Agglomeration and Industry Spillover Effects in the Aftermath of a Credit Shock*

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This paper provides empirical evidence showing that industries with intense strategic complementarities exhibit stronger sensitivity to economic shocks. The Portuguese credit crunch of 2009 represents a negative shock for nonfinancial firms, which has created negative spillover effects among firms. Corporate investment declines significantly in industries with strong strategic complementarities following the onset of the crisis, controlling for firm fixed effects, time-varying measures of financial constraints, and investment opportunities. Consistent with a causal effect, the decline is greatest for firms in industries with strong strategic complementarities. To address sample-selection concerns we consider several sample splits and apply a matching approach to find the best counterfactual, and confirm similar results.

JEL Codes: G21, D22, G01, D62, C23.

1. Introduction

Consider a group of interrelated firms which benefit from external scale economies among them. Do spillover effects among firms amplify economic shocks? Will firms reduce their output when their neighbors suffer negative shocks? Which firms suffer the most from

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spillover effects after an adverse shock? What happens when a bank cuts credit access to *one of the firms* in the group? Will it have negative externalities on neighboring firms? To address these questions we consider a simple model where we compare spillover effects among industries before and after a credit shock.

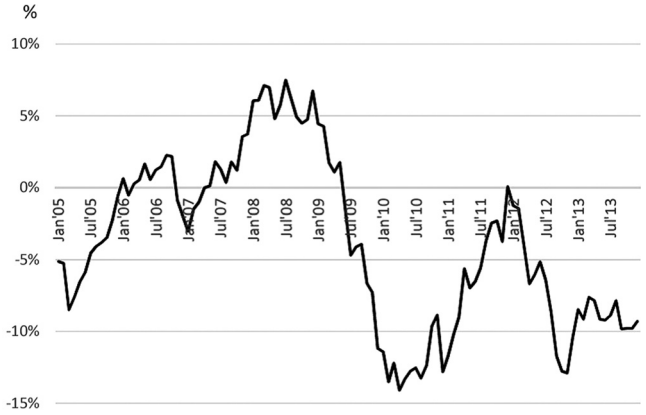
Our analysis is based on the premise that firms in some industries benefit from the production of other firms in the same industry. This interdependence can be generated by multiple channels since a firm's success depends on

- the firms which use its outputs, and on the firms which supply its inputs (see, for example, Cooper and John 1988);
- industry-specific knowledge and information spillovers which take place in the industry (as in Carvalho and Voigtländer 2014);
- access to a large pool of skilled labor, which favors firm–worker matching;
- its financial links, as bankruptcy from industry peers may have negative spillover effects.

As a result of these interdependencies, the firm's productivity and its profitability depend on its industry peers. It follows that the returns firms will make on borrowed capital will increase if other firms are able to obtain financing (either from markets or banks). When the aggregate production of the industry depends on bank financing, then a credit crunch will penalize the productivity of each individual firm *even if that individual firm does not see its credit being rationed*. A credit crunch will thus reduce the set of profitable investment opportunities for each firm.

We use the credit crunch of 2009 in the Portuguese economy to identify the impact of a credit shock. The Portuguese economy has institutional features which make it a convenient empirical setting for the questions we address. First, there are homogenous legal and institutional conditions throughout the country, which ease the comparison among the different industries. Second, most firms are small and medium enterprises (SMEs) which depend on bank lending and are unable to smooth the effects of a credit crunch by borrowing from alternative sources of financing. Third, agglomeration economies—which we take as a measure of the interdependencies

Figure 1. Evolution of Bank Lending in Portugal in the Period 2005–13 to Nonfinancial Corporations



Source: Banco de Portugal.
Note: This figure plots annual growth rates of aggregate bank loans.

among firms—are well documented for the Portuguese economy. We use the Dirichlet-multinomial (DM) index proposed by Guimarães, Figueiredo, and Woodward (2007) as a measure of agglomeration economies. This measure has key advantages over other indexes, as it relies on detailed plant-level data. Typically, access to this type of data is restricted since it raises confidentiality issues and, to the best of our knowledge, the DM index has only been computed for Portugal.

Figure 1 depicts the evolution of bank lending in Portugal from January 2005 until the end of 2013. There was a sharp slowdown in the growth of bank credit after mid-2008, with the annual growth rate becoming negative in 2009 and remaining negative afterwards. The deleveraging of the Portuguese economy is related to the growing needs for bank capital and the liquidity problems faced by Portuguese banks after the global crisis in 2008.

In this paper we measure how banks' reluctance to extend loans to firms has compromised firms' investment. The hypotheses we take to the data are based on models with strategic complementarities among firms, such as Angeletos and Pavan (2004, 2007), Bebchuk and Goldstein (2011), and Jorge and Rocha (2016) (production spillovers and external scale economies create strategic

complementarities among firms; see details below). In theory, negative shocks hinder firms which benefit from external scale economies, as reduced production by one firm hampers the productivity of the others. More specifically, theory suggests that the effects of a credit crunch on output and investment will be stronger in those industries which display intense external scale economies. A shock will have a minor impact on those operating firms which do not benefit from strategic complementarities.

To investigate these ideas, we employ a difference-in-differences approach in which we compare firms' investment before and after the onset of the crisis as a function of how much they benefit from spillover effects (that is, if they belong to an industry which displays external scale economies), controlling for observable measures of external finance constraints and investment opportunities as well as firm fixed effects.

We are mostly interested in studying the role of strategic complementarities on worsening the impact of the credit crunch on investment. There are two key distinctions to be made. The first distinction is between *exogenous* and *endogenous* variation in investment opportunities. Exogenous variation pertains to economic shocks, whereas endogenous variation derives from the propagation mechanism through which spillovers amplify those shocks. If an exogenous credit shock reduces the investment capacity of some firms, then the profitability of the entire sector is endogenously affected (i.e., there is an endogenous change in investment opportunities).

Our analysis is designed to address concerns about exogenous changes in investment opportunities and therefore credit demand. For this purpose, we take a conservative approach and control for observable measures of investment opportunities (such as cash flow, sales, and whether the firm exports or not) as well as external finance constraints (such as the firm's debt). If these measures also represented endogenous variation in investment opportunities, then our empirical approach would reduce the significance of our results.

The second key distinction is between *exogenous* and *endogenous* credit crunches. On the one hand, Jorge and Rocha (2016) show that banks mitigate coordination problems among decentralized investors by monitoring firms. A negative exogenous shock to the supply of bank credit reduces the capacity of banks to monitor firms, thus

depressing firms' investment and productivity. On the other hand, Bebchuk and Goldstein (2011) show that the decision of a bank to extend a loan to a given firm depends on the bank's assessment of the firm's exogenous productivity parameter and on its expectation of whether other banks will lend money to other firms *in the same sector*. This mechanism creates the potential for endogenous credit crunches with inevitable consequences on productivity.

