

CEP Discussion Paper No 1188

February 2013
(revised November 2013)

**Survive Another Day: Using Changes in the Composition
of Investments to Measure the Cost of Credit Constraints**

Luis Garicano and Claudia Steinwender

Abstract

We introduce a novel empirical strategy to measure credit shocks. Theoretically, we show that credit shocks reduce the value of long term investments relative to short term ones. Under the (conservative) assumption that demand shocks affect short and long run investments similarly, credit shocks can be measured *within firms* by the shift in the investment vector away from long run investments and towards short term ones. This within-firm strategy makes it possible to use firm-times-year fixed effects to capture unobserved between firm heterogeneity as well as idiosyncratic demand shocks. We implement this strategy using a rich panel data set of Spanish manufacturing firms before and after the credit crisis in 2008. This allows us to quantify the effect of the credit crunch: our theory suggests that credit constraints are equivalent to an additional tax rate of around 11% on the longest lived capital. To pin down credit constraints as the cause for this investment pattern we use two triple differences strategies where we show (i) that only Spanish owned firms became credit constrained during the financial crisis, and that the drop in long term investments after the crisis is indeed driven by credit constrained Spanish firms; and that (ii) the impact on long term investment is mostly noticeable in firms that started the crisis with more mature debt to roll over.

Keywords: Financial crisis, credit constraints, innovation, investment choices

JEL Classifications: O32; O33; G31; E32

This paper was produced as part of the Centre's Productivity and Innovation Programme. The Centre for Economic Performance is financed by the Economic and Social Research Council.

Acknowledgements

We thank attendants at the LSE/CEP Labour Markets Workshop, at the European Central Bank's and Bruegel's "Economic adjustment in the euro area" conference, at the Toulouse Network on Information Technology, at the Gerzensee Finance Symposium (ESSFM), at the ECB Research department seminar, as well as Daron Acemoglu, Samuel Bentolila and, especially, Daniel Paravisini. The latter made a crucial suggestion that underpins much of what follows.

Luis Garicano is an Associate of the Centre for Economic Performance. He is also Professor (Chair) of Economics and Strategy, Department of Management and Department of Economics at the London School of Economics and Political Science. Claudia Steinwender is an Occasional Research Assistant at the Centre for Economic Performance, LSE.

Published by

Centre for Economic Performance

London School of Economics and Political Science

Houghton Street

London WC2A 2AE

All rights reserved. No part of this publication may be reproduced, stored in a retrieval system or transmitted in any form or by any means without the prior permission in writing of the publisher nor be issued to the public or circulated in any form other than that in which it is published.

Requests for permission to reproduce any article or part of the Working Paper should be sent to the editor at the above address.

© L. Garicano and C. Steinwender, submitted 2013

1 Introduction

Studying the impact of credit constraints on investment empirically requires solving an identification problem: separating the impact of a liquidity crisis from the impact of the aggregate demand shock that usually takes place concurrently. In this context observing a drop of credit and a concurrent reduction in investment tells us little about causality.

In this paper we propose a new identification strategy to study these effects. Our strategy exploits the differential impact of demand shocks and liquidity constraints on the composition of investments. While demand shocks affect investments with a shorter time-to-payoff by more than investments with a longer time-to-payoff (the recession will, after all, finish at some point in the future), the opposite is true for liquidity shocks. As we show formally in a simple model (based on Aghion et al., 2009), absent liquidity constraints, firms equalize the value of the marginal dollar on short term and long term investments. However, under liquidity constraints, long term investments involve a risk, since the firm may have to liquidate before the payoff period. This creates a wedge between the value of short and long term investments: Firms are willing to give up some future expected payoffs in order to increase the probability of surviving another day.

Based on this result we propose an identification strategy that allows us to place a lower bound on the impact of credit shocks. Assuming that demand shocks affect short term and long term investments similarly (a conservative assumption), the difference between the longer term and the shorter term investment, if positive, is a lower bound on a first order approximation of the impact of the credit shock. In other words, our empirical strategy allows us to separate demand and supply factors, since the recession itself, if anything, would shift investments towards the future. A crucial advantage of this strategy is that it allows us to examine the shift in the composition of investment *within firms* before and after a financial shock, including firm-times-year fixed effects to make sure that neither demand shocks nor unobserved heterogeneity between firms (different firms react differently to the crisis, but this is absorbed by the year-firm fixed effects) bias the estimated impact of credit constraints. Our estimate thus has, as we shall show, a clear economic interpretation.

Our identification strategy requires formulating a taxonomy of investments by their time to payoff, or durability. We rely on an extensive existing literature (which we survey) to determine the

relative durability of different investment categories. According to this literature the shortest lived investment is advertising, followed by IT, R&D, with fixed capital investment like equipment and machinery being, on average, the longest lived.

To conduct our empirical analysis we need two things: a credit crisis, and detailed data about different investment types. Luckily for the case of Spain both are available: Spain suffered from a particular severe credit crisis in the wake of the financial crisis in 2008, and at the same time there exists detailed firm level data with investment information.

We use the financial crisis in 2008 as an exogenous shock to credit supply. This is possible because the 2008 crisis was at its core a banking crisis. Previous research has established that the reduced bank liquidity translated into a reduction of credit supply to firms (e.g. Iyer et al 2010, Paravisini et al 2011, Ivashina and Scharfstein, 2010, Adrian et al. 2012, Santos 2011 for the financial crisis in 2008; and Chava and Purnanandam 2011 for the Russian crisis in 1998). This is particularly true for the case of Spain, where the liquidity crisis was exceptionally severe. Jimenez et al (2012) show that weaker banks deny more loans, even when the loans are identical (which allows them to identify the supply rather than demand channel) and that firms can usually not substitute the weak bank with another bank. Bentolila et al. (2013) show that firms who borrowed more from weak financial institutions that were later bailed out (the old “Cajas”) reduced employment by an additional 3.5 to 5 percentage points relative to firms who borrowed from healthier ones.

We use Spanish firm-level data from the Encuesta Sobre Estrategias Empresariales (ESEE, Survey of business strategies); a rich, high quality, long-term panel data set of Spanish manufacturing firms that breaks up investment information into a total of eight different investment categories: Advertising, IT, R&D, vehicles, machinery, furniture, buildings, and land. Since the Spanish financial crisis was based on a real estate bubble, we do not use land and buildings investment in our analysis, as it might bias our results towards finding the hypothesized effect.

Applying our estimation strategy to the Spanish data we find that after the financial crisis the longest term investments were reduced by 17 percentage points more than shortest term investments. This finding is robust to different classifications of short versus long term investment. For example, it does not matter whether we use depreciation rates from the literature directly as a measure for time-to-payoff, or if we just use the ranking of investment types based on their depreciation rates. Similarly, the finding holds for several ways of grouping some investment types with similar depreciation rates into one category. Also, we conduct placebo tests estimating the effects of the financial crisis in 2008 year by year and find reassuringly that the difference in investment behaviour

only appears in the crisis years. We conclude therefore that the 17 percentage point difference is our estimate of the impact of the financial crisis on investment. We show that, given our theory, this is equivalent to an 11% incremental tax rate on the longest term investment.

The second part of our empirical analysis aims to more precisely pin down credit constraints as the mechanism leading to the change in investment patterns, as opposed to other mechanisms which could lead to similar effects, such as an increase in uncertainty (Bloom, 2009). If credit constraints were indeed the cause of the change, we should see a stronger effect for firms that were more affected by credit constraints. We use two ways, suggested by the literature, to identify firms that were particularly affected by the financial crisis: domestic firms (as opposed to foreign ones), and firms with a lot of mature debt that needs to be rolled over at the beginning of the crisis.

Foreign firms are typically less affected by a credit squeeze since they have access to external finance via their parent companies (Desai et al 2004, Kalemlı-Ozcan et al. 2010). Indeed, this is the case in our data: the credit drop is only observed for Spanish firms. Thus under our hypothesis, the shift in the composition of investment (if linked to credit) should only occur in Spanish firms. Our analysis exploits that and amounts to a triple difference estimation: We compare long-term versus short-term investments before and after the financial crisis in 2008 for Spanish versus foreign firms. Our triple diff analysis confirms our initial analysis, and reassures us that credit constraints are indeed at play. Moreover this analysis allows us to include category-year fixed effects (which is impossible in the simple difference in differences analysis as it is collinear with the interaction term). The results are robust to this inclusion. This reassures us that we are not seeing a general shift towards short term investments or the cyclical behaviour of certain investment types such as R&D (which tends to be pro-cyclical, see Barlevy, 2007) but rather a change in composition that only takes place for credit constrained firms.

Of course, this robustness check may still fail to convince us, since domestic and foreign owned firms differ among a variety of other dimensions besides their access to external funding. For example, Spanish owned firms in our data are typically smaller and less likely to export, and might therefore show a different investment behaviour. We address this concern by conducting a variety of robustness checks. First, we use only multinational firms for our comparison. These firms are all large, have subsidiaries in many countries and are heavily export oriented, the only difference between them being the nationality of their majority shareholder. Second, we use an inverse propensity score reweighting scheme based on the size, growth, export status and export development of firms before the financial crisis. This strategy basically matches foreign owned firms

to comparable Spanish ones. Third, we make sure that firm size is not driving the results. Spanish firms are smaller, so this could be just a size effect. However, the magnitude of our estimated result does not vary at all when we control for firm size, so size is not driving the change in investment pattern. Overall, the results are very similar in magnitude across all alternative specifications, which gives us additional confidence that we are picking up the right effect. Fourth, the exit rates of Spanish and foreign firms are not statistically significantly different (maybe precisely because of our mechanism), so compositional effects are not driving our results either. A final alternative hypothesis could be that the liability side of Spanish firms' balance sheets could be responsible for our results: If firms cannot raise long term funding, then maturity matching could lead them to reduce the maturity of their asset side. However, we can rule out this explanation as well, as the data shows not difference between Spanish and foreign firms in the maturities of liabilities after the crisis.

A second way to investigate whether the mechanism we suggest — credit constraints — is at the root of the shift in the investment vector towards shorter time-to-payoff relies on the observation that firms with a lot of mature debt at the beginning of a financial crisis also tend to be more affected by it because they experience difficulty in rolling their debt over under a credit crunch (Almeida et al 2011). Therefore we use the ratio of short term debt over total debt to identify more affected firms. Our estimates are again consistent with the evidence from before: these firms reduce long term investment relatively more than shorter term investments compared to other firms.

Our finding that credit constraints are eating the long term future profits of firms in order to guarantee survival for another day complements a large literature that has established that financially constrained firms invest less,¹ and recent studies that use the world wide financial crisis in 2007/2008 as an exogenous shock to the credit supplied by banks.² A smaller literature has studied how credit rationing affects the composition of firm investments. For example, see Eisfeldt and Rampini (2007) for the allocation of investment between new and used capital, as well as Campello et al. (2010), who point out that firms cut technology and marketing investment by more than capital investment, but do not offer an explanation why certain investment types might be more affected than others.

