.025)	(0.027)	(0.026)
Post-crisis	-0.036*	0.030	0.013
	(0.020)	(0.026)	(0.026)
Distressed * Post-crisis	0.033	-0.025	0.026
	(0.022)	(0.044)	(0.050)
Highest Productivity Quintile			
Distressed	-0.024	-0.025	-0.002
	(0.023)	(0.024)	(0.022)
Post-crisis	-0.064**	-0.061**	-0.074***
	(0.026)	(0.024)	(0.025)
Distressed * Post-crisis	0.039	0.056*	0.035
	(0.028)	(0.031)	(0.030)
Industry fixed effects	Yes	Yes	Yes
Firm controls	Yes	Yes	Yes
R-squared	0.276	0.252	0.298
Observations	18284	18638	19016

The Table reports estimates of Equation 3. Firm year observations are weighted to scale up the observations in the productivity sample so that they match the number of firms in each industry-size-bank group-year cell in our baseline sample of firms. In Column 1 we consider the probability of exit within two years for firms present in 2006 and 2008. The dependent variable in Column 1 is a dummy variable equal to one if the firm subsequently exits in the following 2 years. In Column 2 we consider the probability of exit within three years for firms present in 2005 and 2008. In Column 3 we consider the probability of exit within four years for firms present in 2004 and 2008. *Distressed* is an indicator variable equal to one if a firm has all of its relationships with banks which became distressed during the financial crisis and zero otherwise. $Post - crisis$ is an indicator variable equal to one if the observation year is 2008 and zero otherwise. Both specifications include industry fixed effects and firm controls. Robust standard errors, clustered at the industry level, in parentheses, where ***, **, * shows significance at the 1%,5% and 10% significance levels respectively.

6.4.5 Alternative Measure of Productivity

Given our productivity sample is limited to firms which report $Profits$, $Employees$ and $Cost\,Of\,Employees$, for robustness, we also use an alternative measure of productivity, $Productivity\_a$, given by the ratio of the proxy for real gross value added to the cost of employees:

$Productivity\_a_{i,t} = \frac{GVA_{i,t}}{Cost\,Of\,Employees}$

As noted by Giordano et al. (2015), since firms often do not report the number of $Employees$ when

they submit their accounts, scaling real gross value added by the $Cost\,Of\,Employees$ instead increases the sample size when investigating exit dynamics by productivity quintile.

Table 16 reports the results from estimating equation 3 using our alternative measure of productivity to define the productivity quintiles. Consistent with our initial analysis, the estimates obtained using our alternative measure of productivity, reported in Table 16, suggest that firms at the bottom of the productivity distribution were not adversely affected by being attached to $Distressed\,Banks$ following the financial crisis. For the least productive firms (quintile 1 of the distribution), at the two year and three year horizons the change in exit probability was significantly lower for firms attached to $Distressed\,Banks$ relative to the change for firms attached to $Non\,Distressed\,Banks$. But there is also less evidence that the most productive firms were adversely affected. At the two year horizon, firms with $Distressed\,Banks$ in the second productivity quintile faced a greater change in exit probability following the crisis than firms with $Non\,Distressed\,Banks$, but more productive firms were not adversely affected. At the three year and four year horizon, the exit probabilities were also not significantly different for relatively more productive firms which had relationships with $Distressed\,Banks$.

Table 16: Effect of a Distressed Bank Relationship on Firm Exit, Alternative Measure of Productivity

	(1)	(2)	(3)
	2 Year Exit	3 Year Exit	4 Year Exit
Lowest Productivity Quintile			
Distressed	0.010	0.036*	0.017
	(0.013)	(0.020)	(0.015)
Post-Crisis	-0.001	0.039***	0.057***
	(0.011)	(0.014)	(0.017)
Distressed * Post-Crisis	-0.027*	-0.056**	-0.018
	(0.015)	(0.024)	(0.021)
Productivity Quintile 2			
Distressed	-0.018	-0.015	-0.006
	(0.015)	(0.013)	(0.013)
Post-Crisis	-0.030***	0.007	0.031**
	(0.010)	(0.014)	(0.015)
Distressed * Post-Crisis	0.036**	0.028	0.032
	(0.017)	(0.025)	(0.020)
Productivity Quintile 3			
Distressed	0.006	-0.003	-0.007
	(0.008)	(0.010)	(0.012)
Post-Crisis	0.002	0.008	0.025**
	(0.011)	(0.013)	(0.012)
Distressed * Post-Crisis	-0.003	0.012	0.018
	(0.009)	(0.013)	(0.015)
Productivity Quintile 4			
Distressed	-0.008	-0.015	-0.026*
	(0.010)	(0.010)	(0.013)
Post-Crisis	-0.004	-0.005	0.010
	(0.009)	(0.010)	(0.014)
Distressed * Post-Crisis	0.007	0.017	0.025
	(0.010)	(0.014)	(0.020)
Highest Productivity Quintile			
Distressed	-0.015*	-0.015	-0.016
	(0.009)	(0.014)	(0.010)
Post-Crisis	-0.008	0.000	0.003
	(0.009)	(0.013)	(0.012)
Distressed * Post-Crisis	0.017	0.004	0.006
	(0.012)	(0.017)	(0.016)
Industry Fixed Effects	Yes	Yes	Yes
Firm Controls	Yes	Yes	Yes
R-Squared	0.247	0.234	0.272
Observations	23635	24282	24716

