Credit Supply Shocks and Human Capital: Evidence from a Change in Accounting Norms*

Luciana Barbosa† Andrada Bilan‡ Claire Celerier§

March 23, 2017

Abstract

This paper investigates the effect of an exogenous credit supply shock triggered by a change in accounting norms on firm accumulation of human capital. In 2005, the introduction of new reporting norms for bank defined-benefit pension plans in Portugal led to large increases in the accounting value of pension liabilities. Affected banks increased both direct contributions to their pension plans and prudential deductions from Tier 1 capital, subsequently reducing their supply of credit. Using bank-firm credit exposures matched with a census of Portuguese employees, we document, first, that firms in a relationship with affected banks do not perfectly substitute credit and hence borrow less. Second, we find that affected firms reduce employment. We show that these employment effects are stronger not only among unskilled workers but also among the highly educated ones. Workers holding a college degree, or occupying skill-intensive jobs - such as managers or specialists - are more likely to leave affected firms. These results suggest that credit supply shocks can affect firm accumulation of human capital, with implications for firm long-term productivity.

*We are grateful to Tobias Berg, Diana Bomfin, Martin Brown, Geraldo Cerqueiro, Hans Degryse, Miguel Ferreira, Harald Hau, Adrien Matray, Steven Ongena and Boris Vallee for their insightful suggestions. We also greatly appreciate comments from participants at the 10th Swiss Winter Conference on Financial Intermediation (2017), Nova School of Business Brown Bag seminar (2017), SFI Zurich internal seminar (2015), the SFI Research Days (2016), the SFI Workshop in Finance (2016) and at the internal research seminar of Bank of Portugal (Department of Economics, 2017)

†Department of Economic Research, Bank of Portugal

‡Swiss Finance Institute and University of Zurich

§Rotman School of Management, University of Toronto

[1] *This paper has been prepared by the authors under the Lamfalussy Fellowship Program sponsored by ECB. Any views expressed are only those of the authors and do not necessarily represent the views of the ECB or the Eurosystem.*

1 Introduction

A recent literature shows that, when facing adverse credit supply shocks, firms tend to downscale investment, production and employment (Bentolila et al., 2015; Berton et al., 2016; Berg, 2016; Hochfellner et al., 2015; Jiménez et al., 2016; Popov and Rocholl, 2015; Siemer, 2016). One important question is whether these negative shocks have long-run effects on firm productivity. Negative credit supply shocks could foster firm productivity if, by offsetting existing labor market rigidities, they lead to a more efficient matching between employee skills and occupations. Conversely, labor market rigidities may amplify the adverse effects of credit supply shocks if, for instance, only entrenched workers maintain their job, while high-skilled workers leave affected firms. Our objective is to address this question by investigating whether credit supply shocks affect firm ability to accumulate and retain human capital.

Measuring the effects of credit supply shocks on the accumulation of human capital is challenging. First, it requires a shock that is not only orthogonal to both bank and firm health, but also not contemporaneous to any important variation in labor market conditions. Second, we need bank, firm and employee data, as well as a way to link these three layers of information. Finally, detailed employee-level information on education, experience and occupation are necessary. Our paper exploits the introduction of new accounting norms for bank defined-benefit (DB) pension plans, in 2005 in Portugal, as an exogenous shock to credit supply.[1] We explore the effect of this shock by matching bank-firm credit exposures with a census of all private sector firms in Portugal.

We find that the negative effect of credit supply shocks on employment is concentrated among employees at the two extremes of the skill distribution: firms reduce employment of unskilled workers, but also of the highly-educated ones. We also show that workers holding a college degree and those occupying high-skilled jobs - such as managers and specialists - are more likely to leave firms affected by an adverse credit shock. These results suggest that credit supply shocks may have long-run effects both on the productivity of firms, as their ability to accumulate human capital decreases, and on career outcomes.

[1] In another context, Rauh (2006) exploits firm mandatory contributions to their pension funds as an exogenous shock to internal financial resources and investigates the effect on firm investment

To obtain our results, we exploit a credit supply shock triggered by new accounting norms for bank DB plans - the *International Accounting Standard Nineteen* (or IAS 19) - introduced in 2005 in Portugal. The introduction of IAS 19 resulted in large and heterogeneous increases in the accounting value of bank DB plan liabilities. In a DB plan, the bank pledges retirement benefits to employees according to a formula that is generally a function of each employee's age, tenure and salary, based on actuarial assumptions. The introduction of IAS19 affected bank DB plan liabilities through two channels. On the one hand, new benefits were included into the pension obligations. On the other hand, the actuarial assumptions changed significantly: discount rates decreased and life expectancy estimates were extended, leading to large actuarial losses.

The large and heterogeneous increases in bank pension plan liabilities resulting from IAS19 led banks to both increase the direct contributions to their pension plans and to make prudential deductions from Tier 1 capital. In 2005, the total bank contributions to pension plans and the deductions for pensions from Tier 1 capital amounted, respectively, to 2.5 and 1.6 billion euros, or, in total, to almost 20% of their Tier 1 capital. These increases in prudential deductions and direct pension contributions are 1) *heterogeneous across banks*, as both the size of bank pension plans, and the magnitude of the effect on their funding status, vary across banks, 2) *orthogonal to bank health*, since they result from changes in the valuation norms for DB pension plans that are unrelated to bank financial characteristics, 3) *orthogonal to firm employment decisions*, because pension plans are mostly held by banks in Portugal 4) *not contemporaneous to any important variation in macroeconomic or labor market conditions* as the years 2004 and 2005 where years of steady growth in Portugal.[2]

We identify the effect of the introduction of IAS19 on firm employment by matching all bank-firm credit exposures with a census of Portuguese employees. Bank-firm credit exposures come from the Portuguese Credit Register (CR), which covers the credit exposures of all banks and firms in Portugal since 1980. We combine the CR with data from bank and firm financial statements and information on bank pension plans. We then match this dataset with a census of all private sector firms in Portugal with detailed information on each employee career, educa-

[2]More than 80% of pension fund assets are held by banks. Or analysis is also robust to excluding the three other firms with pension plans

tion, occupation and earnings. This bank-firm-employee matched dataset allows us to measure the impact of the credit supply shock triggered by the introduction of IAS19 not only on total employment, but also on diverse other employment outcomes such as wages, career dynamics, labor mobility, worker inequality and talent allocation or retention.

Our analysis follows three steps. We first investigate the effect of the introduction of IAS19 on bank-firm credit exposures in a difference-in-differences setting at the loan level. Our measure of treatment intensity is the relative size of bank DB plan before the shock, in 2004, i.e., the ratio of pension plan liabilities over total assets. Our specification includes controls such as bank balance sheet data and information on the bank-firm relationship characteristics. In addition, because a large majority of firms are borrowing from several banks, we control for demand by including firm fixed effects (Khwaja and Mian, 2008). In line with the existing literature (Aiyar et al., 2014; Behn et al., 2016; Fraisse et al., 2015; Jiménez et al., 2016), we find that banks facing a negative funding shock react by cutting credit more to the same firm than other banks. These findings hold both for the intensive and the extensive margins, and are stronger for banks with lower pre-existing capital buffers.

In a second step, we show that overall credit exposures and total employment decrease for firms that are associated to treated banks. To do so, we employ a firm-level measure of treatment intensity: the average treatment intensity across all the banks a firm is borrowing from in the pre-treatment period, weighted by each bank relative share in the firm total credit exposure. A one standard deviation increase in the treatment intensity relatively cuts committed loan growth by 10 pp, and employment growth by 0.5 pp. These results are robust to the inclusion of industry and geography fixed effects, of multiple firm and bank controls and are stronger for small firms.

Finally, we further investigate the effect of the credit supply shock on employment, disentangling several compositional effects across worker characteristics. At the firm level, we find that affected firms decrease employment relatively more among employees with low education. But the effect is also large on employees with a high level of education, and of comparable magnitude when we exclude micro firms - i.e. firms with less than 10 employees. These results are confirmed at the individual level: highly educated workers are more likely to leave affected firms. When we investigate the effect of the credit supply shock across occupations, we find that both managers, and at the other extreme, unqualified workers, are more likely to leave firms affected by an adverse credit supply shock.

Our paper adds to the growing literature on the effects of bank financing constraints on lending (Paravisini, 2008; Ivashina and Scharfstein, 2010; Chava and Purnanandam, 2011; Puri et al., 2011; Berg, 2016) and firm employment (Benmelech et al., 2016; Bentolila et al., 2015; Berton et al., 2016; Acharya et al., 2015; Chodorow-Reich, 2014; Popov and Rocholl, 2015; Berg, 2016; Hochfellner et al., 2015; Caggese et al., 2016; Siemer, 2016). Caggese et al. (2016) find that firms facing financing constraints, measured by a change in their credit rating, tend to fire first short-tenure workers, and Berton et al. (2016) that less educated and less skilled workers with temporary contracts are more affected by credit supply shocks. Our paper extends upon these studies in three ways. First, we focus on a credit supply shock triggered by a change in accounting norms and hence orthogonal to both bank and firm health. This credit supply shock occurs in good times, allowing us to better capture the effect of credit supply shocks on talent retention, and on the workforce composition. Second, we are able to differentiate the effect across a large set of employee characteristics, including occupation and education. Third, relying on our bank-firm-employee dataset, we aim at investigating the effect of credit supply shocks not only on the level and composition of employment at the firm level, but also on the allocation of workers across firms and on the career dynamics of each worker, controlling for employee characteristics.

Our paper also complements the literature that quantifies job reallocation effects *across firms*. Davis and Haltiwanger (1992) estimate that job creation and destruction account roughly for 20% of jobs, while Campbell and Kuttner (1996) find that reallocation shocks account for roughly half of the variance in total employment growth. A large literature also explores the relationship between worker reallocation and the business cycle. Acharya et al. (2011) looks at the effect of cross-state banking deregulation in the US on the allocation of output and employment across sectors at the state level. Babina (2016) shows that firm financial distress drives the exit of workers to pursue entrepreneurship.

Finally, the paper contributes to the labor literature on the allocation of workers *within firms*. By looking at a credit supply shock, we are able to examine how the pool of workers within the firm varies with firm access to external funds. Baghai et al. (2015) show that the pool of talented workers significantly deteriorates when firms are close to bankruptcy, and Brown and Matsa (2016) show that talented workers tend to apply less to firms in financial distress.

The rest of the paper is organized as follows. Section 2 describes the institutional background of bank pension plans in Portugal and the related regulations. Sections 3 and 4 introduce respectively the data and the identification strategy. Section 5 presents and discusses the results. Section 6 concludes.

2 Institutional Background: Bank Pension Plans and the IAS19 Reform

This section presents the institutional details of the functioning of bank pension plans in Portugal and describes the effects of the IAS19 accounting reform.