But beyond these findings we believe that our paper points a way forward in learning about credit shocks. We show how the rotation in the investment vector towards the present and away from the

¹Whited 1992, Carpenter et al. 1994, Hubbard et al. 1995, Bernanke 1996, Kaplan and Zingales 1997, Lamot 1997, Cleary 1999, Klein et al. 2002, Amiti and Weinstein 2013, Fazzari et al. 1988.

²Campello et al 2010, Duchin et al 2010, Almeida et al 2011, Kuppupswamy and Villalonga 2012.

future informs us about the existence and the size of the credit crunch. Furthermore, we believe that this shift in the investment vector could have a macroeconomic impact: Reducing long-term investment is likely to have a long term impact on the Spanish economy, impeding recovery after the financial crisis, and reducing long-term economic growth.

2 Theoretical Framework and identification

2.1 Theory: Investment duration and liquidity risk

Most theoretical analysis of liquidity constraints aggregates all investment into one single decision (e.g. Kiyotaki and Moore, 1997). Instead, we assume that a profit maximizing firm can choose between two types of investment: **short-term investments** k_t yield an immediate payoff of $f(k_t)$, while **long-term investments** z_t yield a higher payoff $(1 + \rho)f(z_t)$ which is paid out at a later period. To capture this trade-off we rely on a model that is a simplified version of Aghion et al. (2009). The key difficulty of firms is that with probability $1 - \lambda_{t+1}$ a liquidity crisis in the interim period before the payoff of the long term investment is realized, which may simply force the firm to liquidate. Thus the probability of survival λ_{t+1} measures the probability that the entrepreneur will have enough funds to cover the liquidity shock and is allowed to depend on the levels of short and long term investments. Specifically, reallocating investments from long to short term increases the probability of survival, $\left(\frac{\partial \lambda_{t+1}}{\partial k_t} - \frac{\partial \lambda_{t+1}}{\partial z_t}\right) > 0$. The choice of how much short run and long run investment to undertake is then given by:

$$\max_{k_t, z_t} \mathbf{E}_t [f(k_t) + \beta \lambda_{t+1} (1 + \rho) f(z_t) - q_t k_t - q_t z_t] \quad (1)$$

where λ_{t+1} measures the probability that the entrepreneur will have enough funds to cover the liquidity shock, ρ is the additional productivity of long term investment, and the rest of terms have their usual meanings.

The first order condition with respect to k is:

$$\mathbf{E}_t [f'(k_t)] + \beta \mathbf{E}_t \left[\frac{\partial \lambda_{t+1}}{\partial k_t} (1 + \rho) f(z_t) \right] = q_t, \quad (2)$$

and with respect to z :

$$\beta \mathbf{E}_t [\lambda_{t+1} (1 + \rho) f'(z_t)] + \beta \mathbf{E}_t \left[\frac{\partial \lambda_{t+1}}{\partial z_t} (1 + \rho) f(z_t) \right] = q_t. \quad (3)$$

Combining the two equations, we obtain the marginal condition:

$$\mathbf{E}_t [f'(k_t)] = \beta \mathbf{E}_t [(1 - \tau_{t+1}) (1 + \rho) f'(z_t)] \quad (4)$$

where

$$\tau_{t+1} = (1 - \lambda_{t+1}) + \left(\frac{\partial \lambda_{t+1}}{\partial k_t} - \frac{\partial \lambda_{t+1}}{\partial z_t} \right) \frac{f(z_t)}{f'(z_t)}.$$

This contrasts with the first best, absent liquidity shocks, when it should be the case that the marginal value of a dollar is equalized across both types of investments:

$$\mathbf{E}_t [f'(k_t)] = \beta \mathbf{E}_t [(1 + \rho) f'(z_t)]. \quad (5)$$

Thus the risk that the firm will run out of cash in period $t+1$ works exactly like a tax on investment τ_{t+1} and reduces the value of the (a priori more profitable) long term investments relative to the first best. The first term of this wedge, $(1 - \lambda_{t+1})$, captures the probability of failure. The second term captures the marginal change in this probability as we reallocate investment from long term to short term. Given that reallocating investments from long term to short term increases the probability of survival, the tax wedge $\tau_{t+1} > 0$. Hence the reallocation away from long term investment opportunities to short term ones is higher the higher the probability of avoiding bankruptcy by doing this, the higher the probability of not having enough liquidity next period, and the lower the marginal productivity of long run investments.

The model predicts that credit constrained firms will reduce long term investment by more than short term investment in order to secure survival. Next we discuss how we implement this idea empirically.

2.2 Identification

Our theoretical framework suggests a new empirical strategy, closely linked to the theory, that can help us to identify credit shocks. To get exact expressions, we assume that the function f is Cobb Douglas, that is $y = k^\alpha$ (as usual everything goes through as a log linear approximation otherwise).

Suppose that there are good ex-ante reasons to expect liquidity to be plentiful before the shock to credit supply (denoted by subscript b), and to expect liquidity to be scarce after the credit shock (denoted by subscript a). Then we have from (5) that, for a given firm i ,

$$f'(k_b^i) = \beta(1 + \rho)f'(z_b^i)\varepsilon_b^i \quad (6)$$

where we assume ε_i is an i.i.d. log normal error term with mean 1. Thus, in logs, and using the Cobb-Douglas specification

$$(\alpha - 1) \ln k_b^i = \ln(\beta(1 + \rho)) + (\alpha - 1) \ln z_b^i + \ln \varepsilon_b^i.$$

While after the liquidity crunch we have, from (4):

$$(\alpha - 1) \ln k_a^i = \ln(\beta(1 + \rho)) + \ln(1 - \tau_{t+1}^i) + (\alpha - 1) \ln z_a^i + \ln \varepsilon_a^i.$$

This immediately suggests a difference in differences estimator as the way to identify the wedge introduced by the liquidity shock in firm i . Specifically, the difference in difference estimator is:

$$(1 - \alpha) ((\ln z_a^i - \ln z_b^i) - (\ln k_a^i - \ln k_b^i)) = \ln(1 - \tau_{t+1}^i) + \ln \varepsilon_a^i - \ln \varepsilon_b^i$$

where $\mathbf{E}(\ln \varepsilon_a^i - \ln \varepsilon_b^i) = 0$.

Now consider the following difference-in-differences specification using investment I in investment category $c = k, z$ as dependent variable:

$$\ln I_{ict} = \beta_0 + \beta_1 * \text{crisis}_t * \text{longterm}_c + \text{crisis}_t + \text{longterm}_c + \nu_{ict}$$

where crisis_t is a dummy variable that turns 1 in the years of a financial crisis, and longterm_c is a dummy variable indicating a long term investment (i.e. it equals 1 if investment type $c = z$). In this specification the coefficient on the interaction term equals:

$$\beta_1 = \mathbf{E}((\ln I_{iza} - \ln I_{izb}) - (\ln I_{ika} - \ln I_{ikb}))$$

However, this last expression equals, up to a factor, the wedge between long term and short term investments, which has a clear economic interpretation in the theory:

$$\beta_1 = \frac{\mathbf{E}(\ln(1 - \tau_{t+1}))}{(1 - \alpha)}$$

In reality and in our data we have more than two investment categories, thus we generalize our formula above to multiple investment types. Furthermore we can include firm times year fixed

effects as well as investment category fixed effects to make sure that the structural equation above is identified. This leads to our estimated regression equation:

$$\ln I_{ict} = \beta_0 + \beta_1 * \text{crisis}_t * \text{duration-of-investment}_c + \text{firm} * \text{year FE}_{it} + \text{category FE}_c + \nu_{ict} \quad (7)$$

3 Data

3.1 Identifying Long and Short Term Investments

The theory allows us to make predictions about the behaviour of different investment categories depending on the horizon over which they pay off. For the model to guide our empirical work, we need a taxonomy of tangible and intangible investments by their durability. While accountants and growth accountants have produced a large body of work aiming to estimate the durability of tangible investments, the literature on intangible investment lifespan is somewhat less extensive.

The shortest lived investment category is brand equity and advertising. Landes and Rosenfield (1994) estimate the annual rates of decay of advertising to be more than 50% for most industries, using 20 two-digit SIC manufacturing and service industries. For a number of industries they even find that the effect of advertising doesn't persist until the following year. A more recent literature review by Corrado et al. (2009) concludes that the depreciation rate for advertising is 60%. They also note that 40% of advertising expenditure is spent on advertisements that last less than a year, e.g. on "this week's sale", which partly explains the short-lived impact of advertising.

The literature reports a depreciation rate of around 30% for software investments. The Bureau of Economic Analysis (BEA 1994) estimated a depreciation rate of 33% for a 5 year service life, according to Corrado et al (2009). Tamai and Torimitsu (1992) report a 9 years average life span for software (between 2 and 20 years), relying on industry estimates based on survey evidence. The Spanish accounting rules give a depreciation rate of 26% for IT equipment and software, so we use a value of around 30% as summarizing the evidence in our main specification.

The evidence on the average depreciation rates and average lifespans of R&D capital is extensive, and estimates range from 10-30%. Pakes and Schankerman (1984, 1986) propose 25% based on 5 European countries, and 11-26% in a later study for Germany, UK and France. Nadiri and

Prucha (1996) estimated a rate of 12% for R&D, while Bernstein and Mamuneas (2006) estimate the depreciation rate at 18-29%. Corrado et al. (2009) review the literature and settle on a value of 20% for R&D, which is the value we are using for our main analysis.

Longer lived investments include fixed tangible assets like machinery, vehicles and other equipment. Both the Spanish³ and the BEA's⁴ accounting rules yield similar values for these types of investment, with vehicles having a depreciation rate of around 16%, machinery around 12% and furniture and office equipment around 10%.

The longest lived investments are investments into real estate, i.e. land and buildings. According to the BEA's estimates, industrial and office buildings have a depreciation rate between 2-3%. Spanish accounting rules specify a very similar depreciation rate for buildings of 3%. It's harder to make a general statement about the depreciation of land. While land clearly is long-lived, many factors determine the price of land and therefore the implicit depreciation rate.

Our summary of the literature to classify investment types into time-to-payoff is presented in Table 1, ranked from the shortest to the longest time-to-payoff. We use our summarized depreciation rates as well as the ranks for our estimation and regroup some categories when there is some ambiguity as robustness checks. However, our results are robust to these checks.

3.2 Data

We rely on the Encuesta Sobre Estrategias Empresariales (ESEE), a panel of Spanish manufacturing firms. This data has been collected by the Spanish government and the SEPI foundation every year since 1990. The survey covers around 1,800 Spanish manufacturing firms per year, which include all firms with more than 200 employees and a stratified sample of smaller firms. The coverage is about 50-60% of large firms, and 5-25% of small firms. The sample started out as a representative sample of the population of Spanish manufacturing firms. In order to reduce the deterioration of representativeness due to non-responding firms, every year new companies are re-sampled in order to replace exiting ones.

