Distressed Banks, Distorted Decisions? *

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Exploiting differences in pre-crisis business banking relationships, we present evidence to suggest that restricted credit availability following the 2008 financial crisis increased the rate of business failure in the United Kingdom. But rather than "cleansing" the economy by accelerating the exit of the least productive businesses, we find that tighter credit conditions resulted in some businesses failing despite being more productive than their surviving competitors. We also find evidence that distressed banks protected highly leveraged, low productivity businesses from failure.

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1 Introduction

As is well known, recovery from the recessions that occurred across advanced economies in the wake of the global financial crisis of 2008 was associated with dismal productivity growth. While the cause of the weakness in productivity is not well understood, one possible contributing factor is the apparent intensification of credit market imperfections that lasted for a number of years after the crisis. Weaker productivity growth clearly coincided with more intense credit frictions in the United Kingdom. By 2013, UK productivity had fallen to around 15% below a continuation of its pre-crisis trend. At the same time, the stock of real bank debt owed by UK corporations was more than 20% below its pre-crisis peak, in part reflecting a tightening of credit supply, at least in the immediate aftermath of the crisis (Bell & Young, 2010).

In this paper we investigate some of the channels by which an intensification of credit market imperfections might have contributed to productivity weakness. We focus on how distortions in bank lending markets due to the financial crisis affected the exit rates of different UK businesses. In particular, we provide evidence that credit distortions interfered with the capital allocation process and caused some businesses to fail despite being more productive than their surviving competitors.

Normally, one of the key drivers of aggregate productivity improvements over time is the process whereby more productive firms gain market share and less productive firms lose market share or go out of business altogether; see, for example, Foster et al. (2001) and Baily, Bartelsman & Haltiwanger (2001) for the US, and Disney et al. (2003) for the UK. In a typical 'cleansing' recession, this reallocation process might be accelerated, freeing resources to be used more productively elsewhere (Schumpeter (1934); Caballero and Hammour (1994)). But this reallocation process might be hindered or even reversed in banking crises if the key mechanisms through which productivity growth normally arises are distorted. For example, 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 that 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") whose expansion would be impeded by credit market imperfections.

An additional channel through which financial crises might dampen the cleansing process of recessions is through increased forbearance by banks. Banks with weak balance sheets may be unwilling to crystalise losses on loans and so continue to support a number of low productivity "zombies" that would otherwise have gone out of business (see, for example, Peek and Rosengren (2003) and Caballero et al. (2008)). For the UK, Arrowsmith et al. (2013) present evidence to suggest that the major banks engaged in some loan forbearance in the aftermath of the financial crisis.

We use a quasi-experimental approach to identify the impact of changes in credit market imperfections. As we document later in this paper, the UK banking system is highly concentrated. Four banking groups account for around 80% of business current accounts. Moreover, typical business banking relationships are long term and it is rare for businesses either to borrow from more than one lender or to switch from one lender to another. The financial crisis impacted all UK banks to some extent, but dramatically affected two large banks accounting for around half of bank lending to UK businesses in particular: Lloyds Banking Group and Royal Bank of Scotland both required public injections of capital in order to survive. The differential experience of these banks and their customers provides a natural experiment by which to assess the effects of stress among banks on their business customers.

We use UK company-level information on business banking relationships to identify the impact of credit market imperfections 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 established prior to the crisis. Specifically, we gauge the importance of credit imperfections on company survival, comparing whether the exit rate 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 companies that had established relationships with *Distressed Banks* prior to the crisis had a higher probability of going out of business after the financial crisis than firms which had relationships solely with *Non Distressed Banks*. Furthermore, the impact of being attached to *Distressed Banks* was not uniform 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*. Indeed there is some evidence that the least productive businesses had a better chance of survival with *Distressed Banks*, consistent with them supporting zombie businesses. But for relatively more productive firms, the probability of exit was adversely affected by being with *Distressed Banks*. This suggests that the intensification of credit market imperfections following the financial crisis distorted the possible "cleansing" effect of the recession. We also present a highly stylised theoretical model that helps explain why credit market imperfections might impinge particularly on businesses in the middle of the productivity distribution.

The evidence we present in this paper contributes to a better understanding of the causes of strikingly weak performance of the United Kingdom economy following the global financial crisis. By drawing attention to the role of an intensification of credit market imperfections in this process we contribute to a growing post-financial crisis literature that is more widely applicable outside of just the UK context.

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. (2018) show that concerns about the solvency of Spanish banks during the financial crisis negatively impacted firm employment. A separate literature explores 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.

Recent empirical studies have found some support for the view that credit market imperfections 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 financial crisis 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 a shift in credit conditions. But rather than using only proxies to identify credit conditions, we instead exploit an exogenous source of variation in credit conditions 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. (2018) 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.[1] As far as we are aware, ours is the first study to explore the effect of changing credit conditions on exit dynamics for UK firms 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.

The layout of the paper is as follows. Section 2 sets out a theoretical framework for considering how credit imperfections 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. Section 6 reports estimation results and robustness tests. Section 7 concludes.

2 A Model of Firm Dynamics

Our focus is on how credit market imperfections distort the decisions that affect exit dynamics. 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)). By introducing heterogeneous credit demand into a workhorse model, we show that this result does not necessarily hold when there are credit frictions. While the model is simplistic in a number of its assumptions, it illustrates how augmenting a workhorse heterogeneous firm productivity model with a financial 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. 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.

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.

2.1 Producers

In this model, production is undertaken by a continuum of firms, each of which produces a variety. We assume that there is a large, unbounded pool of potential entrants each period. Entrants are required to pay a fixed entry cost before discovering their productivity level which is assumed to be drawn from a known probability distribution. The total operating cost of each firm has a fixed component and a variable component that depends on its productivity.

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

[1] 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.

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 paid upfront must be financed by borrowing from a financial intermediary.

2.2 Financial Frictions

We assume that credit market imperfections arise because of costly state verification and the possibility that borrowers may choose not to repay ex post what they agreed ex ante. The perception that loans may not be repaid gives rise to financial frictions that affect the ex ante cost of borrowing. In particular, the higher the perceived likelihood of default the more that producers have to promise to repay when they do not default.

The financial contract is such that at the beginning of the period producers contract with a financial intermediary by making a take-it or leave- it offer 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 $\lambda \leq 1$.[2] 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.[3]

2.3 Optimising Behavior

Upon entry, the firm faces the same problem each period, choosing its price, quantity and repayment to maximise profits subject to three constraints. These are: a) the demand for the firm's variety, derived from household utility maximization as shown in the Appendix; b) 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; and c) 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 that there is perfect competition among financial intermediaries, such that constraint c) binds with equality. Upon entry, firms will choose to produce providing that their productivity is sufficiently large to ensure that profits are non-negative and constraint b) 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 b) will be more stringent than the non-negative profit condition and as a result the productivity threshold will be higher. This means that firms will have different productivity thresholds depending on the size of the upfront fixed cost and the extent of credit frictions.

2.4 Solving the Model

In the Appendix we detail how we solve the model to find the two productivity thresholds, $\varphi^*_{d_L}$ and $\varphi^*_{d_H}$ that determine whether firms with low and high upfront fixed costs will exit the market. So that we can illustrate

[2] Manova (2013) argues that λ can reflect the sophistication/development of financial institutions.
[3] 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

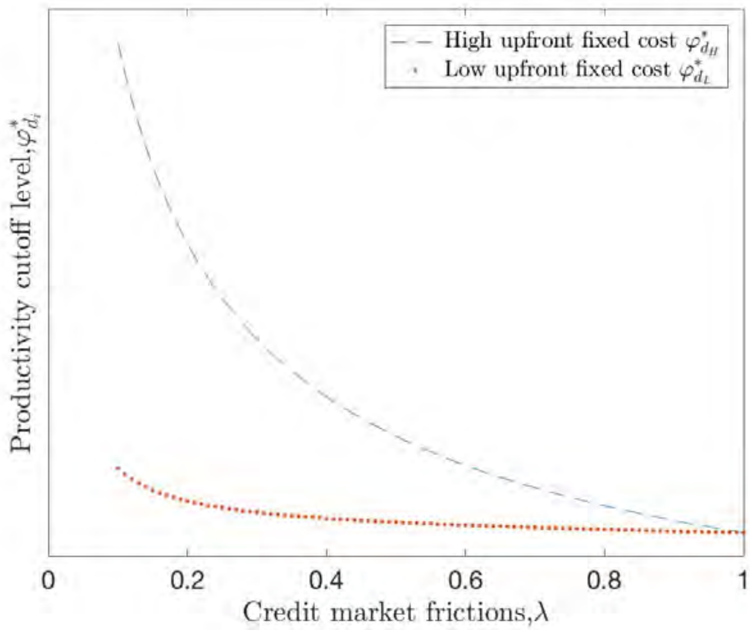


Figure 1 illustrates how the two productivity thresholds, $\varphi^*_{d_L}$ and $\varphi^*_{d_H}$ change as the size of the credit market friction, λ, varies. The calibration of the model is detailed in the Appendix. An increase in λ corresponds to a reduction in credit frictions.