The Table reports estimates of Equation 3 using an alternative measure of productivity, $Productivity\_a$. In Column 1 we consider the probability of exit within two years for firms present in 2006 and 2008. The dependent variable in Column 1 is a dummy variable equal to one if the firm subsequently exits in the following 2 years. In Column 2 we consider the probability of exit within three years for firms present in 2005 and 2008. In Column 3 we consider the probability of exit within four years for firms present in 2004 and 2008. *Distressed* is an indicator variable equal to one if a firm has all of its relationships with banks which became distressed during the financial crisis and zero otherwise. $Post - crisis$ is an indicator variable equal to one if the observation year is 2008 and zero otherwise. All specifications include industry fixed effects and firm controls. Robust standard errors, clustered at the industry level, in parentheses, where ***, **, * shows significance at the 1%,5% and 10% significance levels respectively.

7 Conclusion

This paper suggests that credit constraints faced by UK firms following the financial crisis had a detrimental impact on their probability of survival and may have distorted the productivity distribution of exiting firms. Exploiting pre-crisis banking relationships as an exogenous source of credit constraints faced by firms, we

find that the change in the probability of exit following the financial crisis was higher for firms which were attached to banks which became distressed relative to the change for firms which were attached to non-distressed banks. Furthermore, we find that being attached to distressed banks did not adversely affect the probability of exit for the least productive firms, but increased the probability of exit for relatively more productive firms, implying the crisis may have had "scarring " as well as "cleansing" effects. Our results suggest that following the crisis some firms which were not in the lower tail of the productivity distribution may have been forced to exit their industry as a result of credit constraints.

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Appendix

A 1: Model of Firm Dynamics with Credit Constraints

A 1.1 Firm Maximisation Problem

As described in Section 2.1, upon entry, the problem of the firm is to choose its price, quantity and repayment to maximise profits subject to three constraints:

$$\max_{p(\varphi),q(\varphi),F(\varphi,d_i)} \pi(\varphi,d_i) = p(\varphi)q(\varphi) - \left[\frac{q(\varphi)}{\varphi} + (1-d_i)f + \lambda F(\varphi,d_i) + (1-\lambda)tf_e\right]$$

subject to

(1) $q(\varphi) = Q\left[\frac{p(\varphi)}{P}\right]^{-\sigma}$

(2) $F(\varphi,d_i) \leq p(\varphi)q(\varphi) - \frac{q(\varphi)}{\varphi} - (1-d_i)f$

(3) $d_i f \leq \lambda F(\varphi,d_i) + (1-\lambda)tf_e$

We assume perfect competition among financial intermediaries, such that constraint (3) binds with equality. Substituting this and constraint (1) into the profit condition and assuming that constraint (2) does not bind suggests that the firm's problem simplifies to:

$$\max_{p(\varphi)} \pi(\varphi) = Q\frac{p(\varphi)^{1-\sigma}}{P^\sigma} - \left[\frac{Q}{\varphi}\left[\frac{p(\varphi)}{P}\right]^{-\sigma} + f\right]$$