In contrast to balance sheet firm level data bases, which usually report only a single investment number for each firm, the Spanish data covers a number of different investment choices made by firms. A number of variables can be linked to our investment categories based on time-to-payoff: advertising expenditure, IT expenses, R&D expenses, investment into vehicles, machinery, and

³Please see http://www.individual.efl.es/ActumPublic/ActumG/MementoDoc/MF2012_Coeficientes%20anuales%20de%20amortizacion_Anexos.pdf

⁴Please see http://www.bea.gov/scb/account_articles/national/wlth2594/tableC.htm

furniture & office equipment, as well as investment into land and buildings.

Besides these main investment variables, we also have data on the credit ratio of firms, and other complementary variables such as sales, exports and foreign ownership, which we will use for several types of robustness checks.

Table 2 presents summary statistics for the main variables that are the object of our analysis, before and after the crisis. The data shows that investment in all categories fell after the financial crisis in 2008. However, ex ante it is not clear whether this investment drop is triggered by the credit squeeze or the adverse demand shock. Our empirical strategy aims to disentangle these effects.

It is notable that investment into buildings show the largest statistically significant drop in investment. Land and buildings are also the longest lived investment categories. However, since the financial crisis in Spain was based on a real estate bubble which led to falling real estate prices, it seems safer to exclude land and building from our analysis as it would bias our results towards finding our hypothesized effect: The fall in building and land investment might reflect a fall in prices due to the burst of the real estate bubble rather than be caused by the credit squeeze.

The credit crunch triggered by the financial crisis is also reflected in the Spanish credit data: total credit as a percentage of total assets (the credit ratio) fell by 3 percentage points after the crisis, from 57% to 54%. At the same time, observed average credit cost increased by 0.22 percentage points, from 4.06% to 4.28%. This is obviously a lower bound on the increased cost, as firms often simply could not get access to credit. Together with the observed immediate drop in the credit ratio this suggests that we observe a credit supply rather than a credit demand shock immediately after the financial crisis hit.

4 Results

4.1 Differential effect across investment types

Table 3 presents our main results from estimating regression equation 7. The dependent variable is the log of investment of firm i in year t in investment category c , where investment categories include the six investment types specified above: advertising, IT, R&D, vehicles, machinery, and furniture & office equipment. The main regressor is an interaction term of the inverse of the depreciation rate of an investment category as a measure of the time-to-payoff of an investment type as given by Table 1 and a time dummy variable that indicates the financial crisis ($=1$ in and after 2008). Column (1) implements the regression equation with just category and firm fixed effects. The coefficient on

the interaction term is negative, implying that investments with a longer time-to-payoff fell more after the financial crisis than investments with a shorter time-to-payoff. The coefficient on the crisis dummy is also significant and strong, showing that average investment fell by 17 percentage points after the crisis. In column (2) we replace the crisis dummy with year fixed effects, which doesn't change the coefficient on the interaction term.

It is possible that the demand shock rather than the credit squeeze drives our result. In column (3) we control for firm times year fixed effects. If demand shocks don't have a differential effect across investment types, we manage to control for them in column (3). The magnitude of the effect increases somewhat and stays significant after introducing the firm year fixed effects. Note that in contrast to other papers on the effect of credit squeezes on investment this is likely to be a lower bound of the true estimate, because if demand shocks affect investment types differentially, they are likely to affect investments with a shorter time-to-payoff by more than investments with a longer time-to-payoff (the recession will, after all, finish at some point in the future). It is common that investment observations are often 0 and thus excluded from the analysis (in logs). Column (4) codes the 0's as 1 euro and thus includes all those observations. The results are substantially stronger, suggesting our baseline analysis is very conservative.

Table 4 uses alternative measures for time-to-payoff instead of the inverse of the depreciation rate. For example, column (2) uses the rank of investment types according to depreciation rates, using the highest rank for investment with the longest time-to-payoff. Since the estimated depreciation rates in the literature vary within investment types and sometimes overlap, we regroup the investment categories in the remaining columns of the table. For example, the depreciation rates of R&D and IT are not that different in the literature, so we group them together. Also machinery and furniture have quite similar depreciation rates, justifying a similar treatment. However, our finding is robust across all these alternative measures for time-to-payoff. The magnitudes of the effect differ, but this is because the different measures use different units.

How can we interpret the economic significance of our effect? Our preferred specification in column (3) in Table 3 tells us that investment falls by 2 percentage points for a unit increase in the inverse depreciation rate. When we compare advertising, the investment category with the highest depreciation rate, to furniture and office equipment, the category with the lowest depreciation rate, the inverse depreciation rate increases by 8.3, so we need to multiply the regression coefficient by this value. This leads to our main result: Investment in office equipment gets reduced by 17 percentage points more than advertising expenditure. This is quite a sizeable difference across investment

categories.

Our theory suggests another way to interpret this result: as a tax on capital. Recall that

$$\beta_1 \approx \frac{\ln(1 - \tau_{t+1})}{(1 - \alpha)}$$

Given that the investment gap between capital with the shortest and longest time-to-payoff (β_1 in the theory) is 17% and using $\alpha = 1/3$ (the capital share), this means that the credit crunch is equivalent to an 11% tax on the long run investments relative to the shortest run one ($\tau_{t+1} = 1 - \exp(-0.17 * 2/3) = 10.6\%$).

4.2 Placebo test

So far we have pooled the estimated effect across all years before and after the crisis, respectively. In order to make sure we are capturing the effect of the credit squeeze instead of something else, we check whether the timing of the effect really coincides with the credit squeeze. Therefore we allow the interaction term to vary with each year of the sample, the results are given in Table 5. The change in coefficients over time supports our story: In column (1) the coefficient becomes negative (but still insignificant) in the year 2008, and becomes even more negative and highly significant thereafter. This timing is consistent with the development of the credit squeeze: After the failure of Lehman Brothers in September 2008, conditions tightened severely. 2009 was the first full year in which the effects of the credit crunch were fully spread.

The effect is even more visible in Figure 1, where we plot the coefficients of the regression estimated in column (1) in Table 5 over time. While there was not much going on before the crisis, from 2008 on the reduction in long term investment became apparent.

4.3 Mechanism: credit crunch

In this section we aim to further pin down credit constraints as cause for the observed change in the investment behaviour, as opposed to, for example, the effect of an increase in uncertainty. If our hypothesis is true, we should expect to see a differential effect on firms that are more affected by the credit crunch compared to firms that are less affected.

The literature suggests two types of firms that are typically affected more by credit constraints than others. First, domestic firms are typically more affected by a credit squeeze on domestic banks, since foreign firms have access to external finance in other countries that are less affected via their parent companies (Desai et al 2004, Kalemli-Ozcan et al. 2010).

Second, firms that happen to have a lot of mature debt at the beginning of a financial crisis also tend to be more affected by it because they experience difficulty in rolling their debt over under a credit crunch (Almeida et al 2011).

In the following we test whether we see a differential effect of the credit crisis across these two types of firms.

Foreign versus domestic firms

We start our analysis by looking at foreign versus domestic firms. If it is true that foreign firms are less affected by a credit squeeze, then we should observe a fall in the credit ratio only for domestic firms. Table 6 tests this. In column (1) we find that the credit ratio, defined by total credit divided by assets, on average fell after the crisis, a result that was already visible from the summary statistics in Table 2. Column (2) controls for industry specific demand conditions using the industry's exports and size as a time varying control. Also, firm level fixed effects allow us to control for any other time invariant unobserved firm heterogeneity.

Column (3) compares the drop between Spanish and foreign owned firms and answers the question: comparing two firms of the same size that are facing the same demand conditions, does the firm that happens to be Spanish suffer a significant drop in credit after the crisis? The answer is unambiguous and highly significant: Spanish firms suffer a drop in credit of around 2.5 percentage points after the crisis compared to non-Spanish firms. In column (4) we add time fixed effects to capture any common, time varying aspects of the crisis that are not yet captured by industry exports or size, and the effect remains the same. Column (5) is our most demanding specification, which allows for industry specific time effects (and thus absorbs our previous industry specific controls), and the result is again stronger, with Spanish firms facing a credit drop of 3.5 percentage points. This is equivalent to a 6.1% drop in credit relative to the 2007 baseline of 57.8% credit to assets for Spanish firms before the crisis.

Thus under our hypothesis, the shift in the composition of investment (if linked to credit) should only occur in Spanish firms. In Table 7 we start the analysis by running the main regression separately for domestic and foreign firms. Only the effect in column (1) is negative and statistically significant, suggesting that only domestic firms cut their long term investment relatively more than their short term investment. There is no significant difference across investment types for foreign owned firms.

In columns (3) and (4) we again conduct the placebo tests by allowing the interaction term to

vary by year. Again we see that the effect is driven by domestic firms, in line with our hypothesis. Figure 2 shows this visually, we see the strong drop in long term investments only for domestic firms after 2008.

We can test this more formally by extending our analysis therefore to a triple difference estimation, comparing long-term versus short-term investments before and after the financial crisis in 2008 for Spanish versus foreign firms. This allows us to further challenge our results by including *category times year* fixed effects to control for the possibility that firms might reduce or increase investment in certain categories during recessions. The resulting estimating equation is:

$$\ln I_{ict} = \beta_0 + \beta_1 * \text{crisis}_t * \text{duration-of-investment}_c * \text{domesticfirm}_i \quad (8)$$

$$+ \beta_2 * \text{duration-of-investment}_c * \text{domesticfirm}_i \quad (9)$$

$$+ \text{firm} * \text{year} \text{ FE}_{it} + \text{category} * \text{year} \text{ FE}_{ct} + \nu_{ict}. \quad (10)$$

Table 8 shows the results of the triple difference specification. It shows a significant differential negative effect for long term investments after the crisis undertaken by Spanish firms. As in our baseline case, column (4) codes the 0's as 1 euro and thus includes all the 0 investments. Again the results are substantially stronger, suggesting our baseline analysis is very conservative.

The differential effects for domestic firms by investment category and over time are visualized in Figure 3. Darker lines depict investment types with a longer time-to-payoff, i.e. for which we would expect a larger drop. The visual evidence is broadly in line with our hypothesis, as lighter lines show a smaller, and darker lines show a larger drop after 2008. It is also notable that until 2007 there is no differential effect by investment types, the lines are all parallel and very close. The differential effect only starts to come in after 2007, when the credit crunch hits.

A worry is that domestic and foreign owned firms differ among a variety of other dimensions besides access to external funding. For example, Spanish owned firms in our data are typically smaller and less likely to export and might therefore show a different investment behaviour. To address this concern, Table 9 conducts a variety of robustness checks. One dimension of time-varying, unobserved heterogeneity might be differences between companies that operate across countries and those that operate in a single country. Companies that operate in many countries belong to a corporate group, and this could provide companies with advantages that go beyond their access to capital. For example they might face a more diversified demand. Column (2) conducts our analysis

only for companies that belong to a corporate group, presumably most of them are multinationals. The results are pretty remarkable. Even though the sample size drops very substantially (by more than half), the effect remains remarkably similar and highly significant. Column (3) restricts the sample to firms that have non-industrial plants in foreign countries. The drop in the sample size is now enormous, yet the effect remains. The finding is similar in column (4), in which we restrict the sample to firms that have share holdings in foreign countries.