2.1 Bank DB Pension Plans in Portugal: an Overview

In 2004, 13 out of the 22 major banking groups operating in Portugal provide DB pension coverage to their employees, who are then excluded from the National Social Security Pension Scheme. Historically, all Portuguese banks offered DB plans. They resulted from industry-wide agreements on working conditions between banks and unions. However, over the years, an increasing number of financial institutions that are not tied by these sectoral agreements have emerged, such as state-owned banks, foreign banks, and non-bank financial institutions.[3]

Due to their wide coverage - bank DB plans cover more than 200,000 employees -, bank pension funds are sizable institutions. At the end of 2005, the total liabilities of the bank pension schemes amount to 12.3 billion euros, accounting for almost 8% of GDP. Bank DB plans are largely dominating the private pension sector in Portugal, covering more than 80% of the private pension plan assets under management in 2005.

[3]Banks that are already running pension plans are locked in because of the size of the stakes.

The assets of bank DB plans are generally invested heterogeneously across banks, in a large range of financial securities. In 2005, 38% of total fund assets are invested in fixed income securities, and 25% in equity.

2.2 The Accounting Rules of Bank DB Plans

In a DB pension plan, the bank pledges retirement benefits to employees according to a formula that is a function of each employee's age, tenure and salary. Thus, a bank sponsoring a DB pension plan has a financial liability equal to the present discounted value of the payments pledged to retirees. The bank has to fund that liability in a pension fund with dedicated assets.

Until the introduction of the IAS19 in 2005, the financial reporting of the pension plans followed the Generally Accepted Accounting Principles in Portugal for the banking sector ("Local GAAP"). According to these rules, changes in the value of the pension plans are reflected in the income statement and the balance sheet of the sponsor through two main concepts. The annual cost of the plan appears in the income statement of the bank. It is calculated as the sum of the forecasted annual pension commitments (also known as the "service cost" of the plan) and the interest cost of the plan and amortization amounts, net of the expected return on the plan's assets. Other variations in the funding status of the pension plans are recorded as direct adjustments in the balance sheet of the plan sponsors. This concept includes deferred costs, such as changes in the coverage of the pension plans or unrecognized gains or losses. Deferred costs have little immediate impact on the income statement because they can be amortized over a long period (typically coinciding with the average remaining service period of the participants in the pension plan).

The calculation of the accounting value of a DB plan assets and liabilities is based on actuarial assumptions, which, when they vary, lead to actuarial gains or losses. On the asset side, actuarial gains and losses arise from differences between expected plan returns and actual plan returns.[4] On the liability side, actuarial

[4]Banks apply expected return on plan assets when calculating the pension expense they will deduct from their net income, as long-term expected returns should better reflect the plan's investment strategy and reduce year to year volatility in the pension expense. The use of expected returns is allowed by both GAAP and IFRS. Since this is an asset return, the return on plan assets component acts as a contra expense, offsetting other costs.

gains or losses come from any change in actuarial assumptions that impact the current service cost, i.e. the amount of pension paid to employees. The level of discount rate is the actuarial assumption with the largest impact in calculating the pension benefit obligations. But any increase in employee expected salaries, or longevity, can also lead to actuarial losses.

Actuarial losses can impact bank internal financial resources through two channels: they can raise bank mandatory pension contributions and they need to be deducted from Tier 1 capital as regulatory prudential deductions. Banks that sponsor DB pension plans must make contributions according to legally specified formulas based on the DB plan funding status. When actuarial losses are large, either because of changes in the actuarial assumptions or bad market performance, the status of a DB plan is likely to become underfunded, which may lead to large contributions. On the other hand, actuarial losses can also lead banks to make deductions from Tier 1 capital, the so-called "prudential deductions". Prudential deductions were introduced in 2002 by the Bank of Portugal along with the "corridor approach".[5] The "corridor approach" allows banks not to incorporate actuarial gains/losses into its calculation of pension expenses until it exceeds the greater of 10% of the value of the DB plan assets or liabilities, and to amortize the actuarial losses/gains in excess over the service period of employees. In exchange, in order to shield bank capital, these deferred actuarial losses had to be deducted from consolidated Tier 1 capital as "prudential deductions". Prudential deductions are applied prior to every periodic review of the capital requirements by the Regulator, usually every six months. Thus, banks anticipating an increase in actuarial losses before the upcoming regulatory review have to monitor closely their capital levels, in order to remain compliant.

Figure 1 illustrates how a 50 million Euros increase in the accounting value of a bank DB plan liabilities can lead to contributions and prudential deductions. The technical annex provides more details on the exact accounting rules that drive contributions and prudential deductions.

INSERT FIGURE 1

[5] Notice 12/2001 of Bank of Portugal

2.3 The Introduction of IAS19 as a source of Variations in Regulatory Capital and Internal Financial Resources

The introduction of IAS19 in 2005 led both to large bank contributions to their DB funds and to prudential deductions from Tier 1 capital.

The introduction of IAS19 in 2005

In 2005, in the context of the implementation of the IFRS norms in Portugal, Portuguese banks had to adopt the IAS19 regarding employee benefits. The introduction of IAS19 led, first, to an extension in the benefits covered by bank pension plans and, second, to major changes in the actuarial assumptions used to value bank DB plan liabilities.

Figure 2 shows the variations in the assets and liabilities of bank DB plans in Portugal over the 2002-2010 period and illustrates the effect of the adoption of IAS19. At the end of 2005, the total liabilities of Portuguese bank DB pension plans increased by around 3 billion euros, as a result of three major changes.[6] First, post-employment medical care benefits have to be included in the pension benefit obligations, accounting for about 50% in the increase in the value of bank DB plan liabilities. Second, the discount rate used to calculate the present value of bank DB fund liabilities is revised downwards to take into account the very long maturities of the obligations, accounting for approximately 25% of the effect. Finally, mortality tables are revised to include the higher life expectancy of female workers, accounting for the remaining 25% of the effect.[7] The second part of the technical annex shows extract from the main Portuguese bank 10-K financial statements about pension benefits, and how the accounting value of the liabilities have been affected.

INSERT FIGURE 2

[6] The changes introduced by IAS accounting and their effects are described in Bank of Portugal's 2005 Financial Stability Report.

[7] Before the introduction of the IAS standards, actuaries used one single mortality table for both male and female employees. Adopting the new norms requires using two different tables, adjusting for the higher life expectancy of female employees.

Bank Mandatory Contributions

Following the substantial actuarial deviations resulting from the adoption of IAS19 in 200, banks were required to increase their contributions their pension plans. Figure 3 shows bank contributions to their pension plans from 2002 to 2010. The effect of the introduction of IAS19 is large: bank contributions to their pension plans spike in 2005, amounting to 2.345 billion euros.

INSERT FIGURE 3

Prudential Deductions

Figure 4 shows, in aggregate terms, the deductions applied on the regulated capital of the banks running pension schemes. Visibly, the most substantial constraints on regulated capital are imposed in 2005. Figure 1 and the technical annex provide a stylized example describing the mechanism through which the IAS accounting reform resulted in contributions and prudential deductions.

INSERT FIGURE 4

The richness of our institutional setting allows us to exploit cross-bank heterogeneity in their financing constraints, driven by the substantial ex-ante heterogeneity in the coverage of the pension plans. Figure 5 shows the distribution of prudential deductions across banks in 2005, scaled by pre-existing levels of Tier 1 capital. We observe that, first, deductions are very large form some of the banks, amounting to 50% of their Tier 1 capital. Second, banks are almost uniformly distributed. We will exploit this dimension in the identification strategy, by relying on specifications based on heterogeneous treatment intensity across banks.

INSERT FIGURE 5

3 Data

3.1 Loan Level Data and Bank Characteristics

We collect bank-firm credit exposures using the Portuguese Credit Registry (CR). The CR is held by the Bank of Portugal, and covers *all bank loans* above 50 euros granted to firms from 1980 to present. The CR collects from financial institutions their credit liabilities, as well as amounts in default, on a monthly basis.

The main sample of our analysis covers 165,085 firms borrowing from 59 banks belonging to 22 banking groups over the 2004-2007 period. We obtain this final sample by keeping only non-financial, private firms, and banks for which we have balance sheet information, representing more than 90% of the total credit in Portugal.[8] We then aggregate the different outstanding loans into monthly bank-firm credit exposures. This results in a dataset of over 20 million monthly credit exposures. In addition, we extract for each firm its full credit history since 1995.

We then match our database on credit exposures with annual financial information on bank DB pension plans, bank balance sheets as well as regulatory information on bank capital levels. This data covers bank exposure to their pension plans, any prudential deduction from Tier 1 capital and bank direct contributions to their pension schemes over the 2004-2012 period. Prudential deductions and contributions are at the banking group level, covering 22 banking groups. Bank financial characteristics are at the bank level and are available for 59 banks belonging to these 22 banking groups.

For each bank, we construct a $TreatmentDummy$, indicating whether a bank is treated or not, and the variable $TreatmentIntensity$ measuring the intensity of the treatment. More precisely, for banks running pension plans, $TreatmentIntensity$ is the ratio of the banking group total pension liabilities over banking assets in the pre-treatment period, i.e. the year 2004. In order to obtain balanced treated and control group, we consider as *not treated* both banks with no pension funds, and banks with a fund exposure in the lowest quartile of the distribution.

[8] We drop financial firms, state-owned companies and entrepreneurs.

3.2 Firm and Employee Level Data

We then collapse the loan dataset into firm-level observations. We restrict the sample to those firms that used bank credit in the pre-treatment period and we analyse variations in their volume of credit over the post-treatment period. At firm level, we measure the treatment intensity $WeightedTreatment_i$, as the average of the treatment intensity across all the banks lending to firm i, weighted by their relative credit exposures during the pre-treatment period.

Finally, we investigate the effects of our credit supply shock on labor market outcomes using the Quadros de Pessoal (QP) database, a census of all private sector firms in Portugal that employ at least one worker conducted each October by the Portuguese Ministry of Employment. Each firm and each worker entering the database are assigned a unique, time-invariant identifying number allowing us to follow firms and workers over time. Over our 2004-2007 sample period, we have information on 350,000 firms and on the complete career history of 3 million workers.

The QP asks employers to report each employee's socio-demographic characteristics, employment start and end dates, as well as an extensive set of job characteristics such as the type of employment, job title, wage, hours worked per year (normal and overtime).[9] Socio-demographic characteristics include years of experience, level of education, year of last promotion, age, gender and nationality. Information is also collected on the industry, location, and founding date of the firm, as well as gross sales in the preceding calendar year.

The QP data is key to identifying which type of individuals is more likely to be impacted by credit supply shocks, and how these individuals substitute to alternative employment opportunities. In our analysis, we extract from the database the firms that used bank credit in the pre-treatment period. To identify worker outcomes, we focus only on employees (thus, we exclude entrepreneurs, CEOs and self-employed workers).