Our baseline specification is designed to address the exogenous variation in bank credit as in Jorge and Rocha (2016). We also account for the possibility of endogenous credit crunches by controlling for the supply of bank credit in the industry, but find no significant evidence of the channel described by Bebchuk and Goldstein (2011).

We are also concerned about heterogenous exogenous shocks in the supply of credit across industries, as banks might have cut credit more to some industries than to others—and have thus generated different effects across industries but which were not related to spillover effects. To this purpose, we use alternative measures of the bank credit shock (such as the total debt of the industry).

We investigate the possibility that firms in agglomerated industries informally help each other through the use of trade credit. Consistent with the view that firms avoid trade credit as a means to obtain medium- and long-term funding, we find that trade credit did not offset the impact of the 2009 bank credit shock on investment.

Additionally, we use several sample splits in which we select a sample of firms which established relationships exclusively with banks which did not show reluctance to extend loans throughout the period 2006–12, and a sample of exporting firms which were not affected by shocks to internal demand. Finally, we apply a matching approach to find the best counterfactual in the difference-in-differences approach.

We find that operating firms which benefit from strategic complementarities were the most severely hit by the 2009 credit crunch. We measure the impact on annual investment as a ratio of assets for Portuguese manufacturing firms, and we compare the impact on industries with strategic complementarities with the impact on industries without complementarities. Consistent with the hypothesis that credit shocks are amplified in industries with strategic complementarities, we find that firms in industries with strategic

complementarities reduce their investment by more than firms in other industries. Our final estimate suggests that firms with strategic complementarities reduce (on average) their annual investment (as a fraction of assets) by 3.26 percentage points more than firms without strategic complementarities following the onset of the 2009 credit crunch.

Review of the Literature. Our article is related to several separate bodies of literature. The importance of financial constraints for investment decisions is a classic in finance, with extensions to macroeconomic theory (as, for example, Hoshi, Kashyap, and Scharfstein 1991; Kaplan and Zingales 1997; Bernanke, Gertler, and Gilchrist 1999; and Dell'Ariccia, Detragiache, and Rajan 2008). More specifically, Kashyap and Stein (1994, 2000) and Khwaja and Mian (2008) highlight the role of the bank lending channel. Our paper contributes to this literature by emphasizing the role of strategic complementarities among firms.

The 2007–09 global financial crisis has been used as an experimental field to study the effects of banks' distress on credit supply (as, for example, Campello, Graham, and Harvey 2010; Ivashina and Scharfstein 2010; and Tong and Wei 2011). Within this literature, the paper relates to Duchin, Ozbas, and Sensoy (2010), Lemmon and Roberts (2010), and Almeida et al. (2012), who document a reduction in corporate investment as a consequence of supply shocks to external financing. Our results provide evidence that the 2009 credit shock in Portugal had real effects on firms' investment.

A number of papers in the financial literature have used bankruptcy as an instrument to identify channels for spillover effects among firms. Lang and Stulz (1992) and Ferris, Jayaraman, and Makhija (1997) document spillover effects of bankruptcy filings on investors of industry peers. Hertzel et al. (2008) examine bankruptcy contagion effects along the supply chain of filing firms, while Boone and Ivanov (2012) define proximate nonfiling firms as strategic alliance partners. Jorion and Zhang (2007) and Hertzel and Officer (2012) document bankruptcy contagion effects on industry capital providers. Addoum et al. (2015) document that firms that are located geographically near the bankrupt firm reduce their investment expenditures. They investigate channels for contagion related to executives' career concerns, and document that local firms experience worse credit conditions if

a local firm files for bankruptcy. Benmelech and Bergman (2009, 2011) use data on U.S. airlines to identify the collateral channel in which a firm's bankruptcy is likely to increase the supply of and reduce the demand for assets used as collateral. The downward pressure on the value of these assets reduces the collateral value of other industry participants, thus raising their financing costs.

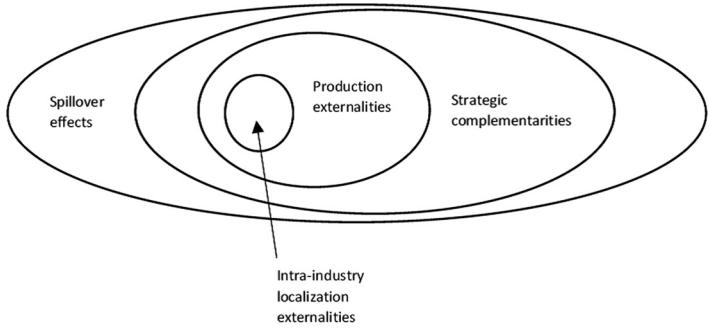
The finance literature has focused exclusively on spillover effects from bankruptcy events, but our priors are rooted in a broader theoretical background which identifies additional sources of external scale economies. See Jorge and Rocha (2016) for a list of contributions on this strand of the literature, and Surico (2003) for a survey on the relationship between external scale economies and geographic agglomeration. A number of papers have explored the aggregate effects of strategic complementarities, and in particular we base our empirical analysis on two theoretical contributions.

In a model with strategic complementarities and bank lending, Bebchuk and Goldstein (2011) show that firms are vulnerable to credit market freezes. Banks avoid lending to firms out of self-fulfilling fear that other banks would withhold loans to firms, thus causing their default.

In a model with production externalities where the production of one firm increases the productivity of the others, Jorge and Rocha (2016) suggest that bank lending is more important when strategic complementarities are most prevalent, so that a credit contraction should have a different impact across industries and geographical areas. The current paper documents how spillover effects from a credit supply shock spread through industries with and without strategic complementarities.

The remainder of the paper is organized as follows: We provide details on the role of strategic complementarities in firms' investment in section 2. Section 3 examines the shock in bank credit in Portugal in 2009. Section 4 states our hypotheses and presents the empirical strategy. Section 5 presents data and research methods. In sections 6 and 7 we present and discuss our results in detail. Section 8 compares the propagation mechanism of loan demand shocks and loan supply shocks. Some conclusions are offered in the final section.

Figure 2. Venn Diagram Illustrating the Different Types of Spillover Effects



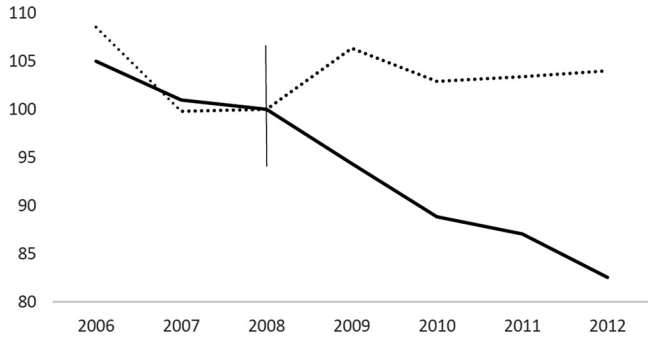
Note: This paper focuses on intra-industry localization externalities.