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 are more restrictive as a result of a lower value of λ, the cutoff productivities are higher, meaning that some firms are now below their relevant cutoff productivity and choose to not produce anymore and exit immediately.

Using our calibrated 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.

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 for other 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,$\varphi^*_{d_H}$.

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. The higher are credit frictions (λ is smaller) the higher is the required productivity cutoff for firms which have to pay a high upfront fixed cost. 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 the level of credit frictions, since these firms are less reliant on obtaining finance from financial intermediaries to cover their fixed cost of production.

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

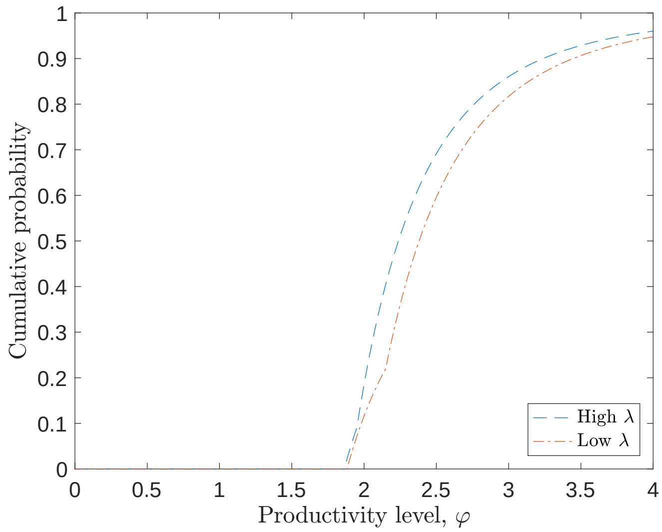


Figure 2 shows the cumulative distribution function of productivity levels for a high value of λ and a low value of λ. The calibration of the model is detailed in the Appendix. In this Figure, the high value of λ is equal to 0.7 and the low value of λ is equal to 0.5.

In Figure 2, we consider how the cumulative distribution function (cdf) of productivity levels in the economy is affected by the level of credit imperfections (modelled as variation in λ). Figure 2 illustrates that when credit frictions are 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 the level of 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 or exit is relatively insensitive to the intensity of credit conditions. This is not true of low liquidity firms that have to pay high upfront costs. More intense credit frictions affect firms which have to pay high upfront fixed costs more severely, leading to a much larger change in their productivity level cutoff, $\varphi^*_{d_H}$.

We can use this model to assess the impact of a tightening of credit conditions that affects the customers of only some of the financial intermediaries, consistent with the UK experience after the financial crisis. In the context of this model, we can think of the tightening of credit conditions as an increase in the amount that producers would have to pay lenders in states where they do not default. For this to have any effect it would need to be the case that producers are not able to switch to other lenders. As we describe later, there is clear evidence that switching is not easy in the UK. The tightening of credit conditions can then be characterized as a reduction in the value of λ for customers of the affected banks and a rightwards shift in the productivity distribution in Figure 2. The shift in the productivity distribution comes about because of the exit of customers with intermediate levels of productivity who stop production rather than pay the expected cost of the financial frictions.

In short, the model suggests that if the structure of the economy changes such that credit conditions 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 markets are already imperfect to some degree, firms with the very lowest productivity levels are relatively unaffected by a further tightening in credit conditions, 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 conditions will affect those firms with intermediate productivity levels which have high upfront costs to pay and so are dependent upon financial intermediaries.

3 Treatment and Control Groups

Following the approach used by Bentolila et al. (2018) 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 the financial reporting year 2008, at the onset of the financial crisis in the UK.

In our analysis, the $Treatment$ group consists of firms which have relationships with just $Distressed\, Banks$. The 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 around 80% of business current accounts: Barclays Bank, HSBC, Lloyds Banking Group (LBG) and the Royal Bank of Scotland Group (RBS).[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 tightened credit supply conditions by more than other lenders.

3.1.1 Drivers of the Credit Crunch

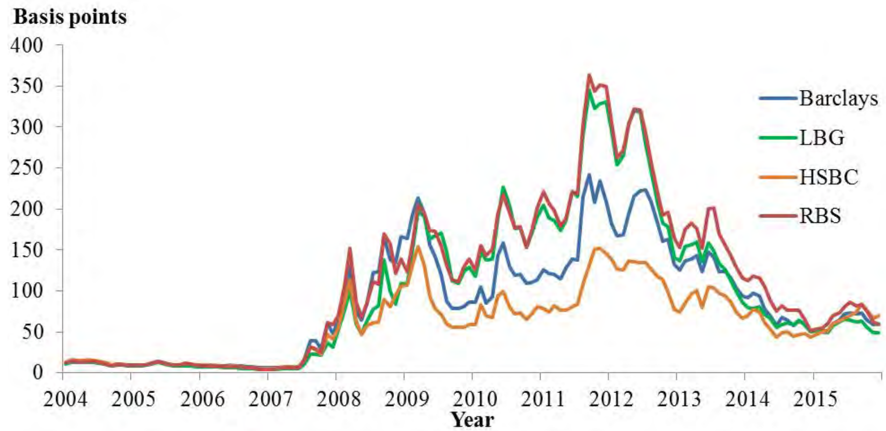
It is noteworthy that our $Treatment$ group is based on an outcome which is realized ex-post, following the financial crisis. Our identification strategy would be undermined if, prior to the crisis, firms anticipated which banks would

[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.

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 non-property corporate loan books of the major lenders (see Broadbent (2012)). The global financial crisis was triggered by emerging losses in the US sub-prime mortgage market. For example, in its 2008 accounts, RBS reported a credit trading loss of £12.2bn, while in the same year the impairment losses on non-property corporate lending were only £2.7bn.[7] 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 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

[7]See "The failure of the Royal Bank of Scotland", Financial Services Authority Board Report, December 2011.

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 was subsequently reduced after 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 that they had agreed with the government. 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' 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.[8]

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

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 *Distressed Banks* 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 would 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 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

Our source of firm-level data is the annual accounts filed by UK companies, accessed via the Financial Analysis Made Easy (FAME) dataset provided by Bureau van Dijk. In the UK, all limited and public limited companies are required to report accounts to Companies House. This includes basic balance sheet information reported by all UK companies.

While the FAME dataset contains information reported by all UK companies, this is quite limited for smaller companies to minimize their reporting burden. 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. This restricts some of our subsequent analysis to mainly larger companies.

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

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 survive over the following 12 months. Each firm is assigned a value between 0 and 100, with a larger value indicating a higher probability of survival. 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". There was a change in the methodology for calculating the credit rating in 2006. In particular, a larger proportion of firms with banking relationships were considered to have a "Normal" credit rating, and a smaller proportion had a "High risk", "Caution" or "Secure" rating. Given this, rather than using the credit rating directly in our analysis, we consider which quintile of the credit rating distribution a firm belongs to in any given year.

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 provides only a live snapshot of the information stored at Companies House. This means that information on variables such as company structure and director information is accurate only 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.[9]

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.[10] We exclude very small companies which report total assets of less than £10,000. Since only incorporated companies are required to file accounts with Companies House, the FAME dataset is not representative of sole-proprietorships and partnerships, and these are also excluded from our analysis.