Finally, the QP database also includes key firm level data such as accounting information - total sales, starting capital, age, number of employees -, indicators of financial health - debt to income ratio, total credit, the number of bank rela-

[9] The information on earnings includes the base wage (gross pay for normal hours of work), seniority-indexed components of pay, other regularly paid components, overtime work, and irregularly paid components.

tionships and indicators for bad credit history - , detailed industry geographical dummies, as well as unique firm identifiers. We use these unique firm identifiers to match the QP database with the CR.

3.3 Preliminary Statistics

Table 1 shows the heterogeneity in the size of bank pension plans across banks. The average bank pension plan exposure, or the $TreatmentIntensity$, is 15%, while the median is 9%, and this bank pension plan exposure varies across banks from 1% (10^{th} percentile) to 25% (90^{th} percentile).

At the firm level, the weighted exposure to bank DB plans, measured by $WeightedTreatmentIntensity$ is 0.1 on average, with a standard deviation of 0.09.

INSERT TABLE 1

Then, Table 1 provides summary statistics on treated versus control banks showing that these banks are broadly identical across many dimensions, such as credit exposures and financial characteristics. The wide range of available bank characteristics also allows us to control for observable differences among treated and control banks.

Finally, we note that Portuguese firms deal with several banks. In 2004, a firm deals with 3.02 banks on average, against 3.35 banks in 2006. This multiplicity of bank relationships allows us to include firm fixed effects, thereby neatly distinguishing demand and supply factors when explaining banks' lending behavior.

4 Identification

We exploit the heterogeneous exposure of banks to the introduction of the new accounting norms on pension plan liabilities as a shock on credit supply. We then investigate the heterogeneous effect of this credit supply shock on firm employment, and career outcomes, across skills and occupations.

4.1 Loan Level Analysis

Overall Effect

We investigate the effects of the new accounting norms on bank lending to firms using a difference-in-differences analysis.

We first build a balanced panel of bank-firm pairs over the 2004-2006 period. For each bank-firm pair that appears at least once in the CR over the period, we back-fill all months for which the pair is not in the CR with a zero exposure. Hence, if a bank b lends to a firm f and the loan is repaid within a year, the bf pair will be in our data every month during the entire sample period, even though the bank-firm exposure will be equal to zero most of the time.

We then collapse our panel into two sub-periods, one pre-treatment period and one post-treatment period. Because IAS19 was introduced on January 1, 2005, we use 2004 as the pre-treatment period and the two subsequent years, 2005 to 2006, as the post-treatment period. For each bank-firm pair, we take the average exposure in each sub-period, as in Bertrand et al. (2004). For all firm and bank controls, as well as the bank pension plan exposure, we take the values *ex-ante*, at the end of the pre-treatment period.

Our difference-in-differences estimation compares the change in the loan exposure of treated banks to the change in the loan exposure of non-treated banks with the following model:

$$\Delta LogExposure_{b,i} = \alpha Firm_i + \beta * Treatment_{b,pre} + \\ + \alpha * BankControls_{b,pre} + \gamma * RelationshipControls_{b,i,pre} + e_{b,i} \quad (1)$$

The dependent variable $\Delta LogExposure_{b,i}$ is the change in the logarithm of lending exposure of bank b to firm i between the pre- and the post-treatment periods. The independent variable $Treatment$ is either our treatment dummy indicating whether the bank is treated or not, or our measure of treatment intensity, i.e. the ratio of the bank pension plan liabilities over the bank assets. $Firm_i$ is either a vector of firm characteristics or firm fixed effects, in the most restrictive specifications, in order to control for demand (Khwaja and Mian, 2008). Finally, $BankControls_{b,pre}$ is an extensive range of bank controls, extracted from detailed bank financial statements, in the pre-treatment period.

Bank controls include total assets, Tier 1 capital ratio, liquidity ratios, the loan to asset ratio, the short term liabilities to asset ratio, and the ratio of non-performing loans to total assets. All ratios are winsorized at the lowest and highest fifth percentile. Firm controls include the logarithm of total credit and the logarithm of the number of banks a firm borrowed from in the pre-treatment period. Relationship controls include the logarithm of total credit a firm borrowed from a given bank.

Effect on Intensive Margins

To investigate to which extent changes in bank-firm exposures come from the intensive margin - that is, from a decrease in volume within existing bank-firm relationships - we estimate our model on the subsample of bank-firm exposures that are strictly positive in the pre-treatment period. We analyze how these exposures change over the post-treatment period.

Effect on Extensive Margins

Then, we analyze the effect on the extensive margin of credit by looking at new lending relationships. In this case, the dependent variable is a dummy that equals one if a new loan is granted in the post-treatment period to a firm that had a zero-exposure in the pre-treatment period. The variable is zero otherwise. The controls are the same as in Model 1. Thus, we estimate the following logit model:

$$\begin{aligned} NewLoan_{bi,post} =& \beta * TreatmentDummy_b * + \gamma * BankControls_{b,pre} + \\ & + FirmControls_i + e_{bi} \end{aligned} \tag{2}$$

Resticting the sample to banks running pension plans At this point, there might be lingering concerns that the group of banks running pension plans vary significantly from those banks that do not offer pension coverage. To alleviate these concerns, we run our main specification on the subset of banks that offer pension plans. Thus, we restrict the sample to a plausibly more homogeneous group of banks, within which we exploit different treatment intensities.

Sensitivity to Bank Capital Buffers

Finally, we investigate whether bank capital buffers partly offset the effects of the shocks. We explore whether the treated banks that had accumulated higher capital buffers above regulatory requirements prior to the shocks react differently from less well-capitalized banks. Since the shocks reduced bank Tier 1 capital, we would expect any negative effects on lending to be less pronounced when capital buffers are larger. To this end, we add to our dataset bank Tier 1 capital during the pre-treatment period. We estimate the following specification, with the coefficient of interest being μ:

$$\Delta LogExposure_{bi,post} = Firm_i + \beta * TreatmentIntensity_b + \eta * Tier1Capital_b + \\ + \mu * Tier1Capital_b * TreatmentIntensity_b + \gamma * BankControls_{b,pre} + e_{bi} \tag{3}$$

4.2 Firm-Level Analysis of Labor Outcomes

We first investigate whether firms are able to substitute across loan providers when their bank is affected by the shock. Second, we compare variations in the level of employment among firms that are differentially affected by the shock. We finally explore whether the effect varies across both levels of education and occupations.

Firm Access to Credit

To measure the impact of the treatment on firm-level credit growth, we aggregate firms' credit exposures across banks and examine their change between the pre and post-treatment periods. We follow the specification below:

$$\Delta LogTotalCredit_{i,post} = Industry_j + Geography_k + \beta * WeightedTreatment_{i,pre} + \\ + \gamma * Controls_{i,pre} + e_i \tag{4}$$

where $\Delta LogTotalCredit_{i,post}$ is the change in the logarithm of strictly positive credit exposure by all banks to firm i. $Industry_j$ and $Geography_k$ are 52 and, respectively, 28 industrial sector and geography dummies. $WeightedTreatment_{i,pre}$ is a differential treatment measure calculated as the average of the treatment intensity across all the banks lending to firm i, weighted by their relative credit exposures during the pre-treatment period. $Controls_{i,pre}$ include a wide range of firm variables - total sales, total credit, the number of bank relationships, indicators for bad credit history, starting capital, age, number of employees and debt to income ratios - and, in some specifications, bank characteristics averaged similarly to the treatment variable. Finally, we disaggregate the analysis by firm size.

Firm Employment

We examine, in a panel analysis over the 2004-2007 period, how firm employment varies across firms following the introduction of IAS19. The model we estimate is the following:

$$\Delta LogTotalEmployment_{i,t} = Firm_i + Year_t + \\ + \beta Post_t WeightedTreatment_{i,pre} + e_i$$

We then split the sample of workers into three groups by level of education.

We estimate the effect of the treatment on firm total number of employees with no high school degree, with only a high school degree and with college education.

Finally, in order to investigate more precisely the effect on the more educated workers, we distinguish firms with more than 10 employees from firms with less than 10 employees. Because small firms employ on average less than one educated worker, we expect the flows of talent in and out these firms to be rather limited.

4.3 Worker-Level Analysis

In the last part of our empirical analysis of labor market outcomes, we further exploit the granularity of the data by investigating the effect of the credit supply shock at the worker level. In particular, we focus on the likelihood that a worker leaves the firm, by estimating whether the probability of a worker leaving an affected firm, in the post period, increases with the intensity of treatment. Because we have ample worker level characteristics, we can measure the probability of leaving *conditional on* a polynomial of age, gender, education and job title. In a first instance, we estimate our model on the full sample. We then separate the analysis in subsamples, in order to investigate how the effect varies across levels of education and occupations.

$$Pr(leavingthefirm)_{j,t} = Firm_i + Year_t + Controls_{j,t-1} +$$
$$+ \beta Post_t WeightedTreatment_{i,pre} + e_j$$

5 Results

5.1 Bank-Firm Credit Exposures

INCLUDE FIGURE 6

Figure 6 plots the evolution of credit for treated and control banks from January 2004 to January 2007. The two lines represent the percentage growth in credit since

2004 in a monthly basis. While credit granted by the two groups of banks evolves in parallel until 2005, treated banks experience lower credit growth from then on. The lag we observe might be driven by the fact that some credit lines might have been negotiated before, and that some banks applied IAS 19 only after the first semester of 2005 as they need to recognize the adjustments only at the end of the year.

INCLUDE TABLE 3

Tables 3 shows the effect of the introduction of IAS 19 on bank-firm credit exposures. Column (1) compares bank-firm credit exposures of treated versus control banks. The coefficient suggests that variations in credit exposures are 65 percentage points lower for treated versus control banks. The coefficients in columns (2) and (3) indicate that bank-firm credit exposure decreases with the intensity of the treatment. One standard deviation increase in the intensity of the treatment leads to a 21 pp decrease in credit growth. In other words, banks with a large pension plan relative to their size tend to reduce their credit exposure to firms more after the introduction of IAS19. Including firm fixed effect to control for demand even increases the magnitude of the effect (column (3)).

The coefficients in columns (5) and (6) suggest that the effect is both at the intensive and extensive margins: firms that are already borrowing from treated banks see their credit exposure growing less than control firms (column (5)), and treated banks are less likely to initiate new loans (column (6)). Column (6) provides additional robustness for the possibility that firms dealing with non-treated banks might be systematically different from firms related to treated banks. We restrict the sample only to treated banks, and we find that the magnitude of the effect is even amplified. Finally, column (7) presents the results when we include the effect of banks' actual capital buffers in the regressions. The coefficient suggest that treated banks with lower capital buffers tend to cut lending more than highly capitalized banks.

5.2 Firm Borrowing

We now focus on the effect of the introduction of IAS 19 on firm total credit exposure.