Column (5) uses another way to make the control group of foreign firms a more suitable counterfactual for the treatment group of domestic firms by applying inverse propensity score weights. This type of matching estimator reweights each observation by its (inverse) propensity score (the “likelihood” that a firm belongs to the treatment group, i.e. is under Spanish ownership) in order to generate the same distribution of (observed) characteristics of treatment and control group, and therefore hopefully also match the unobserved time varying heterogeneity better. We construct propensity scores based on sales and export status (as these observables seem to be the major differences between Spanish and foreign owned firms) of all pre-treatment years based on probit regression of the treatment (i.e. Spanish ownership) on sales and export status in all years between 2003 and 2007. The predicted values of these regressions, \widehat{treat} , are then used to calculate inverse propensity score weights $psw = \frac{\widehat{treat}}{1-\widehat{treat}}$ for each firm, which we use these weights for all firms in the control group in our regression (for more details on the method, see DiNardo et al. 1996 and Nichols 2007 and 2008).

Our results from the inverse propensity score reweighing in column (5) are also robust to this test. Most of the results are numerically very close to the baseline specification, suggesting that selection is not a major concern in our analysis.

The last column in Table 9 analyzes whether firm size is driving the results by including interaction terms with $\ln(\text{sales})$ besides the interaction term with domestic firms. However, size fails to explain the differential drop in investment, the ownership interaction remains significant and its magnitude is unchanged in spite of including this competing explanation.

A separate concern is the extent to which differential exit rates of Spanish and foreign owned firms could explain these results. Suppose simply that ‘worse’ firms are exiting. If ‘worse’ firms are those that feature more long term investments, then we shall see more short term investment and less long term ones in the surviving data. This seems unlikely a priori, as we tend to think of better firms as the ones doing more long term investment. In any case, the exit rates among Spanish versus foreign firms behave very similarly, as Figure 4 shows: Exit rates are not statistically

significantly different, which in fact suggests that our mechanism is operating: Firms reduce their long run investments to generate liquidity, and manage to survive another day.

A final concern is the mechanism through which this process takes place. Specifically, while we postulate in the theory that it takes place through the asset side of the balance sheet (firms have less access to credit in general and decide to cut long-term investments), an alternative hypothesis is that it takes place through the liability side: firms have less access to long-term credit, and therefore cut long-term investment because otherwise they cannot match the liabilities and investments by debt maturity. To test this, in Table 10 we check whether domestic firms suffered a differential drop in long term credit (as a ratio of total credit) compared to foreign firms, using the same specification as in Table 6. However, while Spanish firms suffer from access to credit in general as shown in Table 6, there is no differential effect with respect to long-term credit as opposed to short term credit. So a differential liability matching does not explain our results.

Firms with maturing debt just before the crisis

An alternative approach to studying the mechanism that does not rely on using nationality of ownership as the driver of credit constraints is to use firms whose debt is maturing just before the crisis as a treatment group. These firms are likely to be more severely affected by the credit squeeze as they have to roll over their debt when the crisis starts. We use short term credit with financial institutions divided by total credit in 2007, the year before the crisis, as measure for more credit constrained firms in Table 11. Column (1) repeats our main specification from before using domestic firms as treatment. Column (2) uses a dummy variable if this short term credit ratio is larger than average, and column (3) uses the ratio itself as a continuous measure. Both columns show a very similar effect than our comparisons of domestic to foreign firms, and the magnitude is also similar: More credit constrained firms cut long-term investment relatively more.

5 Conclusions

We have shown how to measure the extent of a credit crunch by analyzing changes in the composition of investment *within firms*. Intuitively, the extent to which firms are altering the composition of investment away from longer time-to-payoff towards more immediate payoff is a measure of the risk that the firms perceive of facing liquidation due to lack of access to cash over the relevant period. In this sense, our measure of the credit crunch yields a clearly identified economic parameter which

is readily interpretable: the credit shock is equivalent to a 11% additional tax on the investment with the longest payoff horizon.

We have tested the hypothesis underlying our methodology by conducting a wide range of robustness and alternative specification tests. Our results have proven remarkably resilient to quite demanding alternatives, such as including firm size times investment duration, category year fixed effects, etc. in addition to the firm times year fixed effects which we include already in the baseline specification. We have also studied the linkage we proposed by analyzing whether the effects are particularly strong for firms that are a priori expected to suffer stronger from the credit crunch: domestic firms, and firms with more maturing debt. Indeed, the effects are stronger for these sets of firms.

Our results suggest that the breakdown of the single European capital market is likely to have long term effects on Spanish firms. Spanish firms which are affected by the credit squeeze cut investments with a medium- to long-term payoff, such as R&D, innovation and capital investment, by more than investment with a short-term payoff such as advertising. Credit constraints force Spanish firms to eat up their future and act as if only the immediate future, tomorrow, mattered. This is likely to have a long term impact on the Spanish economy, impeding recovery after the financial crisis, and reducing long-term economic growth.

Methodologically, our analysis yields estimates of the impact of the crunch that can serve as input for other models. The analysis can be easily extended to other locations, crises and other capital choices, for example by comparing changes in the ratio of used versus new capital equipment, which are induced by the financial crisis to measure the cost of the crunch.

REFERENCES

- Adrian, Tobias, Paolo Colla, & Hyun Song Shin. 2012. "Which Financial Frictions? Parsing the Evidence from the Financial Crisis of 2007-9." *NBER Macroeconomics Annual* 2012, Vol. 27
- Aghion, Philippe, George-Marios Angeletos, Abhijit Banerjee, Kalina Manova. 2009. "Volatility and Growth: Credit Constraints and the Composition of Investment." *Journal of Monetary Economics*, Vol. 51, Issue 6, pp. 1077-1106.
- Allen, Jim & Rolf van der Velden. 2002. "When do skills become obsolete, and when does it matter?". In de Grip, A., van Loo, J. and Mayhew, K. (Eds), "The Economics of Skills Obsolescence, Research in Labor Economics", pp. 27-51.
- Almeida, Heitor, Murillo Campello, Bruno Laranjeira, Scott Weisbenner, 2011. "Corporate Debt Maturity and the Real Effects of the 2007 Credit Crisis," *Critical Finance Review*, Vol 1, pp. 3-58.
- Amiti, Mary and David E. Weinstein. 2013. "How Much do Bank Shocks Affect Investment? Evidence from Matched Bank-Firm Loan Data." Working Paper.
- Arrazola, Maria and José de Hevia. 2004. "More on estimation of the human capital depreciation rate." *Applied Economics Letter*, Vol. 11(3), pp. 145-148.
- Barlevy, Gadi, 2007. "On the Cyclicity of Research and Development," *American Economics Review*, 97(4), 1131-1164.
- Bentolila, Samuel, Marcel Jansen, Gabriel Jimenez and Sonia Ruano. 2013. "When Credit Dries Up: Job Losses in the Great Recession." Working Paper
- Bernanke, Ben, Mark Gertler and Simon Gilchrist. 1996. "The Financial Accelerator and the Flight to Quality." *The Review of Economics and Statistics*, Vol. 78, No. 1, pp. 1-15.
- Bernstein, Jeffrey, I. and Theofanis P. Mamuneas, 2006 "R&D Depreciation, Stocks, User Costs and Productivity Growth for U.S. R&D Intensive Industries," *Structural Change and Economic Dynamics*, 17, 70-98.
- Bloom, Nicholas, 2009. "The impact of uncertainty shocks." *Econometrica*, Vol. 77, No. 3, 623-685.
- Bureau of Economic Analysis. 1994. "A Satellite Account for Research and Development." *Survey of Current Business*, November, 34-71.
- Campello, Murillo, John R. Graham, Campbell R. Harvey. 2010. "The Real Effects of Financial Constraints: Evidence from a Financial Crisis." *Journal of Financial Economics*, Vol. 97, pp. 470-487.

Carpenter, Robert E., Steven M. Fazzari, Bruce C. Petersen, Anil K. Kashyap, Benjamin M. Friedman. 1994. "Inventory Investment, Internal-Finance Fluctuations, and the Business Cycle." *Brookings Papers on Economic Activity*, Vol. 1994, No. 2 pp. 75-138.

Chava, Sudheer and Amiyatosh Purnanandam. 2011. "The effect of banking crisis on bank-dependent borrowers." *Journal of Financial Economics*, Vol. 99(1), pp. 116-135.

Chevalier, Judith A & Scharfstein, David S, 1995. "Liquidity Constraints and the Cyclical Behavior of Markups." *American Economic Review*, American Economic Association, vol. 85(2), pages 390-96

Chevalier, Judith A & Scharfstein, David S, 1996. "Capital-Market Imperfections and Countercyclical Markups: Theory and Evidence," *American Economic Review*, vol. 86(4), pages 703-25

Chodorow-Reich, Gabriel. 2013. "The Employment Effects of Credit Market Disruptions: Firm-level Evidence from the 2008-09 Financial Crisis." Working Paper

Cleary, Sean. 1999. "The Relationship between Firm Investment and Financial Status." *Journal of Finance*, Vol. 54, No. 2, pp. 673-692.

Corrado, Carol, Charles Hulten, Daniel Sichel, 2009. "Intangible Capital And U.S. Economic Growth," *Review of Income and Wealth*, International Association for Research in Income and Wealth, Vol. 55(3), pp. 661-685.

de Grip, Andries and van Loo, Jasper. 2002. "The economics of skill obsolescence: a review", in de Grip, Andries, van Loo, Jasper and Mayhew, Ken (Eds), "The Economics Of Skills Obsolescence", *Research in Labor Economics*, Elsevier, Amsterdam, pp. 1-27

Desai, Mihir A. & C. Fritz Foley & James R. Hines, 2004. "A Multinational Perspective on Capital Structure Choice and Internal Capital Markets," *Journal of Finance*, American Finance Association, vol. 59(6), pages 2451-2487

Desai, Mihir A., C. Fritz Foley, Kristin J. Forbes. 2008. "Financial Constraints and Growth: Multinational and Local Firm Responses to Currency Depreciations", *The Review of Financial Studies*, Vol. 21, No. 6, pp. 2857-2888.

DiNardo, J., N. M. Fortin, & T. Lemieux. 1996 "Labour market institutions and the distribution of wages, 1973-1992: A semiparametric approach." *Econometrica*, Vol. 64(5), pp. 1001-1044.

Duchin, Ran, Oguzhan Ozbas and Berk A. Sensoy. 2010. "Costly external finance, corporate investment, and the subprime mortgage credit crisis", *Journal of Financial Economics*, Vol. 97, issue 3, pp. 418-435.

Eisfeldt, Andrea L. and Rampini, Adriano A., 2007. "New or used? Investment with credit

constraints,”” *Journal of Monetary Economics*, vol. 54(8), pp. 2656-2681.