4.2 Banking Relationships

In the UK, standard practice is for commercial lenders to use fixed and floating charge debentures as instruments for lending to limited companies. A charge is the security which companies are required to provide for a loan.[11] Registered companies are required to report charges/mortgages (hereafter 'charges') to Companies House within 21 days of their creation date. 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 an indicator of banking relationships. 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. Evidence suggests that using chargeholder names is a reliable indicator of banking relationships. As part of its 2013 investigation into SME forbearance (Arrowsmith et al. (2013)), the Bank of England was able to confirm that of 4,500 borrowers identified in this way for one bank, 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. We focus on a subsample of firms which have relationships exclusively with either $Distressed\,Banks$ or $Non\,Distressed\,Banks$. We deliberately exclude around three quarters of the companies in the FAME dataset that do not have any outstanding charges and a further 8% of companies that either have outstanding charges with a mixture of both $Distressed\,Banks$ or $Non\,Distressed\,Banks$ or with chargeholders that are not recognisable UK lenders. 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 subsample belonging to each of the four major banking groups. Just over half of the firms in the sample in any given year have relationships

[9] For a discussion of these issues using the global equivalent of the FAME dataset, see Kalemli-Ozcan et al. (2015).

[10] 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).

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

with *Distressed Banks* and of those firms the majority (around 90%) have relationships with either LBG or RBS. Of the firms attached to *Non Distressed Banks*, the majority have relationships with either Barclays or HSBC.

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 banking group belonging to the *Distressed Banks* group 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% and the switching rate at the 4 year horizon was just 9%, implying relationships tend to be very sticky.[12] 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.

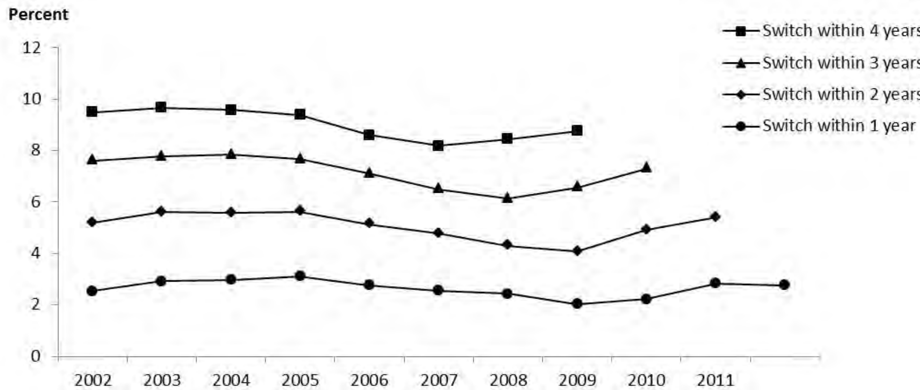
Table 2: Firms with Active Bank Relationships, by Banking Group

	2004	2005	2006	2007	2008	2009	2010	2011
Distressed								
LBG	17%	17%	17%	17%	17%	17%	17%	17%
RBS	31%	31%	31%	32%	33%	33%	33%	33%
Distressed Other	1%	1%	1%	1%	2%	2%	2%	2%
Distressed Mix	3%	3%	3%	3%	3%	3%	3%	3%
Total % Distressed	52%	52%	52%	53%	54%	55%	55%	55%
Non Distressed								
Barclays	18%	18%	17%	16%	16%	15%	15%	15%
HSBC	23%	23%	23%	22%	22%	21%	21%	20%
Non Distressed Other	4%	4%	4%	4%	4%	5%	5%	6%
Non Distressed Mix	4%	4%	4%	4%	4%	4%	4%	4%
Total % Non-Distressed	48%	48%	48%	47%	46%	45%	45%	45%
Observations	147,090	160,211	163,844	165,109	164,319	163,407	160,558	155,872

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*).

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

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* group) 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

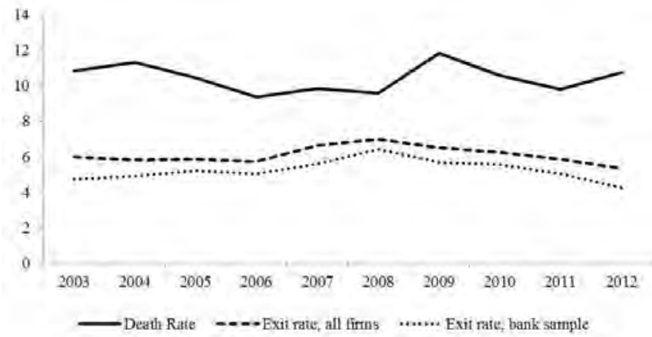
We begin by describing how firm exit rates evolved in the pre-crisis and post-crisis period. We consider firms which report annual accounts and have all of their outstanding charges with either *Distressed Banks* or *Non Distressed Banks*. For any given year, t , we consider firms which file accounts 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 have exited the sample in year t if the final accounts which the firm files are associated with year $t-1$.

In Figure 5 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 when it 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 5 shows that the death rate reported by the ONS tends to be 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 the FAME exit rates, it is notable 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 subsequently receded.[13] In our FAME sample exit rates increase modestly in 2008 before receding.

[13] Barnett et al. (2014) document how the increase in firm deaths in the financial crisis was very modest in comparison to increases in the 1980s and 1990s.

Figure 5: 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 $x-1$.

The chart shows that roughly 5% of all firms with a bank lending relationship in existence in one year had gone out of business by the next year. It is important to note that firms may exit for a variety of reasons, some of which may not be related to business failure. 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.[14]

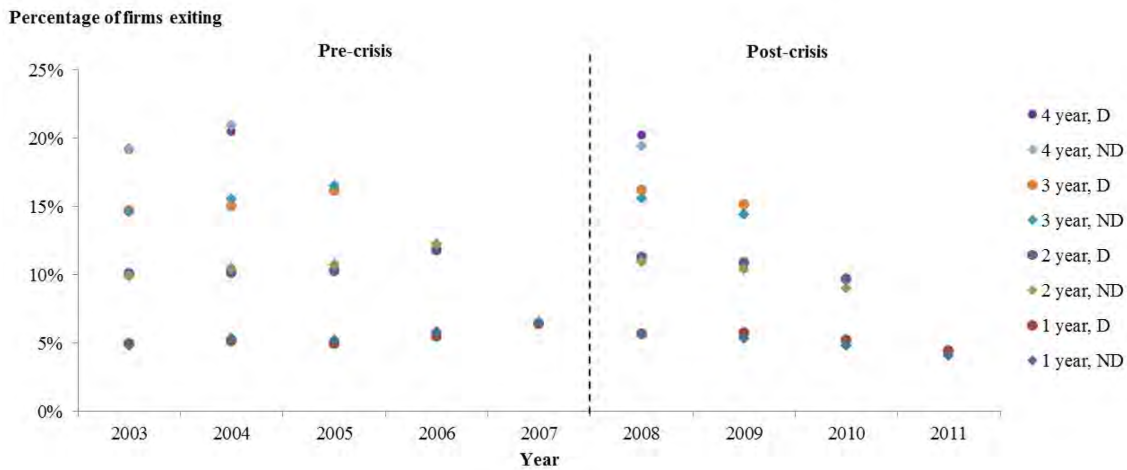
Figure 6 plots the share of firms which exited within 1 year, 2 years, 3 years and 4 years over the period 2003-2011, split by whether the firm had exclusive relationships with $Distressed\,Banks$ or $Non\,Distressed\,Banks$. The figure excludes observations for which the exit horizon spans both the Pre-crisis and Post-crisis period (e.g. the percentage of firms in 2005 which exited within 4 years).

Figure 6 shows that exit rates were very similar, regardless of the type of bank. However, 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 $Distressed\,Banks$. This pattern then reversed after the financial crisis: the exit rate at all horizons was higher for firms with $Distressed\,Banks$ than for firms attached to $Non\,Distressed\,Banks$.[15] This provides further motivation for exploring whether, after controlling for differences between firms with $Non\,Distressed\,Banks$ and firms with$Distressed\,Banks$, having a relationship with $Distressed\,Banks$ adversely affected the probability of exit following the crisis.