INCLUDE TABLE 4

The coefficients in Table 4 suggest that firm total credit exposures decline substantially when they are exposed to treated banks. We find that credit growth is 10 percentage points lower for treated firms relatively to non-treated firms. The results are robust to including different combinations of controls. At the firm level, we control for total sales, initial capital, profitability, credit exposures, historical defaults, age and size (column (1)). The specification in column (2) is saturated with 52 industry and 28 geography fixed effects. In column (3), we add average bank characteristics along the same dimensions as for the bank-firm analysis, but weighted by ex-ante relative credit exposures. Columns (4) to (6) shows the same specifications with the treatment intensity as an independent variable. A one standard deviation in the intensity of the treatment leads to 7 percentage points decrease in credit growth. Finally, columns (7) and (8) show the results across firm size. Consistent with the hypothesis that it is more costly for a small firm to substitute credit, we find that the effect is larger on firms with less than 10 employees.

5.3 Labor Outcomes

INCLUDE TABLE 5

Tables 5 offers evidence that firms cut down employment after facing an adverse credit supply shock. Column (1) first indicates the effect of the treatment on employment growth. We find that increasing the intensity of the treatment by one standard deviation leads to a 0.5 percentage point decrease in employment growth. Column (2) shows that the effect is even larger on the less educated: one standard deviation increase in the treatment intensity leads to a 1 percentage point decrease in employment of the workers with no high school degree. While we do not find any effect on the employees with a high school education but no college degree, the effect is also negative on employees with a college degree.

INCLUDE TABLE 6

In table 6, we refine our analysis by separating micro-firms - i.e. firms with less than 10 employees - from the other firms. The objective is to better identify the effect on the most talented: because micro-firms are less likely to employ highly-skilled workers, including them in the estimation might reduce the precision of our results. We find that the effect on the most educated is much larger when we focus on firms with more than 10 employees (column (6)) and of similar magnitude than on the less educated.

INCLUDE TABLE 7

INCLUDE TABLE 8

Finally, employee-level regressions confirm our results. In Table 7, we look at the effect of the treatment on the probability that a worker leaves the firm over the subsequent three years. After controlling for a large set of individual characteristics, we find that the probability that a worker leaves a firm is 0.5 percentage point larger for a one standard deviation increase in the intensity of the treatment. When decomposing the effect across levels of education, we find that most of the effect is driven by highly-educated workers, that is, workers holding at least a college degree. This result suggests that the net effect on firm employment is driven by lower inflows for the less educated, and larger outflows for the more educated.

Table 8 shows a similar decomposition of our results across occupations. Workers occupying skill-intensive jobs - such as managers, specialists and technicians - are more likely to leave a firm that is affected by the credit supply shock. While we do not observe the exact reason for the separations - whether the separation is driven by firm job destruction or by individuals finding better outside opportunities -, the loss of highly skilled workers is likely to negatively impact firm productivity over the long run.

6 Conclusion

We exploit the introduction of new accounting norms that mechanically increase the liabilities of bank DB pension plan as an exogenous shock to credit supply. We first confirm that firms in a relationship with treated banks borrow less and reduce employment. Then, we investigate which workers are the most affected and we find a U-shaped relationship between the size of the effect and human capital. Less-educated workers and workers with a college degree are the most affected. This result suggests that credit supply shocks might reduce firm long-term productivity by affecting the accumulation of human capital.

References

Acharya, V. V., T. Eisert, C. Eufinger, and C. W. Hirsch (2015). Real Effects of the Sovereign Debt Crisis in Europe: Evidence from Syndicated Loans. *Working Paper*.

Acharya, V. V., J. Imbs, and J. Sturgess (2011). Finance and Efficiency: do Bank Branching Regulations Matter? *Review of Finance 15*(1), 135–172.

Aiyar, S., C. W. Calomiris, and T. Wieladek (2014). Does Macro-Prudential Regulation Leak? Evidence from a U.K. Policy Experiment. *Journal of Money, Credit and Banking 46*(1), 181–214.

Babina, T. (2016). Destructive creation at work: How financial distress spurs entrepreneurship. *Working Paper*.

Baghai, R., R. Silva, V. Thell, and V. Vig (2015). Talent in Distressed Firms: Labor Fragility and Capital Structure. *Working paper*.

Behn, M., R. Haselmann, and P. Wachtel (2016). Pro-Cyclical Capital Regulation and Lending. *Journal of Finance 71*(2), 919–956.

Benmelech, E., C. Frydman, and D. Papanikolaou (2016). Credit Market Disruptions and Employment during the Great Depression: Evidence from Firm-level Data. *Working Paper*.

Bentolila, S., M. Jansen, G. Jiménez, and S. Ruano (2015). When Credit Dries up: Job Losses in the Great Recession. *Working Paper*.

Berg, T. (2016). Got Rejected? Real Effects of not Getting a Loan. Technical report.

Berton, F., S. Mocetti, A. Presbitero, and M. Richiardi (2016). Banks, firms and jobs. Technical report.

Bertrand, M., E. Duflo, and S. Mullainathan (2004). How Much Should We Trust Differences-in-Differences Estimates? *Quarterly Journal of Economics 119*(1), 249–275.

Brown, J. and D. A. Matsa (2016). Boarding a Sinking Ship? An Investigation of Job Applications to Distressed Firms. *The Journal of Finance 71*(2), 507–550.

Caggese, A., V. Cunat, and D. Metzger (2016). Firing the Wrong Workers: Financing Constraints and Labor Misallocation. *Working Paper*.

Chava, S. and A. Purnanandam (2011). The Effect of Banking Crisis on Bank-Dependent Borrowers. *Journal of Financial Economics 99*(1), 116–135.

Chodorow-Reich, G. (2014). The Employment Effects of Credit Market Disruptions: Firm-level Evidence from the 2008–9 Financial Crisis. *The Quarterly Journal of Economics 129*(1), 1–59.

Davis, S. J. and J. Haltiwanger (1992). Gross job creation, gross job destruction, and employment reallocation. *The Quarterly Journal of Economics 107*(3), 819–863.

Fraisse, H., M. Lé, and D. Thesmar (2015). The Real Effects of Bank Capital Requirements. *Debats Economiques et Financiers*.

Hochfellner, D., J. Montes, M. Schmalz, and D. Sosyura (2015). Winners and Losers of Financial Crises: Evidence from Individuals and Firms. Technical report, Citeseer.

Ivashina, V. and D. Scharfstein (2010). Bank Lending during the Financial Crisis of 2008. *Journal of Financial economics 97*(3), 319–338.

Jiménez, G., S. Ongena, J.-L. Peydró, and J. Saurina (2016). Macroprudential Policy, Countercyclical Bank Capital Buffers and Credit Supply: Evidence from the Spanish Dynamic Provisioning Experiments. *Journal of Political Economy*.

Khwaja, A. I. and A. Mian (2008). Tracing the Impact of Bank Liquidity Shocks: Evidence from an Emerging Market. *The American Economic Review 98*(4), 1413–1442.

Paravisini, D. (2008). Local Bank Financial Constraints and Firm Access to External Finance. *The Journal of Finance 63*(5), 2161–2193.

Popov, A. A. and J. Rocholl (2015). Financing Constraints, Employment, and Labor Compensation: Evidence from the Subprime Mortgage Crisis. *ECB Working Paper*.

Puri, M., J. Rocholl, and S. Steffen (2011). Global Retail Lending in the Aftermath of the US Financial Crisis: Distinguishing between Supply and Demand Effects. *Journal of Financial Economics 100*(3), 556–578.

Rauh, J. D. (2006). Investment and Financing Constraints: Evidence from the Funding of Corporate Pension Plans. *The Journal of Finance 61*(1), 33–71.

Siemer, M. (2016). Firm Entry and Employment Dynamics in the Great Recession. *Working Paper*.

A. FIGURES

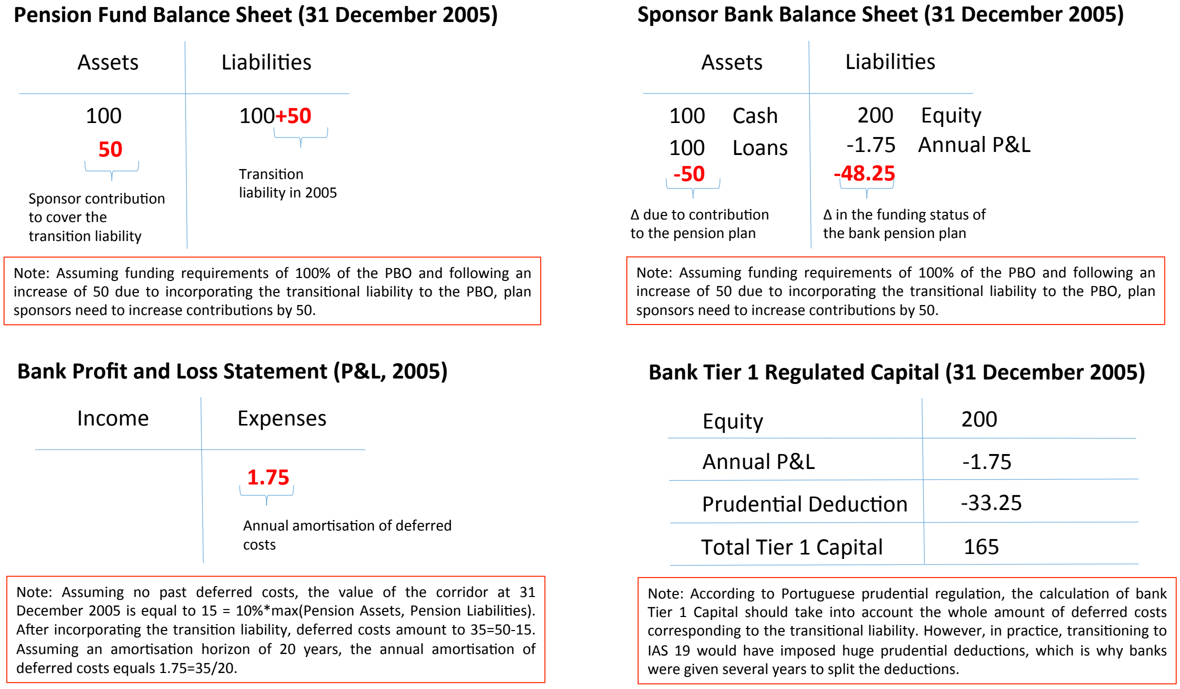

Figure 1. The Impact of an Increase in the Accounting Value of Bank DB Plan Liabilities on Bank Financial Situation

This figure uses stylised numbers to show how, based on the IAS 19 accounting standards, an increase of 50 million Euros of a bank DB-plan liabilities will affect the bank balance sheet, its income statement and its regulated capital.