2. The Role of Strategic Complementarities in Firms' Investment

We are interested in a particular type of spillover effects. First, we are interested in an environment in which operating firms are interdependent, with their success depending on the success of other operating firms—to put it more formally, we are interested in those spillover effects which are the source of strategic complementarities among firms. More specifically, we are interested in production externalities where the production of one firm increases the productivity of the others. Second, we are interested in localization externalities which arise as a result of knowledge spillovers, labor market pooling, and input sharing (the three sources of external scale economies identified by Marshall 1890). Third, we focus exclusively on intra-industry effects; that is, spillover effects among firms will raise the productivity of neighboring firms belonging to the same industry. The Venn diagram in figure 2 clarifies the subset of spillover effects analyzed in this paper.

The benefits of external scale economies depend on the level of output of the industry, thus implying that a reduction in the output of the industry will have a negative impact on firms' productivity. Since productivity is a key determinant of investment opportunities, it follows that a negative shock in industry output is likely to reduce

Figure 3. Effect of the 2009 Credit Shock on Firms' Fixed Capital



Notes: The figure plots the evolution of the average ratio of fixed capital over assets among firms which belong to industries with strategic complementarities (solid line) and firms which belong to industries without strategic complementarities (dotted line). The reference year is 2008, in which the ratio of fixed capital over assets takes the value 100. Fixed capital is the sum of tangible fixed assets plus depreciations.

firms' investment since capital will be less productive. Operating companies will face more difficulties in an environment in which other operating firms reduce their output.

We classify firms into two groups: in the group with strategic complementarities we include those firms which belong to industries which benefit from intra-industry localization externalities, and in the group without strategic complementarities we include those firms which belong to industries which do not benefit from intra-industry localization externalities.

We compare the impact of bank lending on investment across firms in the two groups. Two operating firms with identical economic and financial conditions should react differently to the same credit contraction in terms of their investment decisions, depending on their levels of strategic complementarities. We expect the firm with intense complementarities to have the largest reaction, controlling for its intrinsic conditions.

Figure 3 shows the evolution of fixed capital between 2006 and 2012 among two representative groups of Portuguese manufacturing firms: one group includes industries which display intense

complementarities, and the other group includes firms which display minor strategic complementarities. Using 2008 as the reference year, the figure shows that the evolution of fixed capital is similar among both groups until 2008. After 2009, though, capital falls sharply for those operating firms which benefit from external scale economies, whereas it remains relatively stable for the other group of firms. The evolution of fixed capital suggests that operating firms which benefit from strategic complementarities were the most severely hit by the 2009 credit crunch.

2.1 Identifying Firms with Strategic Complementarities

External scale economies, internal to the industry but external to the firm, are a source of increasing returns for individual firms and create strategic complementarities.

Agglomeration is widely recognized as a source and result of external scale economies. The literature has developed a number of location coefficients which quantify those external scale economies that result from the spatial concentration of firms of a particular industry in a given region and that are internalized by firms of that particular industry (see, for example, Ellison and Glaeser 1997; and Guimarães, Figueiredo, and Woodward 2007). Examples of industries with high geographic concentration are high-tech industries in Silicon Valley, the auto industry in Detroit, the entertainment industry in Hollywood, or investment banking in London.

We use the DM index to evaluate the amount of spatial concentration of an industry which can be related to that industry's specific spillovers (see Guimarães, Figueiredo, and Woodward 2007). The basic principle of this index is to measure the discrepancy between the regional distribution of the number of firms in a particular industry against the regional distribution of the overall employment (details on the construction of the DM index are available in the appendix). The DM index controls for the following:

- Randomness in location decisions, which naturally generates some clustering.
- Industry concentration, which also creates geographical concentration. The high geographical concentration in industries such as petroleum refining or cement and related products

is almost entirely explained by industrial concentration (and thus by internal returns to scale) rather than by external scale economies associated with firms' clustering.
- Market factors, such as wages, land costs, market accessibility, or transportation costs, which may generate geographical concentration but are not directly related to external economies.
- Urbanization economies. Controlling for this factor is a rather conservative approach, which is likely to reduce the significance of our results. Knowledge-intensive industries thrive on the clustering of workers who share ideas and expertise, and this clustering is also the source of external scale economies.

Guimarães, Figueiredo, and Woodward (2007) compute the DM index for the Portuguese economy using Quadros do Pessoal, a unique linked employer–employee data set collected by the Portuguese Ministry of Employment obtained through a yearly survey for all existing companies operating in Portugal. A key feature of Quadros do Pessoal is that it contains plant-level data, whereas many data sets contain firm-level data. Firm-level data are insufficient to study location decisions, as data on plants are often registered where the company's headquarters is located (and not where the plant is actually located).

Since external scale economies are one source of strategic complementarities, we classify operating firms as "firms benefiting from strategic complementarities" if they belong to those industries which display external scale economies. More specifically, we use the DM index as a proxy for strategic complementarities, since firms belonging to industries with high localization indexes are likely to benefit from external scale economies. Hence, we focus on spillover effects among firms which raise the productivity of neighboring firms belonging to the same industry.

We distinguish between firms in industries with strategic complementarities and firms in industries without strategic complementarities. To operationalize this distinction, we divide firms into two groups according to the DM index of their industry. The first group includes firms from industries with high DM indexes (the proxy for strong strategic complementarities), whereas the second group

includes firms in industries with low DM indexes (and which do not benefit from strategic complementarities)—see details below.

3. The Shock in Bank Credit

Portuguese banks reduced their lending after 2008, as a result of liquidity shocks, stricter requirements on regulatory capital, and tensions in sovereign debt markets. First, Portuguese banks started suffering liquidity problems after the demise of Lehman Brothers in September 2008. Second, concerns about the financial crisis led to more demanding regulation on capital requirements for Portuguese banks (see Banco de Portugal 2008) with the tier 1 capital ratio increasing from 6.9 percent in December 2008 to 7.9 percent in December 2009. Third, as tensions in the Greek sovereign debt market threatened to contaminate the Portuguese market during 2009, Portuguese banks reallocated their credit from the private to the public sector. Indeed, Portuguese banks increased their holdings of domestic public debt from 3.5 billion to 9.2 billion euros during 2009.