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

[15]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 Offi ce 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.

Figure 6: Exit Rates, by Banking Relationship

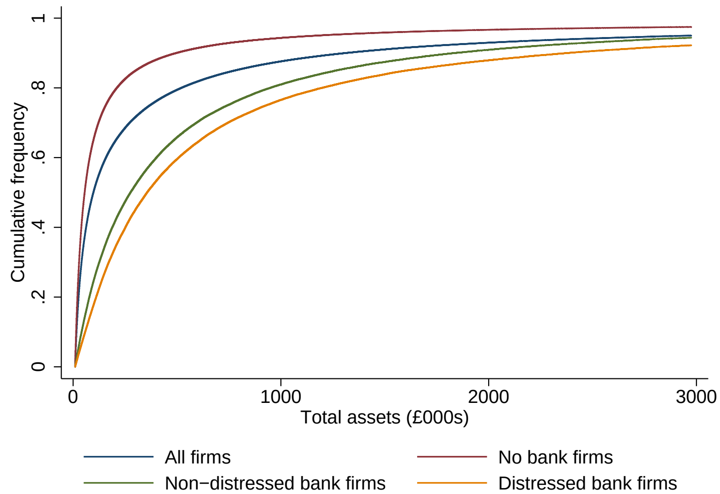


The figure plots the percentage of firms which exit the sample at the 1 year, 2 year, 3 year and 4 year horizon, split by firms which have a relationship with *Distressed Banks* (D) and *Non Distressed Banks* (ND). The chart is split by the Pre-crisis (before 2008) and Post-crisis period. The chart excludes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

In 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 did not have a borrowing relationship with any bank. 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 6: that the proportion of firms in 2004 and 2006 which subsequently exited within 2 or 4 years was the same or slightly higher for firms which had exclusive relationships with *Non Distressed Banks*, but in 2008 this pattern reversed. 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*. There are some, albeit small, differences in the size and age structure of firms with *Distressed Banks* relative to firms with *Non 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 a borrowing relationship. Table 3 shows that those firms without a borrowing relationship are considerably different in nature than firms with a borrowing relationship . In particular, firms without a borrowing relationship are smaller and younger on average, are slightly less leveraged, 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 a borrowing relationship in the year 2006. It illustrates that for the firms without a borrowing relationship, 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.

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	10%	10%	12%	12%	12%	15%	11%	11%	14%
Exit in 4 years	21%	20%	25%	22%	22%	27%	19%	20%	24%
Start-Up	14%	12%	31%	8%	8%	21%	6%	7%	23%
Young	33%	32%	56%	31%	30%	59%	25%	27%	55%
Foreign Owned	3%	3%	3%	2%	3%	3%	3%	3%	3%
Exporter	1%	2%	1%	1%	1%	1%	2%	2%	1%
Median Assets (£000)	301	382	54	276	356	56	301	382	54
Median Leverage Ratio	0.75	0.76	0.71	0.75	0.74	0.68	0.75	0.76	0.71
Credit Rating									
Lowest Quintile	25%	24%	18%	12%	12%	15%	12%	12%	17%
Quintile 2	26%	26%	18%	13%	12%	26%	12%	11%	27%
Quintile 3	17%	17%	18%	16%	15%	20%	17%	16%	22%
Quintile 4	14%	14%	15%	23%	23%	21%	18%	18%	19%
Highest Quintile	16%	15%	28%	33%	35%	15%	39%	40%	14%
Observations	70441	76649	429468	78240	85604	500601	75528	88791	574633

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. Leverage is defined as total liabilities divided by total assets.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 . Based on the "Quiscore", we calculate the quintile of the credit rating distribution a firm belongs to in any given year.

5 Exit Dynamics - Empirical Specification

In our baseline empirical framework, we seek to explore how the probability of firm exit is affected by tighter credit conditions, 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 $Non\,Distressed\,Bank$s 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 relationships with $Distressed\,Banks$ 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.[16] 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 variation in credit conditions, we differ from the existing literature on the implications of tighter credit conditions on firm exit. Eslava et al. (2010), for example, use a proxy for the credit conditions faced by firms, calculated by interacting a measure of the financial external dependence of an industry with a proxy for a firm's ability to access credit.

[16] In contrast to a standard difference in difference framework, the treatment variable can vary over time. In particular, in the pre-crisis period a firm is classed as being attached to $Distressed\,Banks$ if all of its outstanding charges in that year, rather than in 2008, were with banks which subsequently became distressed. Defining the treatment group based just on relationships which existed in 2008 would require all firms in the pre-crisis period to survive until 2008 and so would not facilitate an analysis of the probability of firm exit.

We consider how a tightening in credit conditions impacted on the exit rates at different horizons. We compare exit rates in a window before the crisis with exit rates at the same horizon after the crisis. We choose the windows that are closest to the financial crisis. Specifically, we compare the one-year exit rate in 2007 (firms which are present in 2007 but not in 2008) with the one-year exit rate in 2008 (firms that are present in 2008 but not in 2009).[17] We also 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), 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 (1) are presented in Table 4. We consider specifications without firm controls and industry fixed effects (columns 1, 3, 5 and 7) and with firm controls and industry fixed effects (columns 2, 4, 6 and 8). The first row reports estimates of β_1 and, after controlling for firm characteristics, suggests that prior to the financial crisis, the probability of exit for firms which had relationships with $Distressed\,Banks$ was not significantly different from the probability of exit for firms which had relationships with $Non\,Distressed\,Banks$. The second row reports estimates of β_2 and, after controlling for firm characteristics, suggests that for firms which had relationships with $Non\,Distressed\,Banks$, the one-year exit probability fell following the crisis, but the exit probability at the three-year and four-year horizons rose suggesting the effects of the crisis on firm exit rates took time to emerge. 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 the two-, three- and four-year horizons is significantly higher for firms with $Distressed\,Banks$ following the crisis than for firms attached to $Non\,Distressed\,Banks$. At these horizons, the change in the probability of exit is slightly smaller in those specifications which include firm controls. The estimates suggest that the change in the probability of exit at the two-year horizon was around 0.4 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 four years was around 0.9 percentage points higher. These effects on the probability of exit are material. To provide some context for the magnitude of these effects, the average exit rate is around 10% at the two-year horizon and 20% at the four-year horizon (Figure 6).

[17] Given the way in which we assign firm accounts to years, detailed above, firms present in 2007 will include all firms filing accounts between April 2007 and March 2008 and these firms are deemed to have exited within one year if they do not file accounts from April 2008 onward. 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.

The lack of a significant effect at the one-year horizon suggests that the estimated effect on the aggregate population of firms took time to become apparent.

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

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	1 Year	1 Year	2 Year	2 Year	3 Year	3 Year	4 Year	4 Year
Distressed	-0.003	0.001	-0.007***	-0.000	-0.006**	0.000	-0.007**	0.001
	(0.002)	(0.001)	(0.002)	(0.001)	(0.003)	(0.002)	(0.003)	(0.003)
Post-Crisis	-0.008***	-0.006***	-0.011***	-0.003	-0.007**	0.014***	-0.012***	0.024***
	(0.001)	(0.001)	(0.002)	(0.002)	(0.003)	(0.004)	(0.004)	(0.005)
Distressed * Post-Crisis	0.002	0.000	0.007***	0.004**	0.008***	0.006**	0.011***	0.009***
	(0.002)	(0.001)	(0.002)	(0.002)	(0.003)	(0.003)	(0.003)	(0.003)
Mean Exit Rate	0.060	0.046	0.116	0.100	0.161	0.149	0.202	0.190
Industry Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Firm Controls	No	Yes	No	Yes	No	Yes	No	Yes
R-Squared	0.072	0.101	0.136	0.174	0.188	0.226	0.230	0.270
Observations	329428	322069	328163	320485	324530	315623	311409	302870

Notes: The Table reports the empirical link between the probability of a firm exiting an industry and the banking relationships a firm has. In Columns 1 and 2 we consider the probability of exit within two years for firms present in 2006 and 2008. The dependent variable in Columns 1 and 2 is a dummy variable equal to one if the firm subsequently exits in the following 2 years. In Columns 3 and 4 we consider the probability of exit within three years for firms present in 2005 and 2008. The dependent variable in Columns 3 and 4 is a dummy variable equal to one if the firm subsequently exits in the following 3 years. In Columns 5 and 6 we consider the probability of exit within four years for firms present in 2004 and 2008. The dependent variable in Columns 5 and 6 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 quintile of the credit score distribution), *county court judgements* (measured by the number of county court judgments in the previous 2 years), the *age* of the firm, the *banking relationship age*, whether a firm is *foreign owned*, whether a firm is an *exporter* and whether a firm files *full* or *consolidated* accounts. Robust standard errors, clustered at the industry level, in parentheses, where ***, **, * shows significance at the 1%, 5% and 10% significance levels respectively.