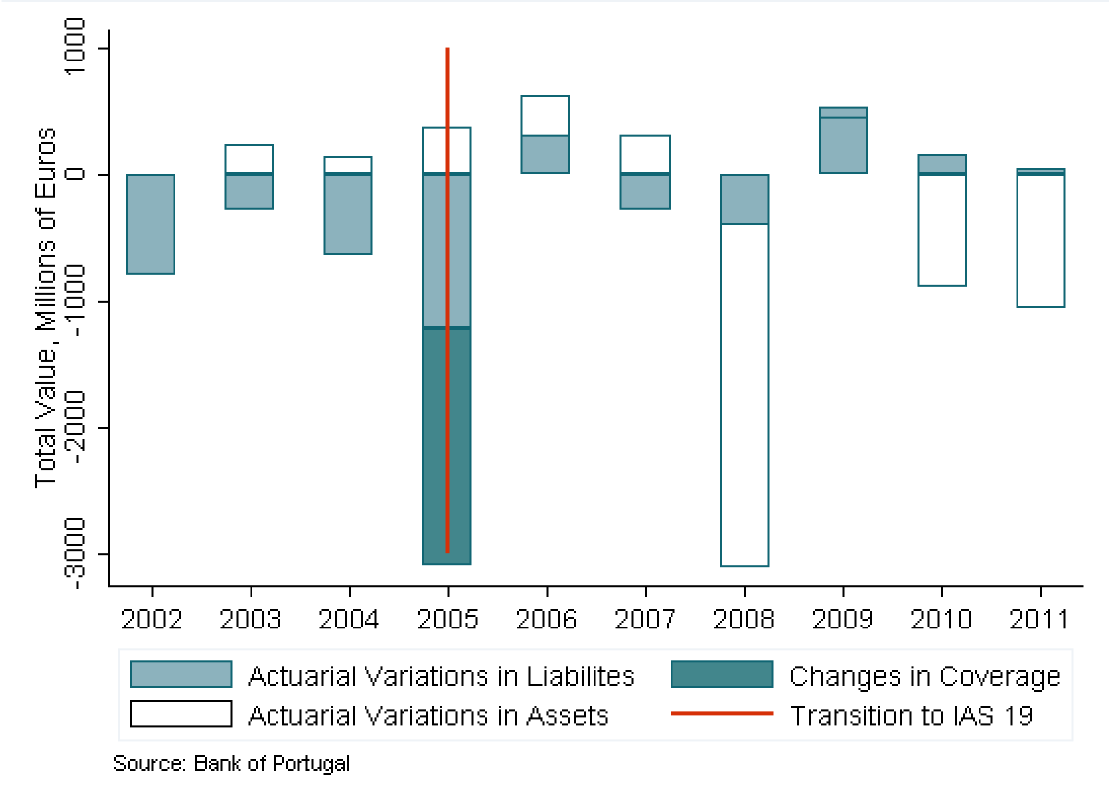

Figure 2. Aggregate Variations in Bank DB Plan Assets and Liabilities over the 2002-2010 Period

This figure shows the actuarial variations in the value of bank DB plan assets and liabilities over the 2002-2011 period, as well as the increase in liabilities due to the extension of coverage following the introduction of IAS 19. Any negative variation in liabilities in excess of the "corridor" is fully discounted from bank Tier 1 regulated capital as prudential deductions. Increases in liabilities may also require bank direct contributions to their pension plans.

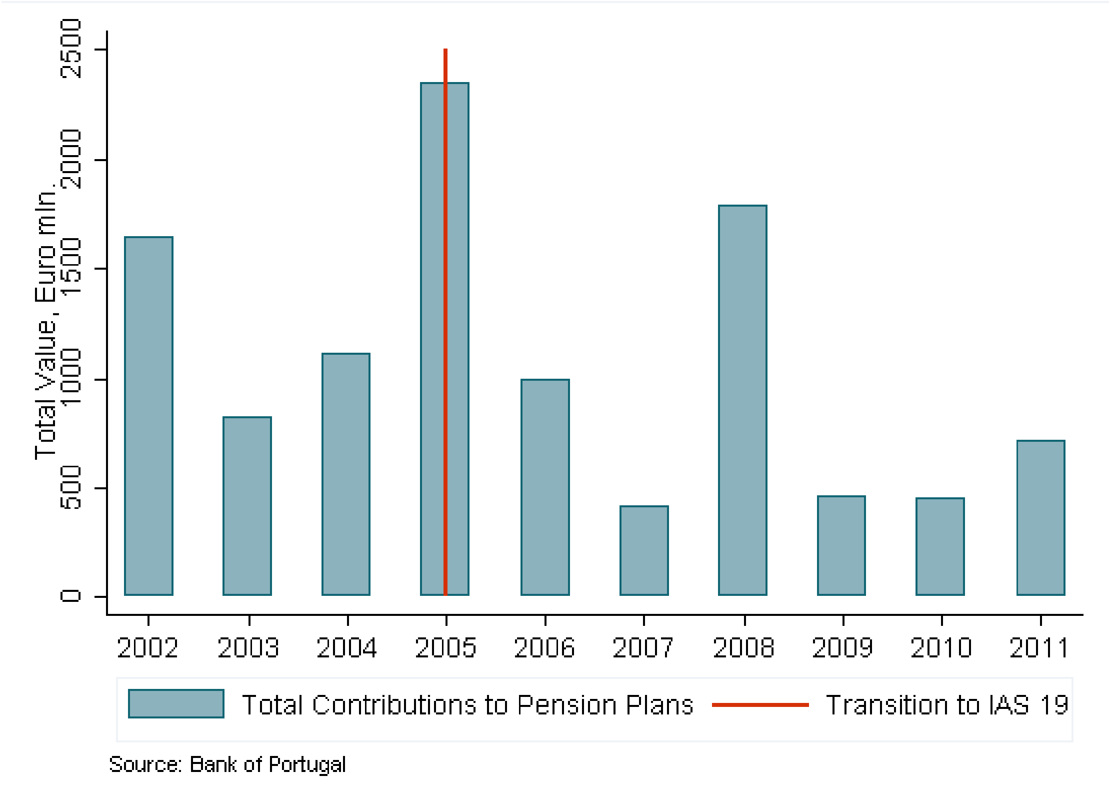

Figure 3. Bank Contributions to their DB Pension Plans (2002-2011)

This figure shows the aggregate value of bank annual contributions to their DB pension plans over the 2002-2010 period. Legislation on privately funded pension plans in Portugal requires the pension benefit obligations to be funded at 100% for pensions in payment and at 95% for employees in service. As a result, negative variations in the funding status of the pension schemes are met with increasing contributions. The large contributions in 2005 correspond to the increase in pension liabilities caused by the introduction of IAS 19.

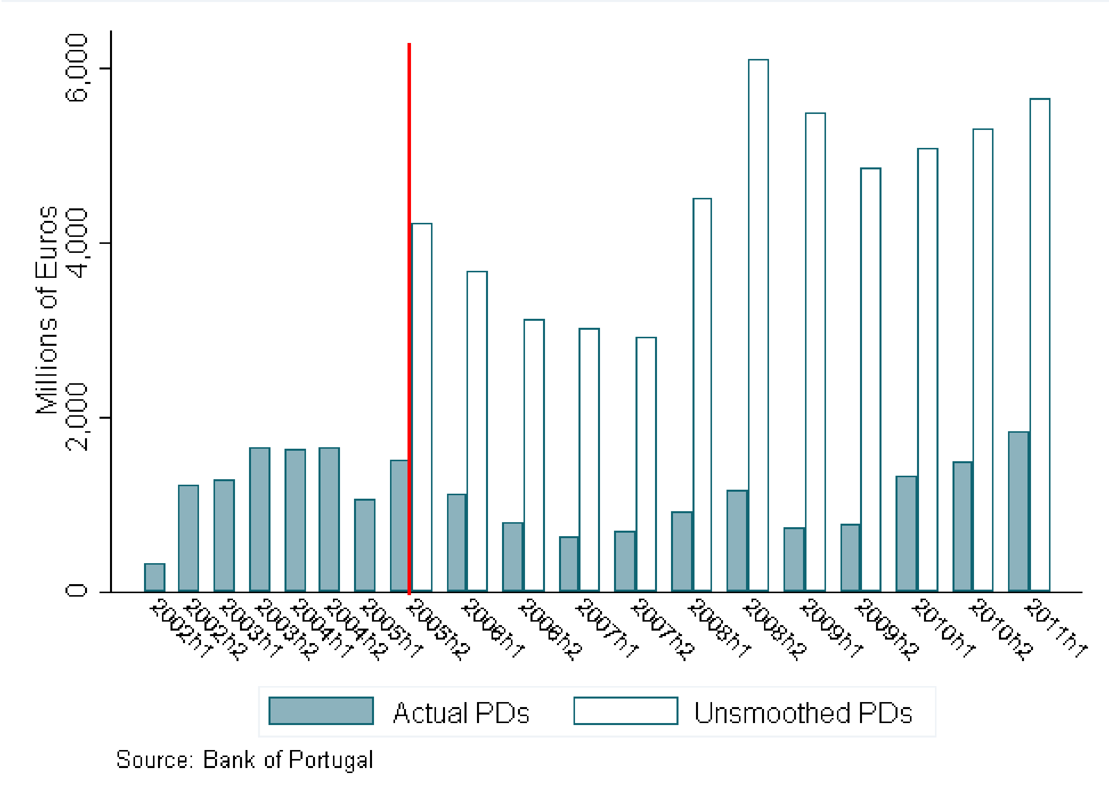

Figure 4. Bank Prudential Deductions to Tier 1 Capital (2002-2011)

This figure captures the aggregated bi-annual prudential deductions from Tier 1 capital over the 2002-2012 period. The blue bars show the actual deductions that banks applied before each regulatory review of capital ratios (usually, at the end of June and December of each year). Due to the high level of excessive variations (i.e., deferred costs in excess of the accounting corridor), special regulations allowed banks to smooth the impact on prudential deductions. The white bars show what the prudential deductions would have been in the absence of smoothing (according to calculations by the authors).