Fazzari, Steven M., Robert Glenn Hubbard, and Bruce C. Petersen. 1988. “Financing Constraints and Corporate Investment.” *Brookings Papers on Economic Activity*, 19(1), pp. 141-206.

Groot, W. 1998. “Empirical estimates of the rate of depreciation of education”, *Applied Economics Letters*, Vol 5, pp. 535-538.

Hubbard, R. Glenn, Anil K. Kashyap, Toni M. Whited. 1995. “Internal Finance and Firm Investment” *Journal of Money, Credit and Banking*, Vol. 27, No. 3 pp. 683-701.

Iyer, Rajkamal, Samuel Lopes, José-Luis Peydró, and Antoinette Schoar. 2010. “Interbank liquidity crunch and the firm credit crunch: evidence from the 2007-2009 crisis”. Working paper.

Ivashina, Victoria, David Scharfstein. 2010. “Bank lending during the financial crisis of 2008,” *Journal of Financial Economics*, Vol. 97(3), pp. 319-338.

Jimenez, Gabriel & Steven Ongena & Jose-Luis Peydro & Jesus Saurina, 2012. “Credit Supply and Monetary Policy: Identifying the Bank Balance-Sheet Channel with Loan Applications,” *American Economic Review*, American Economic Association, vol. 102(5), pp. 2301-26.

Kalemli-Ozcan, Sebnem, Herman Kamil, and Carolina Villegas-Sanchez. 2010. “What Hinders Investment in the Aftermath of Financial Crises: Insolvent Firms or Illiquid Banks?” NBER Working Papers 16528.

Kaplan, Steven N. and Luigi Zingales. 1997. “Do Investment-Cash Flow Sensitivities Provide Useful Measures of Financing Constraints?”. *Quarterly Journal of Economics* , Vol. 112, No. 1, pp. 169-215.

Kiyotaki, Nobuhiro and John Moore. 1997. “Credit Cycles.” *Journal of Political Economy* , Vol. 105, No. 2 , pp. 211-248.

Klein, Michael, Joe Peek & Eric Rosengren. 2002. “Troubled Banks, Impaired Foreign Direct Investment: The Role of Relative Access to Credit.” *American Economic Review*, Vol. 92(3), pp. 664-682.

Kuppuswamy, Venkat and Belén Villalonga. 2012. “Does Diversification Create Value in the Presence Of External Financing Constraints? Evidence from the 2008–2009 Financial Crisis.” Working Paper.

Lamont, Owen. 1997. “Cash Flow and Investment: Evidence from Internal Capital Markets” *Journal of Finance*, Vol. 52, No. 1, pp. 83-109.

Landes, Elisabeth M. & Andrew M. Rosenfield (1994). “The Durability of Advertising Revisited.” *The Journal of Industrial Economics*, Vol. 42(3), pp. 263-276.

Lillard, L. and H. Tan. 1986. "Training: Who Gets It and What Are Its Effects on Employment and Earnings?", RAND Corporation, Santa Monica California.

Nadiri, M. Ishaq and Ingmar Prucha. 1996. "Estimation of the Depreciation Rate of Physical and R&D capital in the US manufacturing sector." *Economic Inquiry*, Vol. 34 (1), pp. 43-56.

Nichols, Austin. 2007. "Causal inference with observational data." *The Stata Journal*, Vol 7(4), pp. 507-541.

Nichols, Austin. 2008. "Erratum and discussion of propensity score reweighting." *The Stata Journal*, Vol 8(4), pp. 532-539.

Pakes, Ariel, and Mark Schankerman. 1984. "The Rate Obsolescence of Patents, Research Gestation Lags, and the Private Rate of Return to Research Resources." In *R&D, Patents, and Productivity*, edited by Zvi Griliches, 73–88. Chicago, il: University of Chicago Press, for the National Bureau of Economic Research

Pakes, A. and M. Schankerman. 1986. "Estimates of the Value of Patent Rights in European Countries during the Post-1950 Period," *Economic Journal*, 96, 1052–76,

Paravisini, Daniel, Veronica Rappoport, Philipp Schnabl, and Daniel Wolfenzon. 2011. "Dissecting the Effect of Credit Supply on Trade: Evidence from Matched Credit-Export Data." 2011. *NBER Working Paper* 16975.

Rosen, S. 1976. "A theory of life earning." *Journal of Political Economy*, Vol. 84(4), pp. S45-S67

Santos, Joao C. 2011. "Bank Corporate Loan Pricing Following the Subprime Crisis." *Review of Financial Studies*, Vol. 24(6), pp. 1916-1943.

Tamai, T. and Torimitsu, Y. 1992. "Software Lifetime and its Evolution Process over Generations." Proc. Conference on Software Maintenance, Orlando, Florida, pp. 63-69.

Whited, Toni M. 1992 "Debt, Liquidity Constraints, and Corporate Investment: Evidence from Panel Data," *Journal of Finance*, Vol. 47, No. 4 , pp. 1425-146.

APPENDIX

TABLES AND FIGURES

Table 1. Depreciation rates of different investment types

| Investment type | Estimates in literature | Consolidated depreciation rate | Rank |
|------------------------------|---|---------------------------------------|-------------|
| Advertising and brand equity | <ul style="list-style-type: none"> • Landes/Rosenfield (1994): >50% for most industries; up to 100% for some industries • Corrado/Hulten/Sichel (2009) conclude on 60% from literature review, with some studies having larger and smaller depreciation rates (lower bound: Ayanian (1938) with 7 years) | 60% | 1 |
| Software/IT | <ul style="list-style-type: none"> • Corrado/Hulten/Sichel (2009): 33% for own-account software based on BEA (1994) • Tamai/Torimitsu (1992): 9 year average lifespan, ranging from 2 to 20 years • Spain accounting rules: 26% (IT equipment and software) | 30% | 2 |
| R&D | <ul style="list-style-type: none"> • Corrado/Hulten/Sichel (2009): 20% based on literature review • Pakes/Schankerman (1984): 25% based on 5 European countries • Pakes/Schankerman (1986): 11-12% for Germany, 17-26% for UK, 11% for France • Nadiri/Prucha (1996): 12% • Bernstein/Mamuneas (2006): 18%-29% for different US industries | 20% | 3 |
| Vehicles | <ul style="list-style-type: none"> • Spain accounting rules: 16% | 16% | 4 |
| Machinery | <ul style="list-style-type: none"> • Spain accounting rules: 12% • BEA accounting rules: 10.31%-12.25% | 12% | 5 |
| Furniture & office equipment | <ul style="list-style-type: none"> • Spain accounting rules: 10% • BEA accounting rules: 11.79% | 10% | 6 |
| Buildings | <ul style="list-style-type: none"> • Spain accounting rules: 3% • BEA: 2-3% (industrial and office buildings) | n/a* | n/a* |
| Land | <ul style="list-style-type: none"> • Spain accounting rules: depends on land prices • BEA: depends on land prices | n/a* | n/a* |

Notes: Spanish accounting rules are given in Table 2, “Tabla simplificada” of http://www.individual.efl.es/ActumPublic/ActumG/MementoDoc/MF2012_Coeficientes%20anuales%20de%20amortizacion_AneXos.pdf

* As the real estate crisis coincided with the credit crunch and resulted in large price drops in rest estate (e.g. of up to 90% in land), we have chosen conservatively not to include this in our analysis, see the text.

Table 2. Summary statistics.

| | Mean (Standard error) | | Change | Change in % |
|---|------------------------------|-----------------------------|-----------|----------------|
| | Before crisis (2003-2007) | After crisis (2008-2010) | | |
| <i>Investment categories, mn EUR (ordered by depreciation rate)</i> | | | | |
| Advertising | 150.99 (9.86) | 118.78 (12.79) | -32.21** | -21.3% ** |
| IT | 6.20 (0.52) | 3.86 (0.53) | -2.34** | -37.7% ** |
| R&D | 1.12 (0.13) | 1.05 (0.16) | -0.07 | -6.3% |
| Vehicles | 4.20 (0.60) | 6.10 (2.33) | -1.90 | -45.2% |
| Machinery | 198.57 (13.86) | 141.78 (13.50) | -56.79*** | -28.6% *** |
| Furniture & office equipment, | 37.73 (4.70) | 33.98 (5.35) | -3.75 | -9.9% |
| Buildings | 40.18 (4.71) | 23.17 (2.42) | -17.01*** | -42.3% *** |
| Land | 7.47 (0.75) | 5.57 (1.29) | -1.90 | -25.4% |
| <i>Credit</i> | | | | |
| Credit ratio (total credit/ total assets) | 0.57 (0.00) | 0.54 (0.00) | -0.03*** | -4.4% *** |
| Credit cost *, % | 4.06 (0.02) | 4.28 (0.03) | 0.22*** | 5.4% *** |

* Total cost of a credit (including interest rates, but also other fees) as a percentage of obtained credit.

Table 3. Main results.

Notes: The dependent variable is log of investment of firm i in year t in investment category c , where investment categories include 6 investment types: advertising, IT, R&D, vehicles, machinery, and furniture & office equipment. The main regressor is an interaction term of the inverse of the depreciation rate (a measure for time-to-payoff) of a investment category as a measure of the time-to-payoff of an investment type as given by Table 1 and a time dummy variable that indicates the financial crisis (=1 in and after 2008). All standard errors are clustered at the firm level, allowing for autocorrelation across time and across investment categories within the firm. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$. Observations are between 2003 and 2010. Column (4) codes the 0 euro observations as 1 euro in order to use the 0s as well, and shows our estimates are conservative without the 0s.

| DEPENDENT VARIABLE: ln(investment value) | (1) | (2) | (3) | (4) |
|---|----------------------|---------------------|----------------------|----------------------|
| (1/depreciation rate)* after 2008 dummy | -0.012** (0.005) | -0.012** (0.005) | -0.020*** (0.006) | -0.072*** (0.016) |
| After 2008 dummy | -0.170*** (0.031) | | | |
| Observations | 43,900 | 43,900 | 43,900 | 88,331 |
| Partial R-squared | 0.710 | 0.711 | 0.582 | 0.153 |
| Category FEs | YES | YES | YES | YES |
| Firm FEs | YES | YES | | |
| Year FEs | | YES | | |
| Firm*year FEs | | | YES | YES |
| Including 0's | | | | YES |

Table 4. Robustness checks: different measures for time-to-payoff

Notes: This table replicates the final specification in the previous table, but uses different measures for time-to-payoff (larger the more long-term an investment) across columns:

- (1) 1/depreciation rate; as before
- (2) Rank of investment type according to depreciation rate (higher rank for more long term investments)
- (3) 4 categories: short term (advertising; value 1), short/mid term (R&D, IT; value 2), long/mid term (vehicles; value 3), long term (machinery, furniture; value 4)
- (4) 3 categories: short term (advertising; value 1), mid term (R&D, IT; value 2), long term (vehicles, machinery, furniture; value 3)
- (5) 3 categories: short term (advertising; value 1), mid term (R&D, IT, vehicles; value 2), long term (machinery, furniture; value 3)