Several hypotheses may justify the reallocation of bank credit. According to the "moral suasion" hypothesis, it is likely that banks support the issuance of domestic public debt in times of stress (see, for example, Uhlig 2014 or Becker and Ivashina 2018). Higher yields (allowing for "carry trade") and favorable treatment in terms of regulatory bank capital also provided incentives for holding sovereign debt from distressed countries (see, for example, Acharya and Steffen 2015 or Drechsler et al. 2016). Broner et al. (2014) point out that sovereign debt offers more attractive expected returns to domestic creditors than to foreign ones, thus justifying the increased exposure of domestic banks to domestic public debt. Finally, Grilo, Jorge, and Rocha (2017) show that it is in the best interest of domestic banks to buy domestic public debt, so as to prevent the default of their government for fear of the destabilizing effects of sovereign default on their local operations. It is thus likely that Portuguese banks reacted to sovereign distress by reducing their supply of private credit. Altavilla, Pagano, and Simonelli (2016) use a sample of European banks from June 2007 to February 2015 to analyze bank behavior in stressed countries, and document a sharper reduction in loans among

Figure 4. Eurosystem Funding by Portuguese Banks

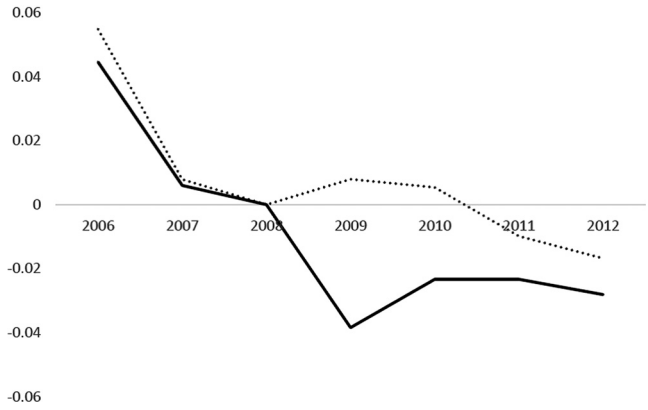
Source: Banco de Portugal.
Note: This figure plots the access to ECB funding by Portuguese banks in the period 2005–13 in million euros.

those banks more exposed to their sovereign. Popov and van Horen (2013) and De Marco (2014) use data from the European Banking Authority stress tests and document that the euro-area banks with larger sovereign exposures granted less credit than the less-exposed banks.

Figure 4 shows a sharp increase in access to European Central Bank (ECB) funding by Portuguese banks only in 2010, thus suggesting that the ECB did not offset the initial liquidity shock suffered by the Portuguese banking system in 2009 (Iyer et al. 2014; Alves, Bonfim, and Soares 2016). Taken together, these events suggest that the Portuguese firms suffered a credit shock in 2009.

Evidence of tighter lending in 2009 abounds, and we compare firms' investment before and after this year (for an overview of the 2009 credit crunch see Antunes and Martinho 2012). This exercise is appropriate since banks are the main source of financing for Portuguese small and medium-sized firms. Although banks displayed considerable reluctance to extend loans to firms and compromised their ability to invest, most of our results would hold if the fall in bank credit were driven by a demand shock.

Figure 5. Effect of the 2009 Credit Shock on Firms' Investment



Notes: We run separate panel regressions for firms with strategic complementarities (solid line) and without strategic complementarities (dotted line) of the ratio of investment over assets on the set of year dummies, controlling for firm fixed effects. The figure plots the coefficients obtained for the year dummies (2008 is the omitted year).

Figure 5 shows the effect of the 2009 credit shock on firms' investment decisions. We run separate panel regressions for firms belonging to the group with strategic complementarities and for firms in the group without strategic complementarities. We regress investment on a set of year dummies, controlling for firm fixed effects. Firms in the group with strategic complementarities suffer a steep reduction on their investment after 2008, confirming the strong impact of the 2009 shock, whereas firms without strategic complementarities do not experience a significant reduction in investment up to 2011. Our empirical strategy consists of measuring the differential reduction in investment for both groups.

4. The Empirical Strategy

We study the role of strategic complementarities in amplifying the impact of economic shocks. For this purpose, we evaluate if a shock has a different impact on the two groups of firms considered.

Formally, we test the hypothesis that the group with strong complementarities is more sensitive to the shock. More specifically, we use the 2009 credit crunch to compare the impact of spillover effects on firms' investment decisions.

To analyze the impact of the spillover effects after the shock, we employ a difference-in-differences approach in which we compare firms' investment before and after the onset of the credit crunch for each of the two groups of firms (with one group including firms which benefit from strategic complementarities, and the other group including firms which do not), controlling for observable measures of external finance constraints and exogenous investment opportunities as well as firm fixed effects.

Our baseline specification regresses firm-level annual investment over 2006–12 on a dummy variable for whether the year in question is after the shock, on a dummy variable for whether the firms belongs to the group with strategic complementarities, and on the interaction of the two dummy variables. The coefficient on the interaction term measures the differential impact of the credit shock on the two groups of firms.

The control variables used are total debt to account for external finance constraints, and cash flow, sales, trade credit, and exporter activity to account for exogenous investment opportunities and demand shocks.

We conduct several additional robustness tests to address concerns that our results may be due to confounding effects. These include an alternative of identifying the credit contraction shock, dealing with sample-selection problems, and applying a matching approach to find the best counterfactual in the difference-in-differences approach.

5. Data and Research Methods

We collect data from Sabi for Portuguese firms for the period between 2006 and 2012, thus covering both crisis and pre-crisis years.[1] Sabi includes information about end-of-year balance sheets,

[1]The Sabi database is a subset of the Amadeus database, which holds information on European firms, and similar is to Compustat for American firms.

income statements, and banking relationships, and includes (almost) all Portuguese firms. Our unit of observation is the firm–year pair.

We collect data on active firms with available accounting information, and restrict the selection to manufacturing industries. We sort firms into two groups, as we distinguish a group of firms in industries with high DM indexes from a group of firms with low indexes. We only use those industries with extreme values of the DM index, so as to make a clear distinction between the group with strategic complementarities and the group without strategic complementarities. Following the classification proposed by Guimarães, Figueiredo, and Woodward (2007), we consider the top 19 industries with the highest DM indexes, as well as the 16 industries at the lower end of the ranking. Industries with strategic complementarities are those with a DM index above 0.026, and industries without strategic complementarities are those for which the DM index is zero or not significantly different from zero at 95 percent confidence. Guimarães, Figueiredo, and Woodward (2007) calculate the DM index for each of the 103 manufacturing industries in the three-digit classification of the Portuguese Standard Classification System (CAE); see tables A.1 and A.2 in the appendix for the complete list of industries at the upper and lower ends of the ranking.

Departing from the list of industries presented by Guimarães, Figueiredo, and Woodward (2007), we exclude five industries because it is likely that their location depends on natural resources and not on spillover effects caused by strategic complementarities. These industries are petroleum refining, shipbuilding and repairing, sea products processing, tobacco, and recycling of nonmetallic products. For example, agglomeration in shipbuilding and repairing naturally arises near seaports.

Finally, we restrict our sample to small and medium-sized firms (fewer than 250 employees) and we exclude micro firms with fewer than 10 employees (to guarantee reliable data). Using these filters, we collect data for 984 firms in the group with large DM indexes and 240 firms in the group with low DM indexes. The panel is not balanced, as only 730 firms have data for the seven years. See table A.3 in the appendix for details.