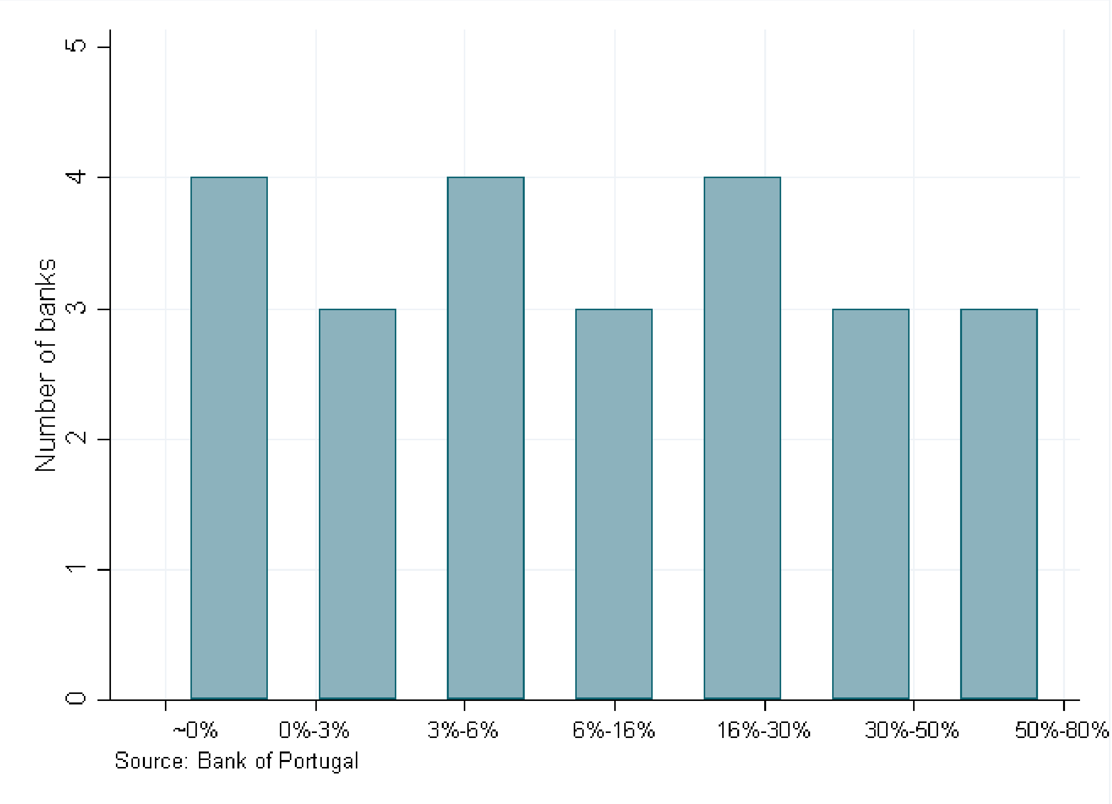

Figure 5. Distribution of Banks across the Ratio of Prudential Deductions to Tier 1 Capital (2005)

This figure groups banks running pension schemes according to the value of the ratio of applied prudential deductions in December 2005 to bank Tier 1 capital the year before. It documents the heterogeneous impact of adopting the IAS 19 standards in 2005, and supports our identification strategy exploiting differing treatment intensity.

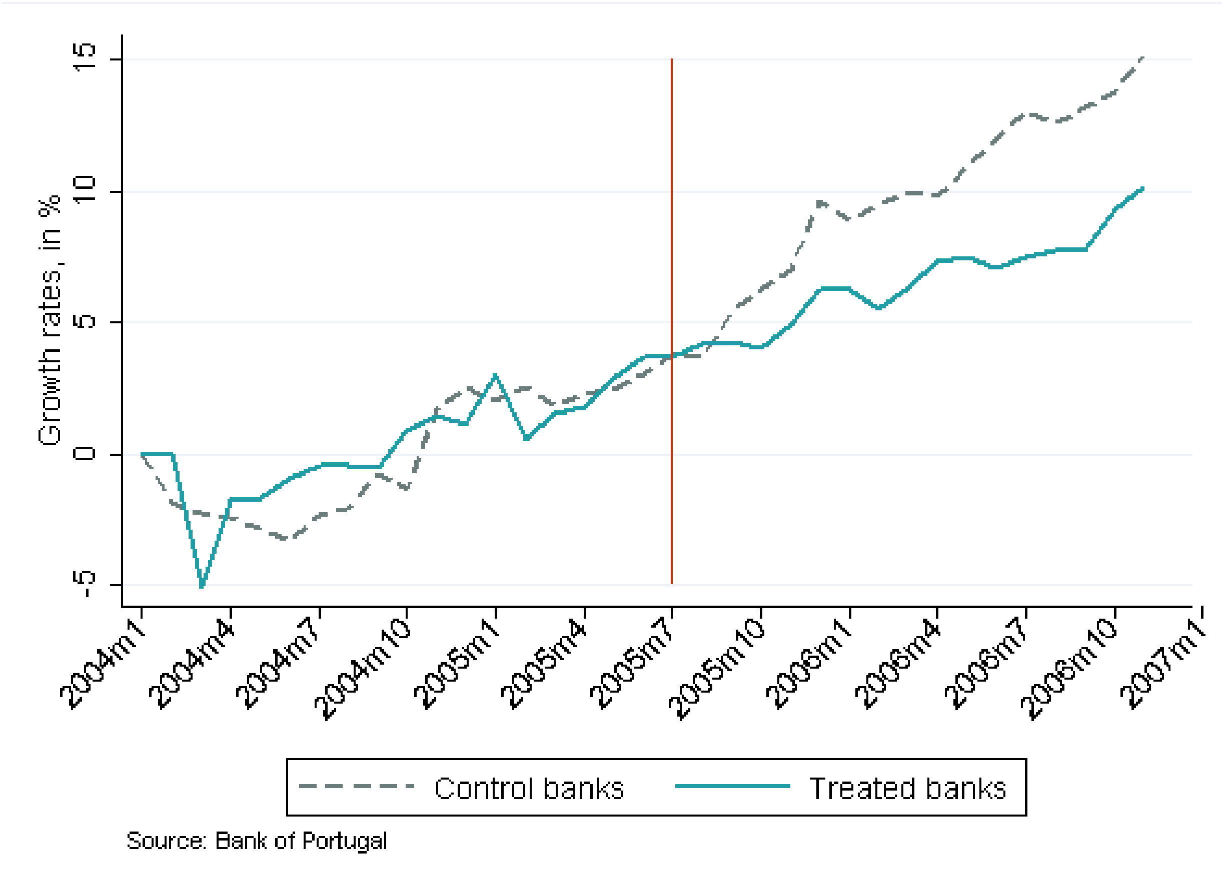

Figure 6. Evolution of Credit: Treated versus Control Banks

This figure captures the evolution of credit for treated and non-treated banks from January 2004 to January 2007. The two lines represent the percentage growth in credit since 2004 on a monthly basis. While credit granted by the two groups of banks evolves in parallel until 2005, treated banks experience visibly lower credit growth from then on.

B. TABLES

Table 1. Summary Statistics

	Mean (1)	SD (2)	P10 (3)	P90 (4)
Bank DB Plan Characteristics				
Ratio of Bank DB Plan Assets to total Bank Assets	0.15	0.09	0.01	0.25
Bank-Firm Exposure (EUR 00,000)				
From Treated Banks	1.80	30.24	0	1.58
From Control Group	1.96	28.30	0	1.86
All	1.87	29.44	0	1.69
Bank Characteristics - Treated Banks				
Log(Total Assets) (EUR 000)	14.98	1.75	12.46	17.16
Capital Ratio	0.09	0.06	0.05	0.14
Liquidity Ratio	0.16	0.12	0.04	0.29
Loans to Assets	0.72	0.20	0.36	0.90
Short Term Liabilities to Assets	0.52	0.24	0.18	0.83
Doubtful Ratio	0.01	0.01	0	0.03
Bank Characteristics - Control Group				
Log(Total Assets) (EUR 000)	13.19	1.91	11.01	15.64
Capital Ratio	0.13	0.13	0.00	0.30
Liquidity Ratio	0.19	0.19	0.02	0.47
Loans to Assets	0.78	0.18	0.46	0.96
Short Term Liabilities to Assets	0.64	0.25	0.28	0.97
Doubtful Ratio	0.02	0.03	0	0.01
Bank-firm Relationship Characteristics				
Total Credit Exposure (EUR mln.)	9.71	159.17	0	8.12
# of Banks	3.02	2.31	1	6
Firm characteristics				
Total Credit (EUR mln.)	81.57	1047.01	0	68.83
Total Sales (EUR mln.)	1.69	23.4	0.02	2.06
Initial Capital (EUR mln.)	0.4	9.4	0.01	0.3
Number Employees	16.4	109.72	2	27
Debt to Revenue Ratio	3.45	4.72	0.13	9.50
Bad Loan Indicator (current)	0.05	0.22	0	0
Bad Credit History	0.11	0.32	0	1
Employee Characteristics				
Probability of Leaving a Firm (unconditional)	0.13	0.34	0	1
Age	38.12	11.27	24	54
Gender (1 Male, 2 Female)	1.41	0.49	1	2
Real Hourly Wage	5.62	10.68	2.45	10.12
Average Tenure	7.62	8.45	0.5	20.25
Fraction with Low Education	0.77	0.35	0	1
Fraction with Middle Education	0.16	0.29	0	0.66
Fraction with High Education	0.05	0.17	0	0.13

This table reports summary statistics for all bank-firm credit exposures, bank and pension plan data as well as firm and worker characteristics in 2004, the year before the shock.

Table 2. The Introduction of IAS 19: Description of the Treatment

Timeline	
Implementation of IAS19	January-June 2005
Pre-treatment Period	Year 2004
Post-treatment Period	Year 2005-2006
The Effect on Banks	
Treated Banks	
Number	13
% of Total Credit	56
Control Banks	
Number	46
% of Total Credit	44
Effect on Bank Fundings	
2005 Contribution to DB plans	
2005 Total Amount, bln euros	2.3
Percentage of Tier 1 Capital	14.5
2005 Prudential Deductions	
Total Amount, bln euros	1.5
Percentage of Tier 1 Capital	9.3
Treatment Variables	
Treatment Dummy (Average)	0.56
Treatment Intensity (Average)	0.15
Treatment Intensity (Standard Deviation)	0.09
Main Effect on Bank-Firm Credit Exposure	
Reduction in credit growth for treated banks	-65 pp
– for one standard deviation increase in treatment intensity	-21 pp
The Effect on Firms	
Treatment Variables	
Treatment Dummy (Average)	0.5
Weighted Treatment Intensity (Average)	0.13
Weighted Treatment Intensity (Standard Deviation)	0.1
Main Effect on Credit Growth	
Reduction in credit growth for treated firms	-12 pp
– for one standard deviation increase in treatment intensity	-8 pp
Main Effect on Employment	
Variation in Total Employment Growth for one standard deviation increase in treatment intensity	-0.5 pp
Inferred effect on Total Employment Growth of a 10 pp decrease in credit growth	- 0.6 pp%

This table summarizes the characteristics and the main effects of the 2005 credit supply shock triggered by the introduction of IAS 19. Effects are computed using the estimation results in Table 3 (columns 1 and 3), Table 4 (columns 3 and 6) and Table 5 (column 1).