6.2 Exit Dynamics and Financially Constrained Firms

The stylized model presented in Section 2 suggests that firms that are not highly leveraged are less likely to be susceptible to a change in credit conditions as this would have less impact on the amount they are obliged to repay when they do not default. 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[18]:

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

We use our measure of firm leverage, $Leverage_{i,t}$, to divide our sample into leverage quartiles, by year.[19] 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 depending upon the quartile of the firm leverage distribution a firm is in. Our specification is given by:

[18] 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.

[19] The lowest quartile consists of firms with leverage of around 0.5 or less. Of those firms in the lowest quartile, just under 20% of firms have leverage of less than 0.1 The highest quartile consists of firms with leverage of around 0.95 or more.

$$
\begin{aligned}
Y_{i,t,} = \gamma_j + X_{i,t}\kappa + & \sum_{k=1}^{4} \beta_{1,k}(Distressed\,Bank_i \times Lev_{i,k,t}) \\
+ \sum_{k=1}^{4} & \beta_{2,k}(Post\,Crisis_t \times Lev_{i,k,t}) \\
+ \sum_{k=1}^{4} & \beta_{3,k}(Distressed\,Bank_i \times Post\,Crisis_t \times Lev_{i,k,t}) + \varepsilon_{i,t}
\end{aligned} \tag{2}
$$

where

$Lev_{i,k,t}$ is an indicator variable equal to 1 if the leverage of firm i at time t is in quartile 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 higher leverage, though splitting the sample into different groups weakens the precision of the estimation somewhat. The largest positive effects on exit are in the top quartile of the leverage distribution, with for example the four-year exit rate being 2 percentage points higher for firms in the top quartile.

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

	(1)	(2)	(3)	(4)
	1 Year	2 Year	3 Year	4 Year
Lowest Leverage Quartile 1				
Distressed	0.004	0.000	0.002	0.003
	(0.002)	(0.003)	(0.003)	(0.003)
Post-crisis	-0.004***	-0.003	-0.010**	-0.017***
	(0.002)	(0.003)	(0.004)	(0.004)
Distressed * Post-Crisis	-0.001	0.001	0.005	0.006
	(0.002)	(0.003)	(0.004)	(0.004)
Leverage Quartile 2				
Distressed	0.000	-0.002	0.003	-0.000
	(0.002)	(0.002)	(0.003)	(0.004)
Post-Crisis	-0.002	0.001	0.014***	0.017***
	(0.002)	(0.002)	(0.004)	(0.005)
Distressed * Post-Crisis	0.001	0.006**	0.001	0.004
	(0.002)	(0.003)	(0.004)	(0.005)
Leverage Quartile 3				
Distressed	0.001	0.002	0.000	0.001
	(0.002)	(0.003)	(0.003)	(0.004)
Post-Crisis	-0.005**	0.005*	0.031***	0.054***
	(0.002)	(0.003)	(0.005)	(0.006)
Distressed * Post-Crisis	0.000	-0.000	0.002	0.004
	(0.003)	(0.003)	(0.005)	(0.005)
Highest Leverage Quartile				
Distressed	-0.003	-0.001	-0.004	-0.001
	(0.003)	(0.004)	(0.005)	(0.007)
Post-Crisis	-0.013***	-0.015***	0.005	0.034***
	(0.003)	(0.004)	(0.007)	(0.009)
Distressed * Post-Crisis	0.002	0.007	0.015**	0.019***
	(0.003)	(0.006)	(0.006)	(0.007)
Mean Exit Rate				
Quartile 1	0.026	0.066	0.104	0.137
Quartile 2	0.021	0.057	0.094	0.128
Quartile 3	0.039	0.099	0.151	0.192
Quartile 4	0.081	0.179	0.253	0.310
Industry Fixed effects	Yes	Yes	Yes	Yes
Firm Controls	Yes	Yes	Yes	Yes
R-Squared	0.102	0.176	0.229	0.273
Observations	322069	320485	315623	302870

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 quartile 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, the model in Section 2 without credit market imperfections and Hopenhayn (1992)). 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 quartiles, 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 $Operating\,Profits$, *Depreciation* and the $Cost\,Of\,Employee$s, deflated by industry deflators. We use GVA deflators, published by the ONS at the two-digit and three-digit SIC code level.

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 $Non\,Distressed\,Banks$. Because of lighter reporting requirements for small companies (Table 1), the number of companies in the productivity sample is considerably smaller than that considered in our baseline specification. This reflects the fact that the productivity sample is composed only of firms which report $Operating\,Profits$, $Cost\,Of\,Employees$ and *Employees* in their accounts. 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. Nevertheless, in the productivity sample there is little difference between the credit profile and average size of firms with $Distressed\,Banks$ and firms with $Non\,Distressed\,Banks$.

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

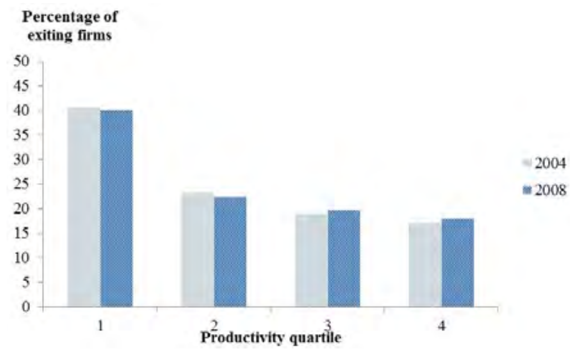
	2004		2006		2008	
	ND	D	ND	D	ND	D
Exit in 2 Years	6%	5%	7%	7%	5%	6%
Exit in 4 years	14%	13%	13%	13%	11%	11%
Start-Up	5%	5%	3%	4%	3%	4%
Young	17%	17%	13%	14%	11%	13%
Foreign Owned	16%	15%	16%	15%	19%	17%
Exporter	18%	18%	18%	17%	19%	17%
Median Assets (£000)	2526	2734	3191	3408	3851	3952
Median Leverage Ratio	0.70	0.71	0.68	0.69	0.66	0.68
Credit Rating						
Lowest Quintile	17%	16%	2%	2%	1%	1%
Quintile 2	25%	27%	2%	2%	1%	1%
Quintile 3	20%	21%	2%	1%	1%	2%
Quintile 4	16%	16%	6%	6%	3%	4%
Highest Quintile	18%	17%	85%	87%	91%	91%
Observations	5140	6714	4853	6526	4629	6586

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. Based on the “Quiscore”, we calculate the quintile of the credit rating distribution a firm belongs to in any given year.

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 borrowing relationships with banks and plots the productivity distribution, by quartile, of those firms which exited in the four years following 2004 and the four years following 2008. The two distributions are very similar, though a slightly smaller proportion of firms exiting in the four years after 2008 were in the lowest quartile of the productivity distribution than in the four years after 2004, contrary to the “cleansing view”.

In Figures 9 and 10, we look separately at the productivity distribution of exiting firms for firms attached to $Non\,Distressed\,Bank$s and $Distressed\,Banks$. For $Non\,Distressed\,Banks$, the percentage of firms exiting from the lowest productivity quartile 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 quartile was lower following the financial crisis, contrary to the cleansing view. These patterns are consistent with the predictions of our model in section 2, which suggests that greater financial frictions will increase the exit of firms with intermediate levels of productivity.