The first order condition for the firm implies that firms set prices as a markup over their variable costs, as in the standard closed economy version of Melitz (2003):

$$p(\varphi) = \frac{\sigma}{(\sigma-1)\varphi} = \frac{1}{\rho\varphi}$$

Hence firm profits are given by:

$$\pi(\varphi) = \frac{r(\varphi)}{\sigma} - f$$

A 1.2 Productivity Thresholds

Upon entry, firms will choose to produce providing that their productivity, φ , is sufficiently large to ensure that profits are non-negative, $\pi(\varphi) \geq 0$ and constraint (2) is satisfied. Using constraint (3), constraint (2) can be expressed as:

$$(1-\lambda)(F - tf_e) \leq \pi(\varphi)$$

If the repayment F is greater than the collateral available to be seized, tf_e , then constraint (2) is more stringent on required productivity than the non-negative profits condition and will bind first. This will be the case if the upfront fixed cost requirement is sufficiently large :

$$d_i f \geq tf_e$$

If the upfront fixed cost requirement is sufficiently large, we can define a productivity threshold for each level of d_i, $\varphi^*_{d_i}$, such that constraint (2) binds with equality. Firms with an upfront fixed cost requirement d_i and a productivity level below the associated threshold will not produce. The threshold is given by:

$$f\left(1 - d_i + \frac{d_i}{\lambda}\right) - \frac{(1-\lambda)tf_e}{\lambda} = \frac{r(\varphi^*_{d_i})}{\sigma}$$

$$f + \frac{1-\lambda}{\lambda}(d_i f - t f_e) = \frac{r(\varphi^*_{d_i})}{\sigma}$$

If however the upfront fixed cost requirement is small, such that $d_i f < t f_e$, then the non-negative profits condition binds before constraint (2). In this case, the productivity threshold, $\varphi^*_{d_i}$, is given by:

$$f = \frac{r(\varphi^*_{d_i})}{\sigma}$$

A 1.3 Relative Threshold Condition

Using the expression for the ratio of expenditures, we can also obtain an expression for the relationship between the threshold productivity for firms facing a high upfront fixed cost, $\varphi^*_{d_H}$, and the threshold productivity for firms facing a low upfront fixed cost, $\varphi^*_{d_L}$.

$$r(\varphi^*_{d_H}) = \left(\frac{\varphi^*_{d_H}}{\varphi^*_{d_L}}\right)^{\sigma-1} r(\varphi^*_{d_L})$$

Assuming that the upfront fixed cost requirements are sufficiently large, the relative threshold condition is given by:

$$\left(\frac{\varphi^*_{d_H}}{\varphi^*_{d_L}}\right) = \left(\frac{f+\frac{1-\lambda}{\lambda}(d_H f - t f_e)}{f+\frac{1-\lambda}{\lambda}(d_L f - t f_e)}\right)^{\frac{1}{\sigma-1}}$$

A 1.4 Cutoff Profit Conditions

We can define a weighted average of productivity for firms which have a high upfront fixed cost requirement, given by $\tilde{\varphi}_{d_H}$, and for firms which have a low upfront fixed cost requirement, given by $\tilde{\varphi}_{d_L}$:

$$\tilde{\varphi}_{d_H} = \left[\int_{\varphi^*_{d_H}}^{\infty} (\varphi)^{\sigma-1} \frac{g(\varphi)}{1-G(\varphi^*_{d_H})} d\varphi\right]^{\frac{1}{\sigma-1}}$$

$$\tilde{\varphi}_{d_L} = \left[\int_{\varphi^*_{d_L}}^{\infty} (\varphi)^{\sigma-1} \frac{g(\varphi)}{1-G(\varphi^*_{d_L})} d\varphi\right]^{\frac{1}{\sigma-1}}$$

We can express the revenue of a firm which has productivity equal to the weighted average productivity as:

$$r(\tilde{\varphi}_{d_i}) = \left(\frac{\tilde{\varphi}_{d_i}}{\varphi^*_{d_i}}\right)^{\sigma-1} r(\varphi^*_{d_i})$$

Hence the profit of a firm with productivity equal to the weighted average productivity is given by:

$$\pi(\tilde{\varphi}_{d_i}) = \frac{1}{\sigma}\left(\frac{\tilde{\varphi}_{d_i}}{\varphi^*_{d_i}}\right)^{\sigma-1} r(\varphi^*_{d_i}) - f$$

If the upfront fixed cost is sufficiently large such that constraint 2 binds, then:

$$f + \frac{1-\lambda}{\lambda}(d_i f - t f_e) = \frac{1}{\sigma} r(\varphi^*_{A_i})$$

Hence

$$\pi(\tilde{\varphi}_{d_i}) = \left(f + \frac{1-\lambda}{\lambda}(d_i f - t f_e)\right)\left(\frac{\tilde{\varphi}_{d_i}}{\varphi^*_{d_i}}\right)^{\sigma-1} - f$$

In the case where there are no financing frictions ($\lambda = 1$) then the cutoff condition reduces to the "zero cutoff profit condition" in the benchmark Melitz (2003) closed economy model, given by:

$$\pi(\tilde{\varphi}_{d_i}) = f\left(\left(\frac{\tilde{\varphi}_{di}}{\varphi^*_{d_i}}\right)^{\sigma-1} - 1\right)$$

Alternatively, if the upfront cost is small, such that $d_i f < t f_e$, then the non negative profit condition binds before constraint 2 and it can be shown that the cutoff condition is then also given by the "zero cutoff profit condition".