Table 3. The Impact of the Introduction of IAS 19 and Bank-Firm Credit Exposures

Dependent variable	Δ log(Loan Exposure)				New Loan Dummy	Δ log(Loan Exposure)	
				Intensive Margin	*Extensive Margin*	Treated only	Robustness
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Treatment dummy	-0.654***						
	(0.083)						
Treatment intensity (I)		-1.397***	-2.319***	-0.723**	-1.939***		- 13.269***
		(0.429)	(0.414)	(0.293)	(0.332)		(0.501)
Treatment intensity (non-zero treatment)						-4.397***	
						(0.540)	
Tier 1 Capital (II)							6.952***
							(0.896)
Interaction (I*II)							0.304***
							(0.162)
Firm Fixed Effects	Yes	-	Yes	Yes	-	Yes	Yes
Firm Characteristics	-	Yes	-	-	Yes	-	-
Bank Char.	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Relationship Char.	Yes	Yes	Yes	Yes	-	Yes	Yes
Observations	275,856	352,815	275,856	182,860	352,815	196,075	275,111
R^2	0.763	0.529	0.763	0.449	-	0.776	0.464

This table reports the coefficients of OLS and Logit estimations. The unit of observation is the loan exposure at bank-firm level. The dependent variable is the change in the log of bank-firm loan exposure, except in column (5) where the dependent variable is a dummy variable that is equal to one if a new loan is granted to a firm with currently zero exposure to the credit granting bank and is equal to zero otherwise. The independent variable *Treatment intensity* is the ratio of the bank DB plan liabilities to the bank total assets in the *pre-period*, and it measures bank initial exposure to the shock. *Treatment dummy* allocates banks into treatment and control groups. Control banks include banks with no DB pension plans or banks in the lowest quartile of the treatment intensity. The initial sample comprises the universe of bank-firm exposures. In columns (1) and (3) the sample is restricted to firms that borrow from several banks. In column (4), the sample is restricted to bank-firm exposures that involve relationship firms, i.e., firms with a strictly positive exposure in the *pre-period*. In column (6), the sample is restricted to bank-firm exposures that involve treated banks. Bank controls include the logarithm of assets, capital ratios, liquidity ratios, loans to assets, securities to assets, short-term liabilities to assets and doubtful ratios. Firm controls include the logarithm of total credit and the number of bank relationships. We control for the strength of the bank-firm relationship by including the logarithm of the total credit exposure between a firm and its bank. Standard errors are clustered at banking group*industry levels and are reported in brackets, $^{\star}p < 0.10, ^{\star\star} p < 0.05, ^{\star\star\star} p < 0.01$

Table 4. The Impact of the Introduction of IAS 19 on Firm Total Credit Exposure

	Δ Log(Total Credit Exposure)							
Sample	*All Firms*						*By Firm Size*	
							<10 Employees	≥10 employees
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Treatment Dummy	-0.099***	-0.095***	-0.124***					
	(0.030)	(0.025)	(0.021)					
Weighted Treatment				-0.674***	-0.651***	-0.781***	-0.866***	-0.448***
				(0.179)	(0.153)	(0.137)	(0.159)	(0.157)
Firm Characteristics	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Average Bank Char.	-	-	Yes	-	-	Yes	Yes	Yes
Industry FE	-	Yes	Yes	-	Yes	Yes	Yes	Yes
Geography FE	-	Yes	Yes	-	Yes	Yes	Yes	Yes
Observations	149,073	149,072	149,072	149,073	149,072	149,072	110,239	36,166
R^2	0.039	0.044	0.044	0.039	0.044	0.045	0.049	0.051

This table reports the coefficients of OLS regressions where the dependent variable is the change in the log of firm total loan exposure. The independent variable *Weighted Treatment* is the average treatment intensity across all the banks a firm borrows from in the pre-period, weighted by their relative share in the firm's total credit exposure over the same period. The independent variable *Treatment dummy* separates firms into treated or control groups, depending on whether they are below or above the median of the weighted treatment index. Firm controls include 52 dummies for 2-digit industrial sectors and 28 geographical dummies, corresponding to districts in Portugal, as well as measures of total sales, total credit, the number of bank relationships, indicators for past defaults, starting capital, age, number of employees and debt to income ratios. Columns (3) and (6) include controls for the "average" bank - i.e. the logarithm of assets, capital ratios, liquidity ratios, loans to assets, securities to assets, short-term liabilities to assets and doubtful ratios - weighted by their ex-ante credit exposure in a firm's total credit. Model (7) restricts the sample to microfirms (with 10 employees or less) while Model (8) includes all firms with more than 10 employees. Standard errors are clustered at main banking group*industry levels and reported in brackets, $^{\star}p < 0.10$, $^{\star\star}p < 0.05$, $^{\star\star\star}p < 0.01$

Table 5. Labor Market Outcomes Following the IAS 19 Shock: Total Effect on Employment and Across Levels of Education

	Δ (Log Number of Employees)			
Sample	*All*	*with Elementary Education*	*with High School Education*	*with College Education*
	(1)	(2)	(3)	(4)
Weighted Treatment	-0.047***	-0.100***	0.001	-0.020***
	(0.004)	(0.004)	(0.004)	(0.003)
Firm Fixed Effects	Yes	Yes	Yes	Yes
Year Fixed Effects	Yes	Yes	Yes	Yes
Observations	624,221	624,221	624,221	624,221
R^2	0.03	0.02	0.01	0.01

This table reports the coefficients of panel regressions over the 2002-2007 period. The dependent variable is the delta log total number of employees in column (1), the total number of employees with less than a high school degree (column (2)), with at least a high school degree but no college degree (column (3)) and a college degree (column (4)). The independent variable *Weighted Treatment* is the average treatment intensity across all the banks a firm borrows from in the pre-treatment period, weighted by their relative share in the firm's total credit exposure over the same period. Standard errors are clustered at the firm level and reported in brackets.

Table 6. Labor Market Outcomes Following the IAS 19 Shock: Composition Effects by Firm Size and Level of Education

	Log Number of Employees					
Sample	Employees with Low Education		Employees with Middle Education		Employees with High Education	
Firm Size	<10 employees (1)	≥10 employees (2)	<10 employees (3)	≥10 employees (4)	<10 employees (5)	≥10 employees (6)
Weighted Treatment	-0.071*** (0.011)	-0.113*** (0.023)	-0.013 (0.010)	-0.026 (0.027)	-0.000 (0.006)	-0.068*** (0.021)
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Observations	579,823	206,533	579,823	206,533	579,823	206,533
R^2	0.82	0.91	0.77	0.90	0.79	0.93

This table reports the coefficients of panel regressions over the 2002-2007 period. The dependent variable is the total number of employees with less than a high school degree (columns (1) and (2)), with at least a high school degree but no college degree (column (3) and (4)), and a college degree (column (5) and (6)). For each specification, we separate microfirms - i.e., firms with less than 10 employees - in (columns (1), (3) and (5)) from firms with 10 employees or more (columns (2), (4) and (6)). The independent variable *Weighted Treatment* is the average treatment intensity across all the banks a firm borrows from in the pre-treatment period, weighted by their relative share in the firm's total credit exposure over the same period. Standard errors are clustered at the firm level and reported in brackets, $^{\star}p < 0.10$, $^{\star\star}p < 0.05$, $^{\star\star\star}p < 0.01$.

Table 7. Labor Market Outcomes Following the IAS 19 Shock: Employee-Level Regressions by Years of Education

	=1 if the Employee Leaves their Firm, 0 if not					
Sample - Years of Education	All (1)	≤ 4 (2)	6 years (3)	9 years (4)	High School (5)	College (6)
Weighted Treatment	0.055* (0.032)	0.034 (0.036)	0.004 (0.026)	0.043 (0.031)	0.094 (0.077)	0.140* (0.084)
Firm Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes
Year Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes
Observations	9,501,752	2,662,958	2,065,966	1,943,982	1,831,660	941,501
R^2	0.19	0.21	0.21	0.20	0.21	0.17

This table reports the coefficients of a linear probability model over the 2002-2007 period. The dependent variable is a dummy variable equal to 1 when a worker leaves the firm they were working for in the previous year and 0 if the worker stays with the same firm. The independent variable *Weighted Treatment* is the average treatment intensity across all the banks a firm borrows from in the pre-treatment period, weighted by their relative share in the firm's total credit exposure over the same period. We saturate the models with firm and year fixed effects and we control for individual characteristics - age, age squared, gender and job level (Columns (2) to (5)) as well as education (Column (1)). Standard errors are clustered at firm level and reported in brackets, $^{\star}p < 0.10$, $^{\star\star}p < 0.05$, $^{\star\star\star}p < 0.01$.

Table 8. Labor Market Outcomes Following the IAS 19 Shock: Employee-Level Regressions across Occupations

	=1 if the Employee Leaves their Firm, 0 if not					
Sample	All Employees	Managers, Specialists and Technicians	Administrators	Service Providers	Qualified Workers	Unqualified Workers
	(1)	(2)	(3)	(4)	(5)	(6)
Weighted Treatment	0.055*	0.112*	0.130	0.031	-0.026	0.083*
	(0.032)	(0.062)	(0.096)	(0.031)	(0.034)	(0.049)
Firm Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes
Year Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes
Observations	9,501,752	1,776,096	1,445,586	1,346,814	2,271,300	2,516,017
Adj. R-squared	0.19	0.17	0.21	0.20	0.21	0.21

This table reports the coefficients of a linear probability model over the 2002-2007 period. The dependent variable is a dummy variable equal to 1 when a worker leaves the firm they were working for in the previous year and 0 if the worker stays with the same firm. The independent variable *Weighted Treatment* is the average treatment intensity across all the banks a firm borrows from in the pre-treatment period, weighted by their relative share in the firm's total credit exposure over the same period. We saturate the models with firm and year fixed effects and we control for individual characteristics - age, age squared, gender and job level (Columns (2) to (5)) as well as education (Column (1)). Standard errors are clustered at firm level and reported in brackets, $^{\star}p < 0.10$, $^{\star\star}p < 0.05$, $^{\star\star\star}p < 0.01$.

C. Technical Appendix.

The regulatory treatment of bank pension plans in Portugal and its implications for regulated capital.

The technical annex provides a detailed review of the institutional framework overseeing the management and regulation of bank pension plans in Portugal. First, we review the history of pension plan regulation since 1995 until the introduction of the IAS 19 reporting on 1 January, 2005. Second, we explain in detail how regulation changed then. We also provide a stylized example of how transitioning to IAS 19 led to large prudential deductions from Bank Tier 1 capital. This example is extended in time with a view to illustrating similar effects following a decline in pension assets.

1. The regulation of bank pension schemes prior to IAS 19

In 1995, Bank of Portugal issues its first specific regulation covering bank DB pension plans. While pension liabilities are a historical feature of the Portuguese banking system, it is with Notice No. 6/1995[10] that Bank of Portugal requires those banking groups sponsoring pension coverage to formalise the set-up of the plans. As a result, pension schemes become separated financial institutions comprising all committed pensions obligations as liabilities and the assets dedicated to their funding. The same regulation defines strict coverage rules to ensure that the plans are sufficiently funded. According to the rules, by the closing of each accounting year on 31 December, the Pension Benefit Obligation (PBO) should be funded at 100% for pensions in payment and at 95% for employees in service. As a result, if a pension plan becomes underfunded in a given year, the sponsoring bank has to step up its contributions so as to comply with the regulatory standards.