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



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 quartiles, with "1" equal to the lowest quartile of the distribution in a given year and "4" equal to the highest quartile.

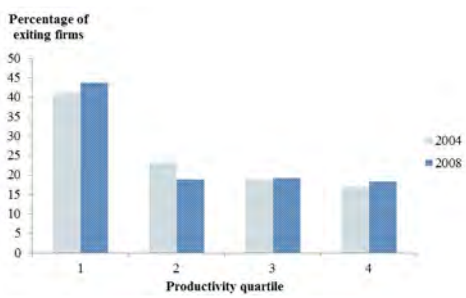


Figure 9: Firms which Exited and Banked with "Non-Distressed" Banks

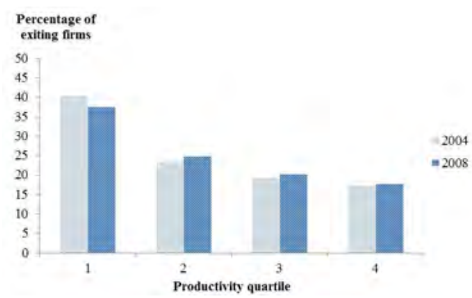


Figure 10: Firms which Exited and Banked with "Distressed" Banks

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, unlike in the full sample, for the productivity sample of firms having a relationship with $Distressed\,Banks$ did not significantly increase the probability of exit relative to firms with $Non\,Distressed\,Banks$ on average. The estimated coefficients on the interaction term between $Distressed\,Banks$ and $Post\,Crisis$ remain positive and similar in magnitude to those reported in Table 4, but are no longer statistically significant due to the larger standard errors. The lack of significance for the smaller productivity sample is likely to be due to the fact that the sample is composed of firms which are on average larger in size, with lower leverage 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. In addition, the reduced 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) 1 Year	(2) 2 Year	(3) 3 Year	(4) 4 Year
Distressed	-0.005	-0.004	-0.004	-0.014**
	(0.004)	(0.005)	(0.005)	(0.006)
Post-Crisis	-0.008***	-0.003	0.016**	0.038***
	(0.003)	(0.005)	(0.007)	(0.011)
Distressed * Post-Crisis	0.004	0.003	0.000	0.009
	(0.004)	(0.006)	(0.009)	(0.010)
Mean Exit Rate	0.020	0.049	0.079	0.110
Industry Fixed Effects	Yes	Yes	Yes	Yes
Firm Controls	Yes	Yes	Yes	Yes
R-Squared	0.065	0.107	0.142	0.186
Observations	20845	20882	21154	21271

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. 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.

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 quartile a firm is in. We also continue to include industry fixed effects and firm specific controls.[20] Our specification is therefore given by:

$$\begin{aligned} Y_{i,t,} = \gamma_j + X_{i,t}\kappa + & \sum_{k=1}^{4} \beta_{1,k}(Distressed\,Bank_i \times Prod_{i,k,t}) \\ & + \sum_{k=1}^{4} \beta_{2,k}(Post\,Crisis_t \times Prod_{i,k,t}) \\ & + \sum_{k=1}^{4} \beta_{3,k}(Distressed\,Bank_i \times Post\,Crisis_t \times Prod_{i,k,t}) + \varepsilon_{i,t} \end{aligned} \tag{3}$$

where

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

Table 8 reports the results from estimating equation 3, showing estimates of the coefficient of interest, $\beta_{3,k}$,

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

for each productivity quartile k. We consider the impact of having a relationship with $Distressed\,Banks$ on the probability of exit at the one-year to four-year horizons.

Focusing first on the results for $Non\,Distressed\,Banks$, there is again evidence that the adverse effect of the crisis on firm exit rates take time to come through. The coefficient on the post-crisis dummy is mainly negative and significant at the one-year and two-year horizons before becoming predominantly positive and statistically significant at the three-year and four-year horizons. This would be consistent with the $Non\,Distressed\,Bank$s offering forbearance and support to distressed businesses in the immediate aftermath of the financial crisis, but withdrawing this in the later period that stretches to 2013. Moreover, there is evidence here of an eventual cleansing effect reflected in the four-year exit rate being 5.3 percentage points higher post crisis for the lowest productivity firms and only 2.3 percentage points higher for high productivity firms.

Our earlier results (reported in Table 4) suggested an increase in the exit probability following the financial crisis for firms attached to $Distressed\,Banks$ relative to the change for $Non\,Distressed\,Banks$. But the results in Table 8 suggest that rather than this effect being focused among low productivity firms, as would be consistent with the "cleansing view", it was more concentrated among intermediate productivity firms as suggested by the model presented in Section 2. Indeed, for firms in the lowest productive quartile, the results reported in Table 8 suggest that the probability of exit for low productivity firms was actually lower for firms with $Distressed\,Banks$ than $Non\,Distressed\,Banks$. For firms in the lowest productivity quartile, at the one-year and two-year horizons the change in exit probability was significantly lower (around 2-3 percentage points) for firms attached to $Distressed\,Banks$ relative to the change for firms attached to $Non\,Distressed\,Banks$. At the three and four year horizon, the estimated coefficients on the interaction term between $Distresed\,Banks$ and $Post\,Crisis$ for firms in the lowest productivity quartile are also negative, but not significant. These results are consistent with distressed banks supporting low productivity zombie businesses.

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

	(1) 1 Year	(2) 2 Year	(3) 3 Year	(4) 4 Year
Lowest Productivity Quartile				
Distressed	0.010	0.013	0.008	-0.008
	(0.008)	(0.012)	(0.016)	(0.015)
Post-Crisis	0.004	0.014	0.026*	0.053***
	(0.007)	(0.012)	(0.015)	(0.019)
Distressed * Post-Crisis	-0.024**	-0.029*	-0.037	-0.024
	(0.011)	(0.018)	(0.023)	(0.024)
Productivity Quartile 2				
Distressed	-0.008	-0.011	-0.029***	-0.013
	(0.007)	(0.008)	(0.011)	(0.012)
Post-Crisis	-0.012**	-0.021**	-0.019**	0.009
	(0.005)	(0.009)	(0.009)	(0.016)
Distressed * Post-Crisis	0.015**	0.020*	0.047***	0.037**
	(0.007)	(0.012)	(0.014)	(0.016)
Productivity Quartile 3				
Distressed	-0.012**	-0.010	-0.003	-0.013
	(0.006)	(0.008)	(0.009)	(0.011)
Post-Crisis	-0.015***	-0.013*	0.016	0.034**
	(0.005)	(0.007)	(0.011)	(0.014)
Distressed * Post-Crisis	0.015**	0.017*	0.000	0.009
	(0.006)	(0.010)	(0.015)	(0.018)
Highest Productivity Quartile 4				
Distressed	-0.010	-0.006	0.008	-0.018**
	(0.006)	(0.007)	(0.009)	(0.009)
Post-Crisis	-0.010**	0.006	0.024**	0.023*
	(0.005)	(0.007)	(0.010)	(0.012)
Distressed * Post-Crisis	0.009	0.002	-0.011	0.012
	(0.007)	(0.009)	(0.012)	(0.012)
Mean Exit Rate				
Quartile 1	0.031	0.078	0.129	0.178
Quartile 2	0.019	0.048	0.075	0.100
Quartile 3	0.011	0.036	0.058	0.087
Quartile 4	0.010	0.033	0.057	0.080
Industry Fixed Effects	Yes	Yes	Yes	Yes
Firm Controls	Yes	Yes	Yes	Yes
R-Squared	0.067	0.110	0.147	0.190
Observations	20845	20882	21154	21271

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 all horizons, relatively more productive firms were adversely affected by having relationships with $Distressed\,Banks$. For firms in the lower middle of the productivity distribution (quartile 2), the change in the probability of exit at all horizons was significantly higher for firms attached to $Distressed\,Banks$ rather than $Non\,Distressed\,Banks$, with the exit rate at the three-year horizon being 4.7 percentage points higher for firms attached to $Distressed\,Banks$ than for firms attached to $Non\,Distressed\,Banks$.