All columns include a full set of firm*year fixed effects to capture any demand specific effects driven by the crisis, as well as category fixed effects. All standard errors are clustered at the firm level, allowing for autocorrelation across time and across investment categories within the firm. *** p<0.01, ** p<0.05, * p<0.1. Observations are between 2003 and 2010.

| DEPENDENT VARIABLE: ln(investment value) | (1) | (2) | (3) | (4) | (5) |
|---|----------------------|----------------------|----------------------|----------------------|----------------------|
| (Time-to-payoff measure)* after 2008 dummy | -0.020*** (0.006) | -0.028*** (0.008) | -0.062*** (0.014) | -0.089*** (0.022) | -0.097*** (0.022) |
| Observations | 43,900 | 43,900 | 43,900 | 43,900 | 43,900 |
| R-squared | 0.582 | 0.582 | 0.582 | 0.582 | 0.582 |

Table 5. Placebo tests: treatment effect by year

Notes: This table replicates the specifications of Table 4, i.e. each column uses a different measure for time-to-payoff, with the exception that it allows the interaction term to vary in each year. All columns include a full set of firm*year fixed effects to capture any demand specific effects driven by the crisis, as well as category fixed effects. All standard errors are clustered at the firm level, allowing for autocorrelation across time and across investment categories within the firm. *** p<0.01, ** p<0.05, * p<0.1. Observations are between 2003 and 2010.

| DEPENDENT VARIABLE: ln(investment value) | (1) | (2) | (3) | (4) | (5) |
|--|----------------------|----------------------|----------------------|----------------------|----------------------|
| (year==2004)* (Time-to-payoff measure) | -0.003 (0.008) | -0.005 (0.010) | -0.016 (0.019) | -0.021 (0.028) | -0.035 (0.030) |
| (year==2005)* (Time-to-payoff measure) | -0.003 (0.009) | -0.006 (0.011) | -0.019 (0.021) | -0.013 (0.032) | -0.047 (0.034) |
| (year==2006)* (Time-to-payoff measure) | 0.005 (0.009) | 0.006 (0.012) | 0.004 (0.023) | 0.010 (0.034) | -0.007 (0.036) |
| (year==2007)* (Time-to-payoff measure) | 0.004 (0.009) | 0.005 (0.012) | -0.003 (0.023) | -0.009 (0.035) | -0.025 (0.036) |
| (year==2008)* (Time-to-payoff measure) | -0.003 (0.010) | -0.004 (0.013) | -0.021 (0.024) | -0.034 (0.036) | -0.060 (0.038) |
| (year==2009)* (Time-to-payoff measure) | -0.026** (0.010) | -0.037*** (0.013) | -0.088*** (0.025) | -0.123*** (0.038) | -0.149*** (0.040) |
| (year==2010)* (Time-to-payoff measure) | -0.032*** (0.010) | -0.046*** (0.014) | -0.101*** (0.025) | -0.134*** (0.039) | -0.161*** (0.040) |
| Observations | 43,900 | 43,900 | 43,900 | 43,900 | 43,900 |
| R-squared | 0.583 | 0.583 | 0.583 | 0.583 | 0.583 |
| <i>F tests on equality of coefficients:</i> | | | | | |
| F-stat 2007=2008 | 0.752 | 0.751 | 0.888 | 0.752 | 1.476 |
| p-val | 0.386 | 0.386 | 0.346 | 0.386 | 0.224 |
| F-stat 2007=2009 | 11.46 | 12.85 | 15.10 | 11.72 | 13.10 |
| p-val | 0.001 | 0 | 0 | 0.001 | 0 |
| F-stat 2007=2010 | 15.86 | 17.86 | 18.99 | 13.34 | 14.80 |
| p-val | 0 | 0 | 0 | 0 | 0 |

Figure 1. Change in composition of investment towards short term investments

This figure shows the coefficients of the regression in column (1) in Table 5 over time.

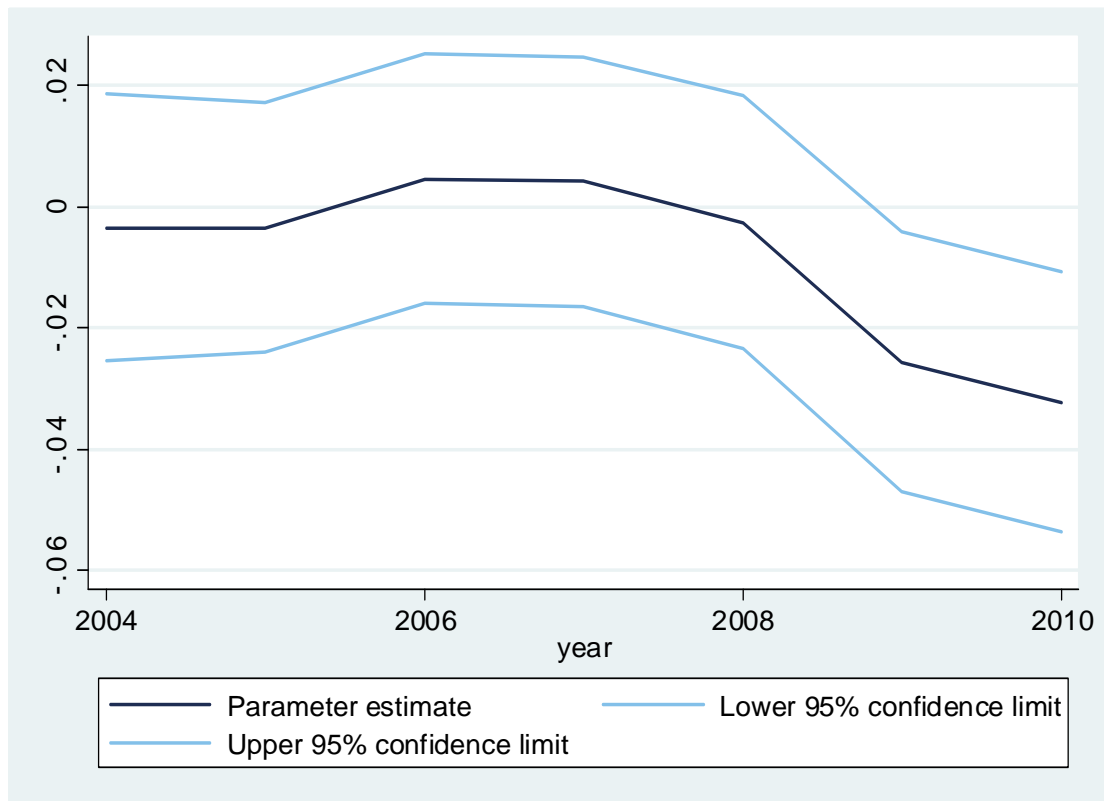


Table 6. Mechanism: Credit squeeze

Notes: This table shows that the financial crisis in 2008 triggered a credit squeeze, which especially affected Spanish owned firms. The dependent variable is credit ratio (total credit divided by total assets, ratio between 0 and 1). The main regressors are a dummy variable that indicates the financial crisis (=1 in and after 2008), and an interaction term of a Spanish ownership dummy (defined by $\leq 50\%$ foreign ownership in same year) and the crisis dummy variable. All columns include firm fixed effects. Columns (2)-(4) also control for industry specific demand variables (Spanish exports to EU, Spanish exports to the World, domestic value added per industry) to capture industry specific demand shocks of the recession driven by the financial crisis. Export data is from the WITS database provided by the Worldbank, and Spanish value added per industry is from National Accounts data provided by the Spanish National Institute of Statistics (INE). Column (4) includes year fixed effects to capture common time effects (the crisis dummy is absorbed by these fixed effects and therefore omitted). Column (5) includes a full set of industry*year specific fixed effects to capture any demand specific effects driven by the crisis (our industry controls are absorbed by these fixed effects and therefore omitted). All standard errors are two-way clustered at the firm and industry*year level. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$. Observations are between 2003 and 2010.

| DEPENDENT VARIABLE: Credit ratio (between 0 and 1) | (1) | (2) | (3) | (4) | (5) |
|---|----------------------|----------------------|----------------------|----------------------|----------------------|
| Dummy if after crisis (year \geq 2008) | -0.015*** (0.004) | -0.016*** (0.004) | 0.006 (0.010) | | |
| Interaction term (Spanish firms) * (after 2008) | | | -0.025*** (0.010) | -0.025*** (0.010) | -0.035*** (0.010) |
| ln(industry exports to EU) | | 0.021 (0.037) | 0.024 (0.037) | 0.058 (0.040) | |
| ln(industry exports to World) | | -0.009 (0.037) | -0.013 (0.037) | -0.056 (0.041) | |
| ln(industry output) | | 0.013 (0.013) | 0.014 (0.013) | 0.005 (0.015) | |
| Observations | 13,915 | 13,915 | 13,897 | 13,897 | 13,897 |
| R-squared | 0.004 | 0.005 | 0.007 | 0.002 | 0.003 |
| Number of firmid | 2,650 | 2,650 | 2,650 | 2,650 | 2,650 |
| Firm Fes | YES | YES | YES | YES | YES |
| Year Fes | | | | YES | |
| Ind*year Fes | | | | | YES |

Table 7. Foreign versus domestic firms

Notes: This table conducts our preferred specification separately for domestic firms (<50% foreign owned) and foreign firms (>50% foreign owned). Columns (1) and (2) pool the effect across post crisis years, columns (3) and (4) show the effect evolving over time. All columns include a full set of firm*year fixed effects to capture any demand specific effects driven by the crisis, as well as category fixed effects. All standard errors are clustered at the level, allowing for autocorrelation across time and across investment categories within the firm. *** p<0.01, ** p<0.05, * p<0.1. Observations are between 2003 and 2010.

| DEPENDENT VARIABLE: ln(investment value) | (1) (domestic only) | (2) (foreign only) | (3) (domestic only) | (4) (foreign only) |
|--|------------------------|-----------------------|------------------------|-----------------------|
| Long term investment* after 2008 dummy (year==2004)* | -0.029*** (0.006) | 0.018 (0.014) | -0.004 (0.009) | -0.002 (0.015) |
| Long term investment (year==2005)* | | | -0.009 (0.010) | 0.009 (0.018) |
| Long term investment (year==2006)* | | | 0.002 (0.010) | 0.005 (0.020) |
| Long term investment (year==2007)* | | | 0.003 (0.010) | -0.003 (0.021) |
| Long term investment (year==2008)* | | | -0.016 (0.011) | 0.045** (0.022) |
| Long term investment (year==2009)* | | | -0.035*** (0.011) | 0.006 (0.023) |
| Long term investment (year==2010)* | | | -0.043*** (0.011) | 0.005 (0.024) |
| Observations | 35,346 | 8,479 | 35,346 | 8,479 |
| R-squared | 0.566 | 0.661 | 0.566 | 0.661 |
| Sample | domestic firms | foreign firms | domestic firms | foreign firms |
| <i>F tests on equality of coefficients:</i> | | | | |
| F-stat 2007=2008 | | | 4.719 | 7.697 |
| p-val 2008 | | | 0.030 | 0.006 |
| F-stat 2007=2009 | | | 15.25 | 0.213 |
| p-val 2009 | | | 0 | 0.644 |
| F-stat 2007=2010 | | | 20.51 | 0.153 |
| p-val 2010 | | | 0 | 0.696 |

Figure 2. Investment change of long term investments by nationality of firm owner

This figure shows the coefficients of the regressions in columns (3) and (4) in Table 7 over time.