Pension plans are reported off the balance sheet of the sponsoring banks. Until the introduction of the International Accounting Standards (IAS 19) in 2005, the financial reporting of the pension plans followed the generally accepted accounting principles in Portugal for the banking sector ("Local GAAP"). According to these rules, changes in the value of the pension plans are reflected in the income statement and the balance sheet of the sponsor through two main concepts. The annual cost of the plan appears in the income statement of the bank. It is calculated as the sum of the forecasted annual pension commitments (also known as the "service cost" of the plan), the interest cost of the plan and amortization amounts, net of the expected return on the plan's assets. Other variations in the funding status of the pension plans are recorded as direct adjustments in the balance sheet of the plan sponsors. This concept includes deferred costs, such as changes in the coverage of the pension plans or unrecognized gains or losses. Deferred costs have little immediate impact on the income statement because they can be amortised over a long period (typically coinciding with the average remaining service period of the participants in the pension plan).

The financial reporting of bank pension funded evolved further with Notice

[10] Available in Portuguese at: http://www.bportugal.pt/sibap/application/app1/docs1/avisos/textos/6-95a.pdf

12/2001 and Notice 7/2002 of Bank of Portugal[11]. These regulations brought about three refinements to the existing methodologies: regulated limits on the actuarial assumptions, a "corridor approach" for deferring actuarial losses and other unforecasted liabilities as well as the deduction of deferred costs from prudential bank capital. We explain the working of each of the three elements below.

First, Notices 12/2001 and 7/2002 imposed bounds on the actuarial assumptions that pension sponsors use in the valuations of the schemes. Examples of actuarial assumptions are the discount rate used to calculate the net present value of the pension PBO, the expected growth rate of wages, the expectation for future inflation as well as the rate of growth of the plan assets. Prior to the two regulations, Portuguese banks were left with more discretion in choosing the value of the assumptions used in valuation. With the new requirements, the level of discretion declines. At the closing of the fiscal year in 2002, banks recalculate the obligations and the assets of their pension schemes using bounded actuarial assumptions. This results in large actuarial losses. The losses have two effects. On the one hand, the increase in liabilities means that plan sponsors need to make substantial contributions to the pension schemes to satisfy the funding rules. On the other hand, the actuarial losses have to be recognised in banks' income statements and prudential capital. As we explain below, the former can be done over a long horizon, while the prudential regulation has a more immediate effect.

Also since 2002, bank pension plans reporting in Portugal use the "corridor method" of accounting. This implies that large actuarial variations (gains or losses) do not have be immediately recognised in banks' financial statements. In exchange, they can be amortised over 15 or 20 years, depending on the average remaining service period of plan participants. In practice, this means that only costs due to the yearly amortisation of the actuarial losses reported at the end of 2002 were reflected in banks' income statements. The remainder was collected as deferred costs. On the contrary, the balance sheet of the sponsoring banks reflected the total change in the funding status of the pension scheme (that is, actuarial variations and new contributions) through compensating accounts.

Finally, deferred costs are immediately recognised through prudential regulation. Due to the long-term amortisation of actuarial losses in the income statement and to reporting through compensating accounts in the balance sheet, actuarial losses risked undermining bank capital regulation. Because large actuarial losses were deferred, their impact in bank capital would have been limited only to their yearly amortisation. Therefore, to protect the integrity of bank capital from deferred costs, Bank of Portugal decided that actuarial losses and other unfunded liabilities - in excess of the corridor - be deducted from the periodical calculation of bank Tier 1 capital. As a result, since 2002 we observe prudential deductions from bank Tier 1 capital due to variations in the valuation of pension funds.

2. The regulation of bank pension schemes after adopting IAS 19

Transitioning to IAS 19 on 1 January 2005 brings about substantial changes

[11] The two notices are available at: http://www.bportugal.pt/sibap/application/app1/docs1/avisos/textos/12-2001a.pdf and http://www.bportugal.pt/sibap/application/app1/docs1/avisos/textos/7-2002a.pdf

in the valuation of pension plans. On the asset side of the balance sheet, fair value becomes prevalent for measuring the securities. This leaves the assets of the plans vulnerable to fluctuations in their market value. On the liability side, the coverage of the plans is broadened and there are several adjustments in the actuarial assumptions used in valuation.

Adopting the new standards generates an immediate impact on financial statements due to the changes in liabilities. New employee obligations are added to the PBO from 1 January 2005. These include post-retirement health care benefits, through contributions to the Social Health Assistance Service for Banking Sector Employees (SAMS), and benefits from life insurance. In addition, there are important changes in the actuarial assumptions about the discount rate and the projected life expectancy of the plan participants.

In pension accounting, the level of the discount rate is the actuarial assumption with the largest impact in calculating the PBO. Prior to IAS 19, actuaries could select any discount rate, as long as it fell inside pre-specified bounds. The new standards specifically require that the discount rate employed be equal to the rate of return on high-quality corporate debt with maturity approximating the duration of the plan's liabilities. In practical terms, this implies a downward revision of the discount rates previously employed by the banks. [12]

IAS 19 also requires the revision of mortality tables employed by actuaries. Prior to 2005, the valuation of bank pension funds relied on a single mortality table for both men and women. The table was based on the estimated life expectancy of male employees. The new standard introduces a separate mortality table for female employees, taking into account their longer life expectancy. [13]

Due to their broader coverage and the change in actuarial assumptions, the liabilities of the pension plans increase significantly during 2005 (leading to what we call "transition liability"). The impact on the asset side is modest. Because financial markets are stable in that period, transitioning to market based valuation does not impose major shifts in the value of securities. The resulting mismatch between assets and liabilities gives rise to a large funding gap. This requires new contributions from the banks, mainly to cover the transition liability.

The increase in contribution was matched by an almost equal growth in prudential deductions. As explained above, introducing the "corridor method" in 2002 implied an adjustment in the measurement of pension schemes that led to actuarial losses outside the corridor. By 2005, most of these actuarial losses have not been amortised, meaning that the transition liability resulting from adopting IAS 19 cannot be absorbed within the corridor. The effect is an increase in deferred costs up the value of the transition liability (net of the corresponding amortisations).

[12]The 2005 Annual Financial Reports of BPI mentions a change in the discount rate from 7% to 5.25%. Similarly, the discount rate used by BCP changed from 5.25% at the end of 2004 to 4.75% at the end of 2005. The 2005 BPI report is avaiable at: http://bpi.bancobpi.pt/storage/download/ficheiro.54C95FF4-1295-42C6-A4F3-BBC3C15A35F2.1.pt.asp?id=9AC48705-CEF6-4B63-9D4C-650C29126FA0. The 2005 BCP report is available at http://ind.millenniumbcp.pt/en/Institucional/investidores/Pages/RelatorioContas.aspx

[13]Again, banks' Annual Financial Reports mention the change from using a single mortality table for both genders, TV73/77, to using the table TV73/77 for male employees and a second table, TV88/90, for female employees.(please refer to Footnote 11 for the exact references).

Prudential regulation requires that deferred costs be deducted from bank Tier 1 capital, which means that the value of the transition liability should have been deducted from banks' capital. However, incorporating the whole transition liability in one go would have crippled banks' capital levels. In response, Notice No. 2/2005 of Bank of Portugal[14] establishes a smoothing period for recognising the impact of transition liability in regulated capital. The amount above the corridor is split across 5 or 7 years, depending on the type of liability. Even so, banks still have to make significant deductions from their Tier 1 capital in 2005. Figure 1 uses stylised numbers to illustrate the impact of a large pension transition liability across banks' financial statements and prudential reports.

Table 7 below illustrates step by step the mechanics of the "corridor approach" and the impact of the transition liability in 2005 by means of another stylised example. Here, the increase in liabilities in 2005 is matched by an almost equal spike in annual deferred costs, because past deferred costs are already larger than the corridor. To keep the story tractable, in this example we do not apply the smoothing of the transition liability. In practice, that reduced prudential deductions in 2005 to 25% of their total impact. [15]

Finally, the last years included in Table 7 provide an illustration of the transmission of actuarial losses through the corridor in the case of a decline in the market value of the pension assets. This generates actuarial losses on the asset side, which are added to any pre-existing deferred costs. Subsequently, the excessive deferred costs generate large prudential deductions from regulated capital, while being amortised gradually in the income statement. We use this empirical setting to study how large prudential deductions compensating losses in pension assets during the financial crisis of 2007-08 and the sovereign debt crisis in 2010-11 impact bank lending behaviour.

[14]http://www.bportugal.pt/sibap/application/app1/docs1/avisos/textos/2-2005a.pdf

[15]While Notice No. 2/2005 of Bank of Portugal allowed smoothing over several years, 25% of the transition liability had to be recognised in the first year.

Table 9. Illustrative example of the "corridor approach"

Concept/Year	2002	2003	2004	2005	2006	2007	2008
Assets (Expected Evolution)	100	160	170	180	210	220	230
Assets (Actual Evolution)	100	160	170	180	210	220	180
Actuarial Variations (Asset Side)	0	0	0	0	0	0	50
Liabilities	150	150	150	200	200	200	200
Transition Liability(*)	50	0	0	50	0	0	0
Contribution	50	0	0	20	0	0	20
Corridor	15	16	17	20	21	22	20
Variation in Corridor	0	1	1	3	1	1	-2
Past Deferred Costs	0	33.3	30.6	28.2	71.4	66.9	62.6
Deferred Costs of the Year	35.0	32.3	29.6	75.2	70.4	65.9	114.6
Horizon for Amortisation through P&L (yrs.)	20	20	20	20	20	20	20
Annual Amortisation of Deferred Costs	1.8	1.6	1.5	3.8	3.5	3.3	5.7
Applied Prudential Deductions	33.3	30.6	28.2	71.4	66.9	62.6	108.9

(*) Transition Liability = Actuarial Variations in Liability + Changes in Coverage. This table relies on stylised numbers to re-create the mechanics of the "corridor approach" for reporting variations in the value of bank pension funds over the period 2002-2008. We use stylised numbers for two reasons. First, not all the concepts outlined above are disclosed through banks' statements. Second, this is a simplified version of pension fund measurements, in order to make it more tractable. Starting with 2002, the introduction of the corridor approach promoted the re-measurement of the pension plans, generating a large transition liability. The part of the transition liability that exceeds the corridor is recorded as deferred costs and amortised over an average of 20 years. Deferred costs net of the annual amortisation are discounted from bank capital as prudential deductions. Past deferred costs are carried over in time, but they decrease both because of an increase in the corridor and due to new rounds of amortisation. However, adopting the IAS 19 standards in 2005 imposes a large transition liability, which gets incorporated in the corridor approach. Because, at that point in time, past deferred costs are still substantially larger than the corridor, the transition liability cannot be absorbed and, consequently, it is charged as a prudential deduction. 2008 illustrates what happens when there are substantial actuarial losses on the asset side. Similarly to 2005, when above the corridor, the actuarial losses get incorporated as deferred costs and deducted from regulated capital as prudential deductions.