Following much of the investment literature (as, for example, Duchin, Ozbas, and Sensoy 2010; Ivashina and Scharfstein 2010; and Almeida et al. 2014), we measure investment as capital expenditures

divided by total assets. Capital expenditures in year t are calculated as the difference between "fixed tangible assets plus depreciations" in year t and the amount of "fixed tangible assets" in year $t-1$.

Table 1 reports summary statistics for firm–year units from 2006 until 2012. Panel A of table 1 includes information on all observations in our sample, of which 6,154 observations are on firms with strategic complementarities and 1,490 observations are on firms without strategic complementarities. Panel A provides mean, standard deviation, minimum, and maximum for several variables. Panel B of table 1 distinguishes between both groups of firms and provides means, and difference-in-means tests for both groups.

The average values for variables like the ratio of fixed capital, total debt, and cash flow over assets show that the differences between the two groups are economically small, and the difference in investment between the two groups is not economically or statistically significant. There is a substantial difference in sales and assets, thus implying that the group of firms without strategic complementarities includes larger firms and suggesting that firms in this group benefit from internal scale economies. These firms also have more debt, which could potentially make them more sensitive to a credit crunch and bias the results against our hypotheses.

We have confirmed that the share of each group in the overall sample is stable during the 2006–12 period, so that the proportion of firms which benefit from strategic complementarities is not significantly affected by the credit shock.

6. Results

6.1 Preliminary Results

Table 2 presents results for the two groups of firms (with and without strategic complementarities) in which we compare investment before the onset of the crisis with investment after. In the comparison, we average each firm's time series into two sample means—one for the period 2006–08, which we label as "before the crisis," and one for the period 2009–12, which we label as "after the crisis." Subsequently, we average the firms' sample means for each combination group-period. The table reports whether the differences in

Table 1. Summary Statistics

	A. Mean, Standard Deviation, Minimum, and Maximum for All Observations			
	Mean	**Std. Dev.**	**Min.**	**Max.**
Employees (n)	48.75	44.41	10.00	246.00
Capital/Assets	0.30	0.21	0.00	1.23
Investment/Assets	0.05	0.24	−16.81	0.87
Debt/Assets	0.22	0.22	0.00	6.11
CashFlow/Assets	0.07	0.11	−2.69	1.01
Sales (Euros)	4,418.31	9,912.47	0.00	243,291.49
Sales Variation	8.60	35.23	−97.40	991.84
Assets (Euros)	4,612.42	13,158.94	5.00	279,324.54
Bank Lending Relationships (n)	2.55	1.51	1	11
No. Obs.	7,644			
	B. Mean Values for Firms with and without Strategic Complementarities			
	Without SC	**With SC**	**Difference**	**p-Value**
Employees (n)	43.21	50.00	−6.89	0.00
Capital/Assets	0.28	0.3	−0.02	0.00
Investment/Assets	0.06	0.05	0	0.54
Debt/Assets	0.23	0.21	0.02	0.00
Cash Flow/Assets	0.06	0.07	−0.01	0.00
Sales (Euros)	8,071.69	3,533.76	4,537.92	0.00
Sales Variation	8.09	8.73	−0.64	0.53
Assets (Euros)	8,732.26	3,614.93	5,117.33	0.00
Bank Lending Relationships (n)	2.71	2.52	0.19	0.00
No. Obs.	1,490	6,154		

Notes: Panel A reports summary statistics for the variables used in the analysis. The sample period is 2006 to 2012. "Employees" is the number of a firm's employees. "Capital/Assets" is the ratio between fixed capital (fixed tangible assets plus depreciations) and assets (total assets). "Investment/Assets" is the ratio between investment (fixed tangible assets plus depreciations in period t minus fixed tangible assets in period $t-1$) and assets. "Debt/Assets" is the ratio between total debt (long- and short-term debt) and assets. "CashFlow/Assets" is the ratio between cash flow and assets. "Sales" is the value of total sales. "Sales Variation" is the net sales growth rate. "Bank Lending Relationships" is the number of banks with which firms establish relationships. Panel B reports mean values for the same variables, distinguishing between firms with ("With SC") and without ("Without SC") strategic complementarities. Differences in means are assessed with the t-test.

Table 2. Investment Before and After the Credit Crisis

	Before the Crisis	After the Crisis	Difference	(p-value)
Without SC	0.066	0.050	0.016	0.005
With SC	0.077	0.037	0.040	0.000
No. Obs.	2,915	4,729		

Notes: The table presents results for the two groups of firms (with and without strategic complementarities) in which we compare the ratio of investment over assets before the onset of the crisis with the ratio after. In the comparison, we average each firm's time series into two sample means—one for the period 2006–08, which we label as "before the crisis," and one for the period 2009–12, which we label as "after the crisis." Subsequently, we average the firms' sample means for each combination group-period. Differences in means are assessed with the t-test.

average investment between groups for each period are statistically significant.

The table shows that investment decreases by one-half for the group of firms with strategic complementarities. Although the reduction in investment for firms without strategic complementarities is statistically significant, it is substantially smaller from the economic point of view. Overall, results are consistent with our main hypothesis that tight credit conditions hurt firms with strategic complementarities more. In the analysis which follows, we investigate these patterns in more detail.

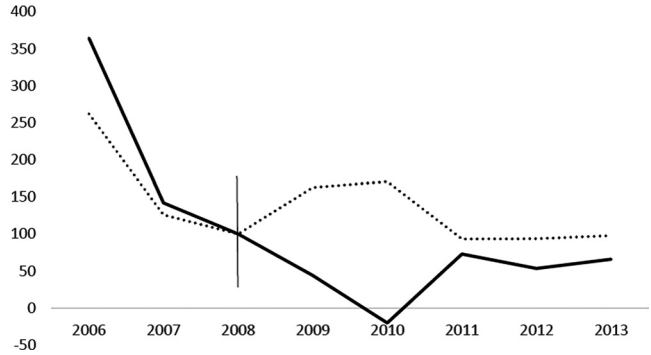
6.2 Baseline Regressions

To quantify the impact of strategic complementarities on investment for both groups of firms *after the credit shock*, the analysis relies on the following difference-in-differences specification:

$$INV_{it} = \alpha_1 + \beta_1 CC_t + \beta_2 SC_i + \beta_3 CC_t.SC_i + \boldsymbol{\beta}\mathbf{W}_{it} + \eta_t + \eta_i + \epsilon_{it}, \tag{1}$$

where INV_{it} measures the investment of firm i in period t, CC_t stands for "credit contraction" and takes a value of 1 in the period "after" the shock (the period from 2009 through 2012) and 0 in the period "before" the shock (the period from 2006 through 2008), SC_i is a dummy variable which takes unit value for those firms which

Figure 6. The Parallel Trend Assumption



Notes: The figure plots the evolution of the average ratio of investment over assets for firms with strategic complementarities (solid line) and firms without strategic complementarities (dotted line). The reference year is 2008, in which the ratio of investment over assets takes the value 100.

belong to the group with high DM indexes and zero otherwise, the interaction term $CC_t.SC_i$ takes the value of 1 in the period of the credit contraction if the firm has strategic complementarities and zero otherwise, $\mathbf{W}_{it}$ is a vector of firm control variables (cash flow, net sales variation, total debt, and a dummy variable which takes a value of 1 if firm i is exporter), η_t is a set of year dummies, and η_i represents firm fixed effects.