A 1.4 Free Entry Condition

Once a firm has entered, we assume each period they face an exogenous probability δ of exit. The value of entry is therefore given by:

$$v_e = \chi\left(1 - G(\varphi^*_{d_H})\right)\left(\frac{\pi(\tilde{\varphi}_{d_H})}{\delta}\right) + (1-\chi)\left(1 - G(\varphi^*_{d_L})\right)\left(\frac{\pi(\tilde{\varphi}_{d_L})}{\delta}\right) - f_e$$

Given free entry, in equilibrium the value of entry is equal to zero: $v_e = 0$. Hence:

$$\chi\left(1 - G(\varphi^*_{d_H})\right)\pi(\tilde{\varphi}_{d_H}) + (1-\chi)\left(1 - G(\varphi^*_{d_L})\right)\pi(\tilde{\varphi}_{d_L}) = \delta f_e$$

A 1.5 Solving the Model

Together the two cutoff profit conditions, the relative cutoff condition and the free entry condition provide four equations with four unknowns ($\varphi^*_{d_H}$ $\varphi^*_{d_L}$ $\pi(\tilde{\varphi}_{d_H})$ $\pi(\tilde{\varphi}_{d_L})$). We can use these four equations, summarised below, to solve for the productivity cutoffs of firms which face a high upfront fixed and firms which face a low upfront fixed cost and their average profits.

(1) $\left(\frac{\varphi^*_{d_H}}{\varphi^*_{d_L}}\right) = \left(\frac{f + \frac{1-\lambda}{\lambda}(d_H f - t f_e)}{f + \frac{1-\lambda}{\lambda}(d_L f - t f_e)}\right)^{\frac{1}{\sigma-1}}$

(2) $\pi(\tilde{\varphi}_{d_H}) = \left(f + \frac{1-\lambda}{\lambda}(d_H f - t f_e)\right)\left(\frac{\tilde{\varphi}_{d_H}}{\varphi^*_{d_H}}\right)^{\sigma-1} - f$

(3) $\pi(\tilde{\varphi}_{d_L}) = \left(f + \frac{1-\lambda}{\lambda}(d_L f - t f_e)\right)\left(\frac{\tilde{\varphi}_{d_L}}{\varphi^*_{d_L}}\right)^{\sigma-1} - f$

(4) $\chi\left(1 - G(\varphi^*_{d_H})\right)\pi(\tilde{\varphi}_{d_H}) + (1-\chi)\left(1 - G(\varphi^*_{d_L})\right)\pi(\tilde{\varphi}_{d_L}) = \delta f_e$

A 1.6 Calibration

So that we can illustrate comparative statics, we calibrate the model, closely following the approach of Melitz and Redding (2013). The elasticity of substitution between firm varieties is set as $\sigma = 4$. We assume that firm productivity follows a Pareto distribution, such that:

$$G(\varphi) = \begin{cases} 1\text{-}(\frac{\varphi_{min}}{\varphi})^k & \varphi \geq \varphi_{min} \\ 0 & otherwise \end{cases}$$

The Pareto shape parameter is set as $k = 4.25$ and we set φ_{min} equal to one. The probability of firm exit is set as $\delta = 0.025$. The fixed entry cost is set as $f_e = 1$ with the fraction which can be seized as collateral set as $t = 0.1$. The fixed cost of production is set as $f = 0.2$. The high upfront fixed cost requirement is set as $d_H = 0.9$ and the low upfront fixed cost requirement is set as$d_L = 0.55$, with the probability of a the high upfront fixed cost requirement set as $\chi = 0.5$. In the illustrative example of a tightening of credit constraints in Figure 2, we consider how the cumulative distribution function (cdf) of productivity levels in the economy changes as λ decreases from $\lambda_1 = 0.7$ to $\lambda_2 = 0.5$.