For firms in the upper middle of the productivity distribution (quartile 3) the change in the probability of exit is significantly higher at the one-year and two-year horizons for firms attached to $Distressed\,Banks$, but not at the three-year and four-year horizons. This suggests that while $Non\,Distressed\,Banks$ provided support to these types of firms in the immediate aftermath of the financial crisis, this was not the case for higher than average productivity firms with $Distressed\,Banks$.

For firms in the top quartile of the productivity distribution there is not a significant difference in the post-crisis change in the exit rates of firms with $Distressed\,Banks$ and $Non\,Distressed\,Banks$.

Overall, the results presented in Table 8 suggest that having a relationship with $Distressed\,Banks$ appears to have distorted the "cleansing" process of the financial crisis, increasing the probability of exit for firms in the middle of the productivity distribution and reducing it for the least productive firms. These effects on the exit rates of different groups of firms are large in magnitude, but are masked on average across the sample (Table 7).

The most likely explanation for these results, 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 middle of the productivity distribution. Another 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 highly-indebted but unproductive firms, these firms may not be susceptible to a tightening of credit conditions, whereas more productive firms may suffer from either more costly credit or reduced credit availability, for example due to concern about banks' balance sheet.

To test whether the productivity results from our quasi-experiment are indeed driven by changes in credit conditions, we split our sample by leverage ratio into three groups (terciles) and then re-estimate our productivity specification for each leverage tercile. We expect highly leveraged firms to be more susceptible to changes in credit conditions than other firms, and hence we might expect to see our productivity results more evident amongst higher leverage firms.

In Tables 9 and 10 we report estimates of the effect of being with a $Distressed\,Bank$ on the probability of exit at different horizons across the productivity distribution for each of our three leverage terciles. As shown in Table 8 , having a relationship with $Distressed\,Banks$ reduced the exit rate post-crisis of firms in the lowest productivity quartile. These effects were statistically significant at the one and two year horizons. In the first row of Table 9 we see that these effects are concentrated amongst low productivity firms in the highest leverage tercile and are smaller in magnitude and not statistically significant for lower leverage firms. These effects are thus consistent with distressed banks supporting zombie businesses to protect their own balance sheets. In Table 8 having a relationship with $Distressed\,Banks$ increased the exit rate post-crisis for firms in the lower and upper middle of the productivity distribution (quartiles 2 and 3). In the second row of Tables9 and 10 we see that the estimated increases in exit rates for lower middle productivity firms are largest in magnitude amongst firms that are also in the highest leverage tercile. These effects are large. For example, for firms in the highest leverage tercile, there is evidence that having a relationship with $Distressed\,Banks$ increased the probability of exit for firms in the lower middle of the productivity distribution by 5.9 percentage points at the two-year horizon and 10.1 percentage points at the three-year horizon. These effects should be seen in the context of an average exit rate for this group of firms of around 8% at the two-year horizon and 11% at the three-year horizon. For firms in the upper middle of

Table 9: Effect of a Distressed Bank Relationship on Firm Exit, by Leverage and Productivity, 1 Year and 2 Year Exit

	(1)	(2)	(3)	(4)	(5)	(6)
	Lowest Leverage Tercile		Middle Leverage Tercile		Highest Leverage Tercile	
	1 Year Exit	2 Year Exit	1 Year Exit	2 Year Exit	1 Year Exit	2 Year Exit
Lowest Productivity Quartile						
Distressed * Post-Crisis	-0.011	-0.024	-0.004	-0.007	-0.036*	-0.045*
	(0.012)	(0.021)	(0.018)	(0.029)	(0.018)	(0.027)
Productivity Quartile 2						
Distressed * Post-Crisis	-0.008	0.008	0.021*	-0.003	0.029	0.059***
	(0.009)	(0.015)	(0.011)	(0.020)	(0.018)	(0.022)
Productivity Quartile 3						
Distressed * Post-Crisis	0.006	0.026**	0.017	0.001	0.020	0.022
	(0.007)	(0.012)	(0.011)	(0.016)	(0.015)	(0.023)
Highest Productivity Quartile 4						
Distressed * Post-Crisis	0.003	-0.011	-0.011	-0.002	0.040*	0.040*
	(0.009)	(0.015)	(0.008)	(0.014)	(0.020)	(0.021)
Mean Exit Rate						
Quartile 1	0.016	0.042	0.021	0.053	0.045	0.112
Quartile 2	0.009	0.024	0.017	0.042	0.033	0.077
Quartile 3	0.007	0.018	0.007	0.030	0.020	0.066
Quartile 4	0.007	0.023	0.007	0.027	0.019	0.057
Industry Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes
Firm Controls	Yes	Yes	Yes	Yes	Yes	Yes
R-Squared	0.051	0.089	0.108	0.106	0.128	0.178
Observations	6925	6932	6906	6938	7014	7012

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.

the productivity distribution (quartile 3) increases in exit rates are generally less significant. When we differentiate our results by leverage tercile in Table 9 we also find some evidence of an increase in one- and two-year exit rates amongst firms in the highest productivity quartile concentrated amongst the highly leveraged group. These effects on firms in the highest productivity quartile were not evident in Table 8 where we considered all leverage groups together.

Taken together, the results in Tables 9 and 10 support the interpretation that the distortion to the "cleansing" process of the financial crisis associated with having a relationship with a $Distressed\,Bank$ is driven by changes in credit conditions.

Table 10: Effect of a Distressed Bank Relationship on Firm Exit, by Leverage and Productivity, 3 Year and 4 Year Exit

	(1)	(2)	(3)	(4)	(5)	(6)
	Lowest Leverage Tercile		Middle Leverage Tercile		Highest Leverage Tercile	
	3 Year Exit	4 Year Exit	3 Year Exit	4 Year Exit	3 Year Exit	4 Year Exit
Lowest Productivity Quartile						
Distressed * Post-Crisis	-0.028	0.006	-0.014	-0.017	-0.058	-0.041
	(0.027)	(0.038)	(0.041)	(0.044)	(0.039)	(0.033)
Productivity Quartile 2						
Distressed * Post-Crisis	0.020	0.001	0.013	0.037	0.101***	0.064*
	(0.021)	(0.025)	(0.025)	(0.027)	(0.032)	(0.035)
Productivity Quartile 3						
Distressed * Post-Crisis	0.001	0.012	0.015	0.010	-0.024	0.004
	(0.017)	(0.020)	(0.020)	(0.025)	(0.037)	(0.045)
Highest Productivity Quartile 4						
Distressed * Post-Crisis	-0.008	0.015	-0.020	0.002	-0.001	0.009
	(0.019)	(0.019)	(0.021)	(0.023)	(0.028)	(0.034)
Mean Exit Rate						
Quartile 1	0.068	0.117	0.096	0.153	0.172	0.230
Quartile 2	0.039	0.067	0.067	0.095	0.114	0.138
Quartile 3	0.030	0.047	0.052	0.076	0.099	0.149
Quartile 4	0.041	0.061	0.047	0.068	0.088	0.126
Industry Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes
Firm Controls	Yes	Yes	Yes	Yes	Yes	Yes
R-Squared	0.134	0.169	0.148	0.183	0.225	0.276
Observations	7091	7149	7076	7133	6987	6989

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 Placebo Crises

Our difference in difference specification relies on the assumption of parallel trends in exit rates for firms which had relationships with the banks that we have classified as $Distressed\,Banks$ and firms which had relationships with the banks that we have classified as $Non\,Distressed\,Banks$ had there not been a financial crisis. To provide evidence of parallel trends in the absence of a financial crisis, we undertake placebo tests where we consider alternative placebo "crisis" periods.

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 0.4 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.

These results confirm that exit rates rose for firms that had a relationship with $Distressed\,Banks$ following the actual crisis in a way that they did not in other similar periods, suggesting that the higher exit rate was a genuine reaction to changes that occurred for customers of $Distressed\,Banks$ after the crisis.