The key coefficient of interest is β_3—the coefficient on the interaction term—which measures the impact of the credit shock on the investment of firms with strong strategic complementarities.

The validity of the difference-in-differences approach relies on satisfying the parallel trend assumption. When applied to equation (1), this assumption requires that the dependent variable would have followed the same trend for both groups (with and without strategic complementarities) in the absence of the credit shock.

Figure 6 plots the time series for investment for both groups of firms, with both series indexed to 100 in 2008. The figure shows a clear message: the trends in both groups are nearly identical until 2008, whereas in 2009 there is a clear break. After the onset of the crisis, the time series for investment by firms with large DM indexes continues its downward trajectory, whereas investment for the group

of firms with low DM indexes grows in 2009 and later returns to the 2008 level. Such evolution in investment for both groups suggests that the parallel trend assumption applies.

6.2.1 Baseline Results

Table 3 presents the estimates of regression equation (1). Firm fixed effects subsume the dummy SC_i for the groups of firms (since groups are fixed over time, as firms do not change groups) and control for time-invariant heterogeneity across firms. Standard errors are clustered at the firm level to correct for within-firm residual correlation.

Columns 1 and 2 do not include controls or the dummy variable for strategic complementarities, but they do include fixed effects and a dummy variable for the credit contraction. Column 1 presents the basic patterns of investment. We find that, on average, annual investment as a fraction of assets fell by 3.71 percentage points following the onset of the credit shock, a decline of 74 percent relative to the unconditional mean of 5 percent. The magnitude of the decline is substantially bigger than that suggested by aggregate statistics, thus suggesting that our sample does not represent the whole Portuguese economy. Banco de Portugal reports a fall of 17 percent in the average value of annual gross fixed capital formation in the period 2009–12 relative to the overall average in the 2006–12 period.[2]

Column 2 includes the interaction term. Following the onset of the credit shock, annual investment (as a fraction of assets) declined by 2.09 percentage points more for firms with strategic complementarities. The coefficient on the interaction term shows that the decline in investment is economically large and statistically significant for firms with strategic complementaries, thus establishing a role for spillover effects in the aftermath of the credit shock.

The remaining columns include the control variables. Column 3 considers random effects and column 4 includes firm fixed effects. The coefficient on the dummy for strategic complementarities in column 3 suggests that firms with strategic complementarities invest around 1 percentage point more than firms without strategic complementarities. Yet, the Hausman test unambiguously rejects the

[2]In our sample, average investment falls 33 percent in the period 2009–12 relative to the overall average in the 2006–12 period.

Table 3. Strategic Complementarities and Investment Before and After the Credit Crisis (regression estimates)

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
SC			0.0091*			0.0092*	
			(1.69)			(1.68)	
CC	−0.0371***	−0.0204***	−0.0126**	−0.0201***	−0.0207***	−0.0115**	
	(−10.67)	(−3.85)	(−2.26)	(−3.66)	(−3.77)	(−2.05)	
CC*SC		−0.0209***	−0.0249***	−0.0212***	−0.0199***	−0.0261***	−0.0217***
		(−3.11)	(−3.34)	(−3.17)	(−2.82)	(−3.39)	(−3.24)
Sales			0.00019***	0.0001**	0.000134**	0.0002***	0.0001*
			(4.77)	(2.02)	(2.02)	(4.68)	(1.81)
CashFlows/Assets			0.156***	0.0708**	0.0698**	0.137***	0.0681**
			(4.79)	(2.33)	(2.27)	(4.87)	(2.04)
Debt/Assets			0.0420**	0.0426	0.0423		0.0438
			(2.21)	(1.50)	(1.48)		(1.50)
DebtIndustry					0.0463		
					(1.33)		
Debt/Assets_06						0.0006	
						(0.05)	
Exporter			0.0017	0.0212	0.0212	0.0028	0.0208
			(0.19)	(1.29)	(1.29)	(0.31)	(1.31)
Constant	0.0758***	0.0758***	0.0437***	0.0462***	0.0456***	0.0531***	0.0336**
	(35.21)	(35.26)	(3.51)	(2.90)	(2.94)	(4.94)	(2.31)
RE			Yes			Yes	
Firm FE	Yes	Yes		Yes	Yes		Yes
Year FE							Yes
R^2	0.0069	0.0072	0.0079	0.0092	0.0093	0.0077	0.0122
No. Obs.	7,644	7,644	7,644	7,644	7,644	7,644	7,644

Notes: This table shows estimates from panel regressions of the effect of a credit contraction shock on firms' investment, comparing firms with and without strategic complementarities. The dependent variable is firm-level investment. Observations are at the firm–year level. Coefficients in columns 3 and 6 are estimated by random effects. Columns 1, 2, 4, 7, and 8 consider firm fixed effects. Control variables include sales (net sales variation), cash flows, debt, and an exporter activity dummy (we classify exporting firms by year; that is, an exporting firm in year t is a firm which has sold abroad in year t). The variables' definitions are provided in table A.4 in the appendix. SC—strategic complementarities dummy, CC—credit shock dummy, Sales—net sales variation, "DebtIndustry" measures the difference between the values of year t and of year $t-1$ for the aggregate debt of the industry (normalized by assets), Assets_06—assets in 2006, Exporter—exporter dummy, RE—random effects, FE—fixed effects. Standard errors are clustered at the firm level. *, **, and *** denote statistical significance at the 10 percent, 5 percent, and 1 percent levels, respectively, and t statistics are in parentheses.

existence of random effects. Column 4 considers the existence of fixed effects and shows that the differential effect between firms with and without strategic complementarities increases to about 2.12 percentage points, and the effect remains highly statistically significant.

As suggested by Bebchuk and Goldstein (2011), banks will restrict credit more strongly to those industries which display strategic complementarities. Concerned about the endogenous reaction of the banking system, we control for the total debt of the industry in column 5 and find that the estimated coefficient on the interaction term is both significant and comparable to the coefficient obtained in column 4. Moreover, the coefficient on the total debt of the industry, which measures the degree of endogenous reaction of the banking system, is not statistically significant.

We use the firm's total debt (as a fraction of assets) in year t to control for external finance constraints. Yet, variation in firm's total debt as the crisis unfolds may be related to unobserved changes in its investment opportunities—to some extent, total debt is endogenous to the choices made by the firm. We remove these changes from our specification by using the total debt over assets *before* the crisis. This is equivalent to using instrumental variables, assuming that the ratio of debt to assets before the crisis is not correlated with unobserved within-firm changes in investment opportunities after 2008. In column 6 from table 3, we repeat the exercise in column 3, replacing debt over assets in each year by the debt over assets in 2006. The table documents economically equivalent results, since the coefficient on the interaction term does not change substantially between the two alternative difference-in-differences specifications.