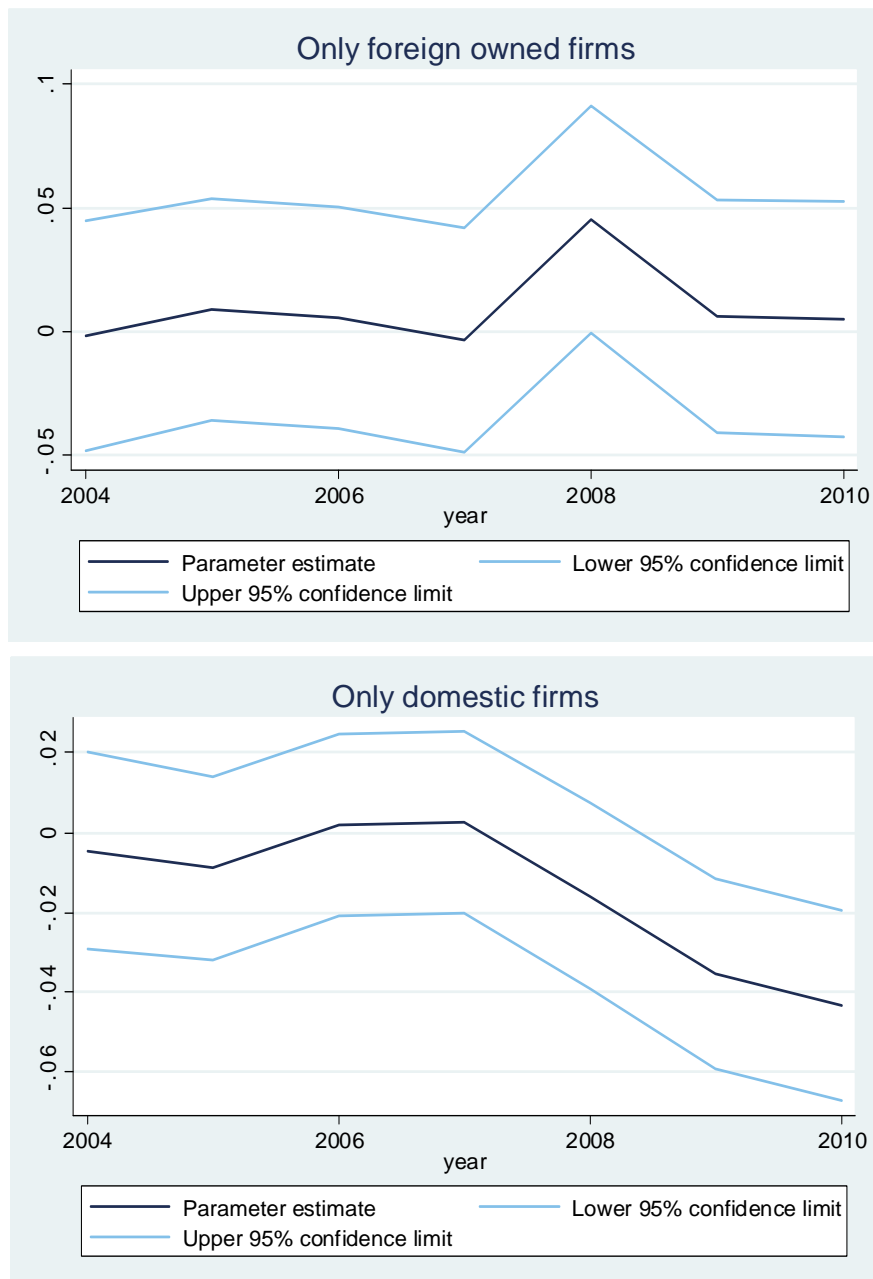


Table 8. Difference-in-difference-in-differences

Notes: This table implements a triple difference estimation using the interaction of time-to-payoff (here measured by the inverse of the depreciation rate), after crisis dummy (=1 in 2008 and after) and a domestic firm dummy (defined by $\leq 50\%$ foreign ownership in the same year). Note that the domestic firm dummy variable is not time invariant, as it changes with ownership changes. However, there are very few of those in the data, and they are not driving our results. All standard errors are two-way clustered at the firm and industry*year level. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$. Observations are between 2003 and 2010. Column (4) codes the 0 euro observations as 1 euro in order to use the 0s as well, and shows our estimates are conservative without including the 0s.

| DEPENDENT VARIABLE: ln(investment value) | (1) | (2) | (3) | (4) |
|---|--------------------|----------------------|----------------------|----------------------|
| (Time-to-payoff measure)* (after 2008 dummy) | -0.020* (0.012) | 0.020 (0.019) | | |
| (Time-to-payoff measure)* (after 2008 dummy)*(domestic firm dummy) | | -0.049*** (0.019) | -0.052*** (0.020) | -0.152*** (0.058) |
| (Time-to-payoff measure)* (domestic firm dummy) | | 0.033** (0.017) | 0.034** (0.017) | -0.314*** (0.048) |
| Observations | 41,550 | 41,475 | 41,475 | 88,223 |
| R-squared | 0.582 | 0.583 | 0.585 | 0.005 |
| Firm*year FEs | YES | YES | YES | YES |
| Category FEs | YES | YES | | |
| Category*year FEs | | | YES | YES |
| Including 0's | | | | YES |

Figure 3. Investment change by investment type, triple diff

Note: Darker lines depict investment types with a longer time-to-payoff, for which we would expect a larger drop.

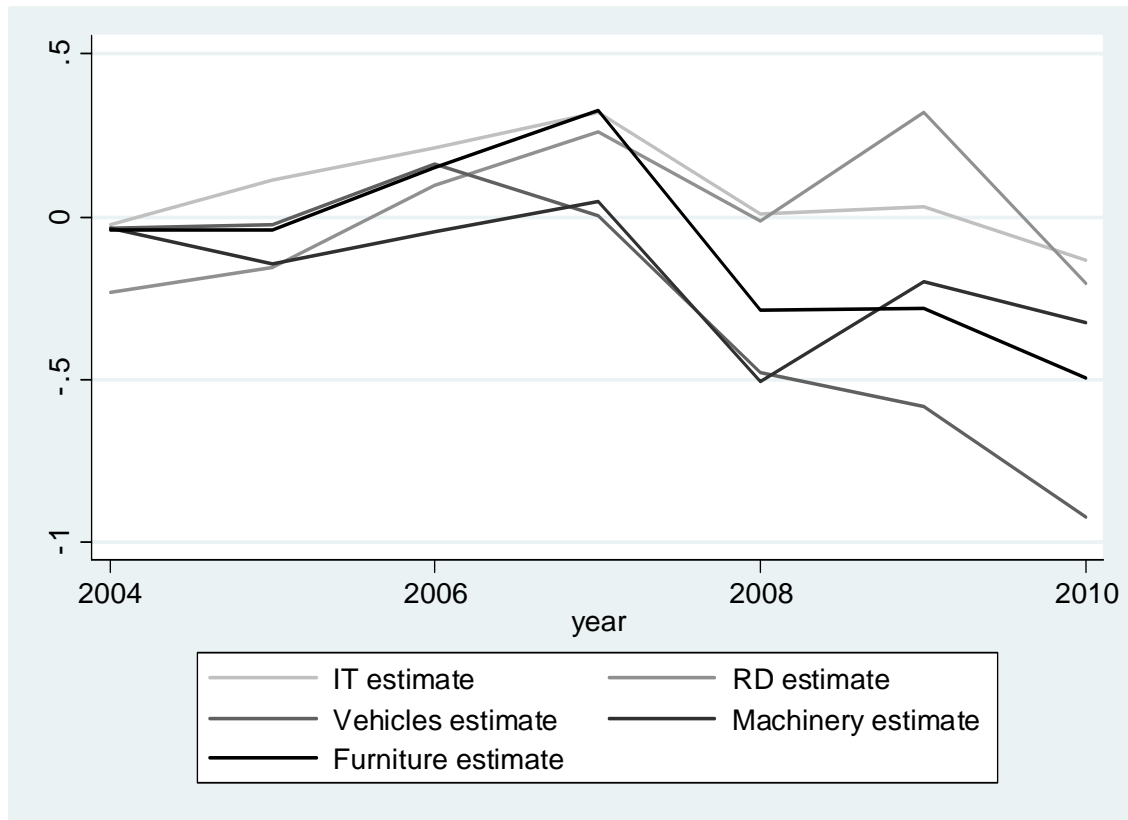


Table 9. Robustness checks foreign versus domestic firms

Notes: This table implements a triple difference estimation using the interaction of time-to-payoff (here measured by the inverse of the depreciation rate), after crisis dummy (=1 in 2008 and after) and a domestic firm dummy (defined by $\leq 50\%$ foreign ownership in the same year). The regressions in the columns are as follows:

1. Baseline, all companies
2. Only firms that belong to a corporate group
3. Only firms that have foreign non-industrial plants
4. Only firms that have foreign shareholdings
5. Inverse propensity score reweighting based on sales and exports in all the years between 2003 and 2007 (before crisis years)
6. Uses the baseline specification, but adds another interaction term with size as measured by $\ln(\text{sales})$

All standard errors are two-way clustered at the firm and industry*year level. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$. Observations are between 2003 and 2010.

| DEPENDENT VARIABLE: $\ln(\text{investment value})$ | (1) | (2) | (3) | (4) | (5) | (6) |
|---|----------------------|----------------------|--------------------|---------------------|--------------------|----------------------|
| (Time-to-payoff measure)* (after 2008 dummy)*(domestic firm dummy) | -0.052*** (0.020) | -0.049*** (0.019) | -0.066* (0.039) | -0.061** (0.024) | -0.074* (0.039) | -0.045*** (0.018) |
| (Time-to-payoff measure)* (domestic firm dummy) | 0.034** (0.017) | 0.031* (0.017) | 0.005 (0.041) | 0.003 (0.023) | 0.063 (0.038) | 0.007 (0.015) |
| (Time-to-payoff measure)* (after 2008 dummy)* $\ln(\text{sales})$ | | | | | | 0.002 (0.006) |
| (Time-to-payoff measure)* $\ln(\text{sales})$ | | | | | | -0.013*** (0.004) |
| Observations | 41,475 | 22,909 | 3,181 | 11,318 | 23,965 | 41,475 |
| R-squared | 0.001 | 0.001 | 0.001 | 0.001 | 0.004 | 0.003 |
| Number of firm*yr | 11,028 | 5,731 | 710 | 2,584 | 6,302 | 11,028 |
| Firm*year FEs | YES | YES | YES | YES | YES | YES |
| Category*year FEs | YES | YES | YES | YES | YES | YES |

Figure 4. Exit rates by domestic and foreign firms

Note: The solid line shows the exit rate (firms that went bankrupt over active firms) separately for foreign and domestic firms. The dashed lines show the 95% confidence interval of the rates.