Table 11: Placebo Crises, 2 Year Exit Rate

	(1) Placebo "Crisis"=2004	(2) Placebo "Crisis"=2006	(3) Actual Crisis=2008
Distressed * Placebo Crisis	-0.002	-0.000	0.004**
	(0.003)	(0.002)	(0.002)
Mean Exit Rate	0.089	0.098	0.100
Industry Fixed Effects	Yes	Yes	Yes
Firm Controls	Yes	Yes	Yes
R-Squared	0.147	0.167	0.174
Observations	280057	301887	320485

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	-0.003	0.006**
	(0.003)	(0.003)
Mean Exit Rate	0.142	0.149
Industry Fixed Effects	Yes	Yes
Firm Controls	Yes	Yes
R-Squared	0.208	0.226
Observations	292810	315623

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.

7 Conclusion

This paper suggests that the tightening in credit conditions 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 a tightening in credit conditions 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. Underlying these changes on average across firms we find substantial differences across the productivity distribution. We find that being attached to *Distressed Banks* did not increase the probability of exit for the least productive firms; in fact it reduced the probability of exit for these firms, but increased the probability of exit for relatively more productive firms. These effects imply that 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 tighter credit conditions.

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Appendix

A 1: Model of Firm Dynamics

A 1.1 Firm Maximisation Problem

As described in Section 2, upon entry, the problem of the firm is to choose its price, quantity and repayment to maximise profits subject to three constraints:

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

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:

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

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

If however the upfront fixed cost requirement is small, such that $d_i f < tf_e$, 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:

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

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:

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

Hence

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

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:

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

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 conditions 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 $\lambda_2 = 0.5$.

A 2: Robustness Tests

A 2.1 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 13 , 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.[21] 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 $Non\,Distressed\,Banks$.

Table 13: Probit Model, Marginal Effects

	(1) 2 Year	(2) 3 Year	(3) 4 Year
Distressed * Post-crisis	0.004*	0.007***	0.008***
	(0.002)	(0.003)	(0.003)
Observations	295744	291200	281022

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. Robust standard errors, clustered at the industry level, in parentheses, where ***, **, * shows significance at the 1%, 5% and 10% significance levels respectively.

A 2.2 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

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

$t-1$) . 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 14 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 the 3 and 4 year horizons.

In Table 15 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 one, two and three year horizon, the change in the probability of exit following the crisis is significantly lower for firms in the lowest productivity quartile attached to *Distressed Banks*. In contrast, for firms in the second productivity quartile, the change in the probability of exit at the three year and four year horizon following the financial crisis was significantly higher for firms attached to *Distressed Banks* than for firms attached to *Non Distressed Banks*.

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

	(1) 1 Year Exit	(2) 2 Year Exit	(3) 3 Year Exit	(4) 4 Year Exit
Distressed	0.001	0.001	0.001	-0.000
	(0.001)	(0.002)	(0.002)	(0.002)
Post-Crisis	-0.005***	-0.000	0.016***	0.022***
	(0.001)	(0.002)	(0.004)	(0.005)
Distressed * Post-Crisis	-0.000	0.002	0.005*	0.009***
	(0.001)	(0.002)	(0.003)	(0.003)
Mean Exit Rate	0.042	0.092	0.139	0.179
Industry Fixed Effects	Yes	Yes	Yes	Yes
Firm Controls	No	No	No	No
R-Squared	0.054	0.077	0.085	0.094
Observations	277648	274570	262416	253704

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.

Table 15: Effect of a Distressed Bank Relationship on Firm Exit, by Productivity Quartile. Alternative *Treatment* Group Definition

	(1) 1 Year Exit	(2) 2 Year Exit	(3) 3 Year Exit	(4) 4 Year Exit
Lowest Productivity Quartile				
Distressed	0.023**	0.018	0.015	-0.022
	(0.010)	(0.016)	(0.019)	(0.016)
Post-Crisis	0.017*	0.007	0.011	-0.016
	(0.010)	(0.013)	(0.017)	(0.019)
Distressed * Post-Crisis	-0.041***	-0.039**	-0.054**	-0.010
	(0.013)	(0.019)	(0.025)	(0.023)
Productivity Quartile 2				
Distressed	-0.003	-0.009	-0.019	-0.014
	(0.007)	(0.009)	(0.012)	(0.013)
Post-Crisis	-0.007	-0.017*	-0.027**	-0.043***
	(0.006)	(0.009)	(0.011)	(0.014)
Distressed * Post-Crisis	0.007	0.014	0.035**	0.036*
	(0.008)	(0.014)	(0.016)	(0.018)
Productivity Quartile 3				
Distressed	-0.012*	-0.004	-0.000	-0.016
	(0.007)	(0.009)	(0.011)	(0.012)
Post-Crisis	-0.018***	-0.017**	-0.008	-0.015
	(0.006)	(0.008)	(0.011)	(0.013)
Distressed * Post-Crisis	0.017**	0.011	0.000	0.018
	(0.008)	(0.012)	(0.016)	(0.019)
Highest Productivity Quartile				
Distressed	-0.009	0.000	0.003	-0.014
	(0.006)	(0.008)	(0.009)	(0.010)
Post-Crisis	-0.008	-0.003	-0.001	-0.011
	(0.005)	(0.007)	(0.009)	(0.012)
Distressed * Post-Crisis	0.005	-0.003	-0.010	0.001
	(0.007)	(0.011)	(0.012)	(0.015)
Mean Exit Rate				
Quartile 1	0.030	0.069	0.116	0.163
Quartile 2	0.018	0.042	0.066	0.094
Quartile 3	0.010	0.035	0.056	0.081
Quartile 4	0.010	0.030	0.051	0.073
Industry Fixed Effects	Yes	Yes	Yes	Yes
Firm Controls	Yes	Yes	Yes	Yes
R-Squared	0.064	0.092	0.129	0.168
Observations	17767	17778	17627	18092

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.

A 2.2 Weighted Regression

As noted above, one drawback of our productivity sample is that is limited to firms with banking relationships which report $Operating\,Profits$, $Employees$ 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-year cell, following a similar procedure to Gal (2013). 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.[22] Using these weights, we then estimate our productivity specification, given by Equation 3.[23] Consistent with the unweighted results, the weighted results reported in Table 16 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, there is evidence that for relatively more productive firms relationships with $Distressed\,Banks$ increased the probability of exit.

[22] 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.

[23] 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.

Table 16: Weighted Regression. Effect of a Distressed Bank Relationship on Firm Exit, by Productivity Quartile

	(1)	(2)	(3)	(4)
	1 year exit	2 year exit	3 year exit	4 year exit
Lowest Productivity Quartile				
Distressed	0.009	0.027	-0.017	-0.060**
	(0.020)	(0.025)	(0.027)	(0.030)
Post-crisis	0.035*	0.019	0.088***	0.051
	(0.019)	(0.025)	(0.028)	(0.035)
Distressed * Post-crisis	-0.060**	-0.052	-0.077*	-0.049
	(0.027)	(0.036)	(0.042)	(0.046)
Productivity Quartile 2				
Distressed	-0.001	0.001	-0.034	-0.029
	(0.011)	(0.023)	(0.027)	(0.030)
Post-crisis	-0.006	-0.007	-0.013	0.033
	(0.016)	(0.024)	(0.031)	(0.033)
Distressed * Post-crisis	0.010	0.040	0.069*	0.070*
	(0.020)	(0.032)	(0.037)	(0.038)
Productivity Quartile 3				
Distressed	-0.019***	-0.033**	-0.026	-0.024
	(0.007)	(0.016)	(0.025)	(0.025)
Post-crisis	-0.014	-0.013	0.061	0.100**
	(0.010)	(0.021)	(0.040)	(0.040)
Distressed * Post-crisis	0.024**	0.008	-0.022	-0.013
	(0.011)	(0.028)	(0.044)	(0.048)
Highest Productivity Quartile				
Distressed	-0.014	-0.011	0.007	-0.022
	(0.013)	(0.016)	(0.011)	(0.016)
Post-crisis	-0.025***	-0.015	0.031	0.007
	(0.009)	(0.015)	(0.019)	(0.025)
Distressed * Post-crisis	0.016	0.010	0.004	0.035*
	(0.014)	(0.021)	(0.016)	(0.021)
Industry fixed effects	Yes	Yes	Yes	Yes
Firm controls	Yes	Yes	Yes	Yes
R-squared	0.138	0.199	0.241	0.283
Observations	20238	20549	20848	20972

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--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.