The estimates in column 7 include time dummies to control for aggregate shocks (which subsume the CC_t variable) together with firm fixed effects. The estimate of the differential impact increases to 2.17 percentage points and continues to be highly statistically significant.

6.3 Robustness Check: An Alternative Way to Identify the Shock

We now address potential concerns with our baseline specification. First, we have defined the year 2009 as the year of the shock, but

there may be concerns that this may not be the correct year—that is, the dummy CC_t does not correctly identify the economic shock. To address this issue, we repeat the baseline regression in column 4 of table 3 and show that we do not obtain similar results for placebo (i.e., nonexistent) shocks in other years, which is suggestive evidence that our choice for the date of the shock is indeed appropriate. Table 4 presents the results and shows that none of the placebo shocks has significant coefficients for the interaction term, except for the coefficient on the 2008 placebo shock. This coefficient may be significant because the difficulties in international financial markets started immediately after the demise of Lehman Brothers in September 2008, and therefore the credit shock may have initiated in the last quarter of 2008.

Another concern is that the dummy variable CC_t is insufficient to capture different credit shocks across industries. The initial credit shock may have hit industries heterogeneously, and one dummy variable common to all industries will not fully capture the richness of the information found in the data.

To address these concerns, we change the definition of the variable which proxies the credit contraction. We repeat the baseline specification, replacing the dummy variable for the periods "before" and "after" the shock with a variable which measures the *evolution of credit for each industry*. We hope to identify the spillover effects which derive from the credit contraction for each particular industry.

We use the total debt (normalized by assets) of an industry as a proxy for the industry's bank credit. We sum the total debt of the firms belonging to a given industry to obtain the total debt of the industry—the debt reported in firms' balance sheets is closely related to bank credit since most of the credit to SMEs is granted by banks. Being a continuous variable which takes values for all years in our sample, the new variable solves our two above-mentioned concerns.

We apply a difference-in-differences specification similar to equation (1), where we replace the variable CC_t with the variable $DebtIndustry_{it}$, which measures the difference between the values of year t and of year $t-1$ for the total debt of the industry (normalized by assets) to which firm i belongs. The variable $DebtIndustry_{it}$ takes negative values as long as the credit to the industry to which firm i belongs falls in year t.

Table 4. Placebo Shocks

	Baseline Regression	Placebo 2007	Placebo 2008	Placebo 2010	Placebo 2011	Placebo 2012
	(1)	(2)	(3)	(4)	(5)	(6)
SC	−0.0201***	−0.0538***	−0.0286***	−0.0203***	−0.0229***	−0.0225***
	(−3.66)	(−4.45)	(−4.52)	(−3.87)	(−4.31)	(−3.23)
CC*SC	−0.0212***	−0.00741	−0.0144**	−0.00265	0.00557	0.00676
	(−3.17)	(−0.54)	(−1.98)	(−0.28)	(0.71)	(0.75)
Sales	0.000134**	0.000120*	0.000113*	0.000162***	0.000135**	0.000133*
	(2.02)	(1.79)	(1.70)	(2.59)	(1.98)	(1.94)
CashFlows/A	0.0708**	0.0823**	0.0722**	0.0793**	0.0826**	0.0886**
	(2.33)	(2.47)	(2.24)	(2.30)	(2.33)	(2.55)
Debt/A	0.0426	0.0380	0.0416	0.0357	0.0311	0.0298
	(1.50)	(1.37)	(1.50)	(1.31)	(1.11)	(1.06)
Exporter	0.0212	0.0160	0.0188	0.0182	0.0167	0.0152
	(1.29)	(1.01)	(1.17)	(1.15)	(1.10)	(0.97)
Constant	0.0462***	0.0811***	0.558***	0.0365**	0.0338*	0.0316*
	(2.90)	(4.51)	(3.32)	(2.02)	(1.84)	(1.75)
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes
R^2	0.0092	0.0087	0.0083	0.0048	0.0038	0.0031
No. Obs.	7,644	7,644	7,644	7,644	7,644	7,644

Notes: In column 1 we show the baseline regression presented in column 4 of table 3. Columns 2–6 show placebo shocks regressions. All columns consider firms' fixed effects. Control variables include sales (net sales variation), cash flows, debt, and an exporter activity dummy (we classify exporting firms by year; that is, an exporting firm in year t is a firm which has sold abroad in year t). The variables' definitions are provided in table A.4 in the appendix. SC—strategic complementarities dummy, CC—credit shock dummy. Standard errors are clustered at the firm level. *, **, and *** denote statistical significance at the 10 percent, 5 percent, and 1 percent levels, respectively, and t statistics are in parentheses.

$$INV_{it} = \alpha_1 + \beta_1 DebtIndustry_{it} + \beta_2 SC_i + \beta_3 DebtIndustry_{it}.SC_i + \boldsymbol{\beta}\mathbf{W}_{it} + \eta_t + \eta_i + \epsilon_{it}$$

All other variables are as defined earlier. The interaction term $DebtIndustry_{it}.SC_i$ combines the variation in industry's debt with its strategic complementarity level, and we want to evaluate if the coefficient β_3 is positive and statistically significant. Column 1 in table 5 reports the results for the estimated equation.

The results are broadly consistent with the previous results. The coefficient on the interaction term β_3 suggests that a reduction of 1 percentage point in the ratio of debt variation over assets for an industry with strategic complementarities, on average, leads to a decline in firms' annual investment as a fraction of assets equal to 0.172 percentage points more than for industries without complementarities.

6.4 Robustness Check: Trade Credit

We have considered that the credit crunch has a negative impact on firms' investment, which then has a negative impact on the industry's productivity and profit. Still, firms can adapt endogenously to industry spillover effects, by providing some sort of insurance among them. Firms may be able to weather a credit shock better because they informally help each other to raise funding—for example, in the form of trade credit. As Petersen and Rajan (1997) or Cuñat (2007) point out, suppliers provide insurance through trade credit to offset shocks that could endanger the survival of their customer relationships. In particular, firms may use more trade credit when bank credit is unavailable. Moreover, bank credit can be redistributed via trade credit from firms with access to bank credit to firms without access.