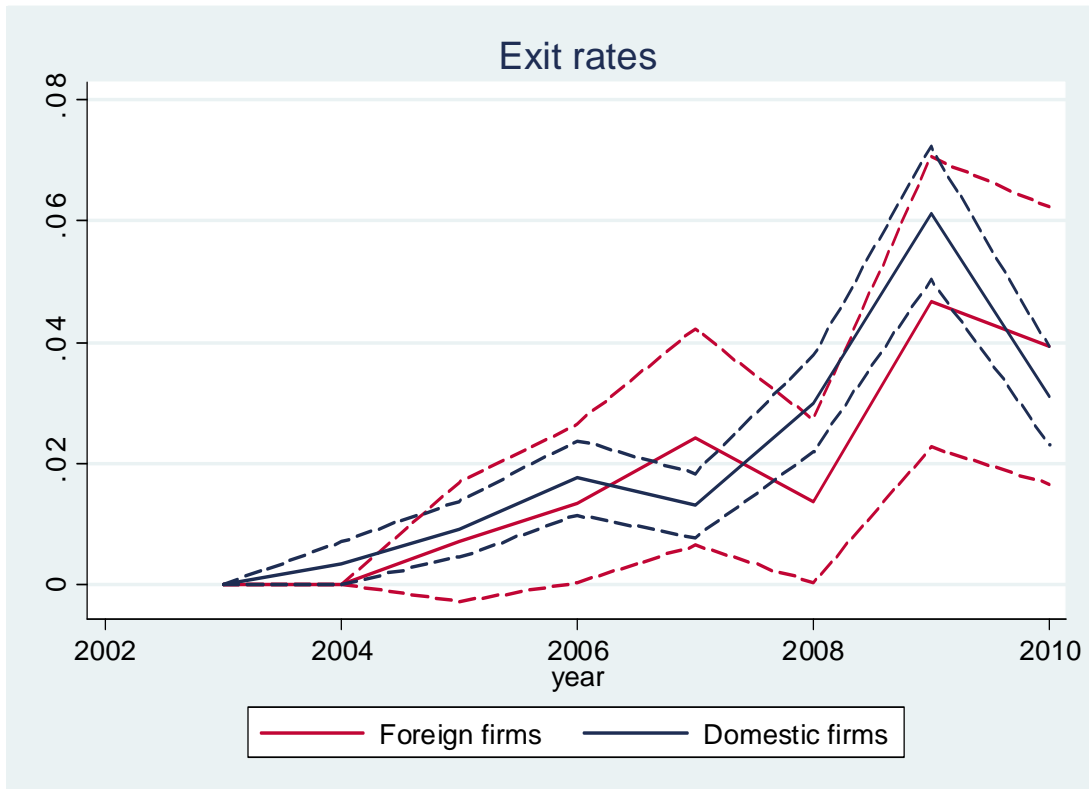


Table 10. Liabilities by maturity

Notes: The dependent variable is long term credit divided by total credit (ratio between 0 and 1). The main regressors are a dummy variable that indicates the financial crisis (=1 in and after 2008), and an interaction term of a Spanish ownership dummy (defined by $\leq 50\%$ foreign ownership in same year) and the crisis dummy variable. All columns include firm fixed effects. Columns (2)-(4) also control for industry specific demand variables (Spanish exports to EU, Spanish exports to the World, domestic value added per industry) to capture industry specific demand shocks of the recession driven by the financial crisis. Export data is from the WITS database provided by the Worldbank, and Spanish value added per industry is from National Accounts data provided by the Spanish National Institute of Statistics (INE). Column (4) includes year fixed effects to capture common time effects (the crisis dummy is absorbed by these fixed effects and therefore omitted). Column (5) includes a full set of industry*year specific fixed effects to capture any demand specific effects driven by the crisis (our industry controls are absorbed by these fixed effects and therefore omitted). All standard errors are two-way clustered at the firm and industry*year level. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$. Observations are between 2003 and 2010.

| DEPENDENT VARIABLE: Long term credit/ total credit (between 0 and 1) | (1) | (2) | (3) | (4) | (5) |
|---|---------------------|----------------------|----------------------|-------------------|------------------|
| Dummy if after crisis (year \geq 2008) | 0.051*** (0.005) | 0.050*** (0.005) | 0.050*** (0.011) | | |
| Interaction term (Spanish firms) * (after 2008) | | | 0.000 (0.012) | 0.001 (0.012) | 0.000 (0.013) |
| ln(industry exports to EU) | | -0.071 (0.046) | -0.073 (0.046) | -0.042 (0.044) | |
| ln(industry exports to World) | | 0.060 (0.045) | 0.061 (0.045) | 0.037 (0.047) | |
| ln(industry output) | | -0.050*** (0.018) | -0.050*** (0.018) | -0.029 (0.020) | |
| Observations | 14,410 | 14,410 | 14,392 | 14,392 | 14,392 |
| R-squared | 0.029 | 0.032 | 0.033 | 0.002 | 0.001 |
| Number of firmid | 2,707 | 2,707 | 2,707 | 2,707 | 2,707 |
| Firm FE | YES | YES | YES | YES | YES |
| Year FE | | | | YES | |
| Ind*Year FE | | | | | YES |

Table 11. Short term credit before crisis

Notes: This table implements a triple difference estimation using the interaction of time-to-payoff (here measured by the inverse of the depreciation rate), after crisis dummy (=1 in 2008 and after) and a treatment variable. Column (1) uses domestic firms as treatment variable as in our baseline specification. Column (2) uses a dummy variable if short term credit with financial institutions/total credit is larger than average in 2007. Column (3) uses the ratio of short term credit with financial institutions/total credit in 2007 as treatment variable. All standard errors are two-way clustered at the firm and industry*year level. *** p<0.01, ** p<0.05, * p<0.1. Observations are between 2003 and 2010.

| DEPENDENT VARIABLE: ln(investment value) | (1) | (2) | (3) |
|---|----------------------|----------------------|----------------------|
| (Time-to-payoff measure)* (after 2008 dummy)*(treatment) | -0.052*** (0.020) | -0.042*** (0.011) | -0.086*** (0.027) |
| (Time-to-payoff measure)* (treatment) | 0.034** (0.017) | 0.020* (0.011) | 0.019 (0.029) |
| Observations | 41,475 | 36,135 | 36,135 |
| R-squared | 0.585 | 0.584 | 0.584 |
| Firm*year FEs | YES | YES | YES |
| Category*year FEs | YES | YES | YES |

CENTRE FOR ECONOMIC PERFORMANCE
Recent Discussion Papers

| | | |
|------|---|---|
| 1187 | Alex Bryson George MacKerron | Are You Happy While You Work? |
| 1186 | Guy Michaels Ferdinand Rauch Stephen J. Redding | Task Specialization in U.S. Cities from 1880-2000 |
| 1185 | Nicholas Oulton María Sebastián-Barriel | Long and Short-Term Effects of the Financial Crisis on Labour Productivity, Capital and Output |
| 1184 | Xuepeng Liu Emanuel Ornelas | Free Trade Agreements and the Consolidation of Democracy |
| 1183 | Marc J. Melitz Stephen J. Redding | Heterogeneous Firms and Trade |
| 1182 | Fabrice Defever Alejandro Riaño | China's Pure Exporter Subsidies |
| 1181 | Wenya Cheng John Morrow Kitjawat Tacharoen | Productivity As If Space Mattered: An Application to Factor Markets Across China |
| 1180 | Yona Rubinstein Dror Brenner | Pride and Prejudice: Using Ethnic-Sounding Names and Inter-Ethnic Marriages to Identify Labor Market Discrimination |
| 1179 | Martin Gaynor Carol Propper Stephan Seiler | Free to Choose? Reform and Demand Response in the English National Health Service |
| 1178 | Philippe Aghion Antoine Dechezleprêtre David Hemous Ralf Martin John Van Reenen | Carbon Taxes, Path Dependency and Directed Technical Change: Evidence from the Auto Industry |
| 1177 | Tim Butcher Richard Dickens Alan Manning | Minimum Wages and Wage Inequality: Some Theory and an Application to the UK |
| 1176 | Jan-Emmanuel De Neve Andrew J. Oswald | Estimating the Influence of Life Satisfaction and Positive Affect on Later Income Using Sibling Fixed-Effects |
| 1175 | Rachel Berner Shalem Francesca Cornaglia Jan-Emmanuel De Neve | The Enduring Impact of Childhood on Mental Health: Evidence Using Instrumented Co-Twin Data |

| | | |
|------|---|--|
| 1174 | Monika Mrázová J. Peter Neary | Selection Effects with Heterogeneous Firms |
| 1173 | Nattavudh Powdthavee | Resilience to Economic Shocks and the Long Reach of Childhood Bullying |
| 1172 | Gianluca Benigno Huigang Chen Christopher Otrok Alessandro Rebucci Eric R. Young | Optimal Policy for Macro-Financial Stability |
| 1171 | Ana Damas de Matos | The Careers of Immigrants |
| 1170 | Bianca De Paoli Pawel Zabczyk | Policy Design in a Model with Swings in Risk Appetite |
| 1169 | Mirabelle Muûls | Exporters, Importers and Credit Constraints |
| 1168 | Thomas Sampson | Brain Drain or Brain Gain? Technology Diffusion and Learning On-the-job |
| 1167 | Jérôme Adda | Taxes, Cigarette Consumption, and Smoking Intensity: Reply |
| 1166 | Jonathan Wadsworth | Musn't Grumble. Immigration, Health and Health Service Use in the UK and Germany |
| 1165 | Nattavudh Powdthavee James Vernoit | The Transferable Scars: A Longitudinal Evidence of Psychological Impact of Past Parental Unemployment on Adolescents in the United Kingdom |
| 1164 | Natalie Chen Dennis Novy | On the Measurement of Trade Costs: Direct vs. Indirect Approaches to Quantifying Standards and Technical Regulations |
| 1163 | Jörn-Stephan Pischke Hannes Schwandt | A Cautionary Note on Using Industry Affiliation to Predict Income |
| 1162 | Cletus C. Coughlin Dennis Novy | Is the International Border Effect Larger than the Domestic Border Effect? Evidence from U.S. Trade |
| 1161 | Gianluca Benigno Luca Fornaro | Reserve Accumulation, Growth and Financial Crises |

The Centre for Economic Performance Publications Unit
Tel 020 7955 7673 Fax 020 7404 0612
Email info@cep.lse.ac.uk Web site <http://cep.lse.ac.uk>