This type of insurance is likely to be more relevant for agglomerated industries, in which spillover effects are more important. It is thus possible that the evolution of trade credit in these industries offsets the effects of the 2009 bank credit shock on investment. To address this concern, we repeat the baseline regression in column 4 of table 3, but now including the firm's trade credit (normalized by assets) among the control variables. Column 2 of table 5 reports the estimates and shows that

Table 5. Robustness Checks

	(1)	(2)	(3)	(4)	(5)
CC		−0.0186***	0.0361**	0.0084	−0.0014
		(−2.96)	(−2.19)	(0.50)	(−0.20)
DebtIndustry	0.0244				
	(1.07)				
DebtIndustry*SC	0.172**				
	(2.10)				
CC*SC		−0.0219***	−0.0608***	−0.0312*	−0.0147**
		(−2.87)	(−3.58)	(−1.90)	(−2.10)
Sales	0.000142**	0.000122**	0.00000516	0.000262**	0.0000571
	(2.08)	(2.33)	(0.03)	(2.17)	(1.25)
CashFlows/Assets	0.0914***	0.0793*	−0.0244	−0.0760	0.00737
	(2.64)	(1.69)	(−0.32)	(−0.94)	(0.32)
Debt/Assets	0.0302	0.0520	−0.101**	−0.00223	0.0198
	(1.08)	(1.04)	(−2.14)	(−0.06)	(1.43)
Exporter	0.0143	0.0211	−0.00990		
	(0.92)	(1.30)	(−0.74)		
Trade Credit/Assets		0.0306			
		(0.40)			
Constant	0.0262	0.0357	0.0767***	0.0530***	0.0550***
	(1.58)	(0.88)	(4.85)	(5.81)	(12.02)
Firm Fixed Effects	Yes	Yes	Yes	Yes	Yes
Year Fixed Effects			Yes	Yes	Yes
R^2	0.0031	0.0094	0.2167	0.1030	0.0392
No. Obs.	7,644	7,644	574	367	5,197

Notes: In column 1 we see the difference between the variation in aggregate debt of the industry (normalized by assets) as the explanatory variable to determine the shock. In column 2 we add firms' trade credit (normalized by assets) as a control variable. Columns 3–5 show estimates for appropriately selected subsamples. In column 3 we restrict the sample to firms which worked only with non-bailed-out banks. In column 4 we restrict the sample to firms which worked only with non-bailed-out banks and are exporters (we classify exporting firms by year; that is, an exporting firm in year t is a firm which has sold abroad in year t). In column 5 we restrict the sample to all exporting firms. Observations are at the firm–year level. All columns consider firm fixed effects. Control variables include sales (net sales variation), cash flows, debt, an exporter activity dummy (we classify reporting firms by year; that is, an exporting firm is year t is a firm which has sold abroad in year t), and trade credit. The variables' definitions are provided in table A.4 in the appendix. "DebtIndustry" measures the difference between the values of year t and of year $t-1$ for the aggregate debt of the industry (normalized by assets). SC—strategic complementarities dummy, CC—credit shock dummy. Standard errors are clustered at the firm level. *, **, and *** denote statistical significance at the 10 percent, 5 percent, and 1 percent levels, respectively, and t statistics are in parentheses.

the estimated coefficient on the interaction term is both significant and comparable to the coefficients obtained in the baseline regressions.

The coefficient on trade credit is not statistically significant, thus suggesting that trade credit does not offset the impact of the 2009 bank credit crunch on investment. This may be because firms refrain from using this type of funding for investment. As Petersen and Rajan (1997) point out, firms avoid trade credit to obtain medium- and long-term funding (the type of funding usually allocated to investment).

6.5 Robustness Check: Sample Splits

The regression model (1) was specified according to our theoretical priors, and we have added controls to the specification to capture additional sources of firm heterogeneity. But the inclusion of controls in the regression per se does not address the fact that the two groups being compared may have very different characteristics (see, for example, Heckman et al. 1998). When the control variables have poor distributional overlap, one can improve the estimation of group differences by estimating the model for more homogenous groups of firms.

Motivated by the potential sensitivity of our results to our sample, we estimate the model for appropriately selected subsamples. For the same reason, we will also conduct our analysis combining a difference-in-differences approach with the use of matching estimators.

6.5.1 Handling a Possible Sample-Selection Problem

One obvious concern about our identification strategy is the sample-selection problem, which could arise from the possible migration by firms from those banks which have restricted their loans to those banks which have not. Since 2009, "good" firms could have migrated from banks which have restricted their credit or, alternatively, these banks could have "cherry-picked" the "good" firms. In any of these cases, the portfolio of banks which restricted their credit after 2009 represents a biased sample. For the same reason, the set of firms which has migrated among banks is also a biased sample.

For these reasons, we focus on those firms which have worked exclusively with banks which were more willing to extend loans to firms in the period 2009–12. This strategy alleviates concerns about sample selection, such as bank–firm sorting. Recall that we are not interested in the direct effects of credit rationing, but rather in the spillover effects coming from neighboring firms which have been credit rationed.

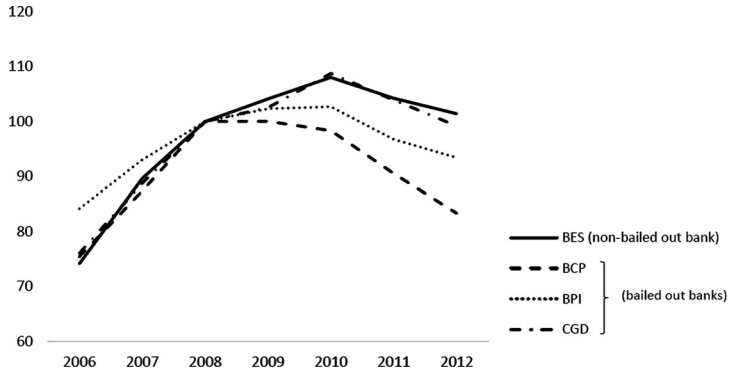
The next step is to identify those banks which were less reluctant to extend loans to firms after 2009. Capital adequacy ratios have a major impact on the willingness of banks to grant credit, and it is plausible to assume that banks with less capital are more likely to ration their clients (see, for example, Bebchuk and Goldstein 2011).[3] In 2008 the largest Portuguese banks officially reported capital ratios near their regulatory requirements, but these results may hide substantial heterogeneity. The reason is that banks must comply (or appear to comply) with regulatory requirements on their minimum level of capital, and the formulas to compute regulatory capital are complex. It is likely that some banks have understated the risk in their portfolio, and banks with the same reported capital ratios faced different restrictions in terms of lending (which requires regulatory capital).

With the benefit of hindsight, we know which banks had substantial capital shortfalls two years later, in 2011, since the international official assistance program obtained by the Portuguese government led to a close inspection of banks' balance sheets. As a result, some of the biggest Portuguese banks were required to ask for state financial support in 2012. Augusto and Félix (2014) analyzed the effects of this recapitalization in the period between 2010 and 2013 and its effect on firms' credit access, concluding that these bailout operations contributed to an increase in credit supply; that is, they prevented an even sharper decline in loan growth rates.

Banco Comercial Português, Banco Português de Investimento, and Caixa Geral de Depósitos (the state-owned bank) were bailed

[3] Albeit there are arguments in the opposite direction. For example, Caballero, Hoshy, and Kashyap (2008) study zombie lending as a way to avoid writing off existing capital.

Figure 7. Effect of the 2009 Credit Shock on the Lending Behavior of the Four Largest Portuguese Banks



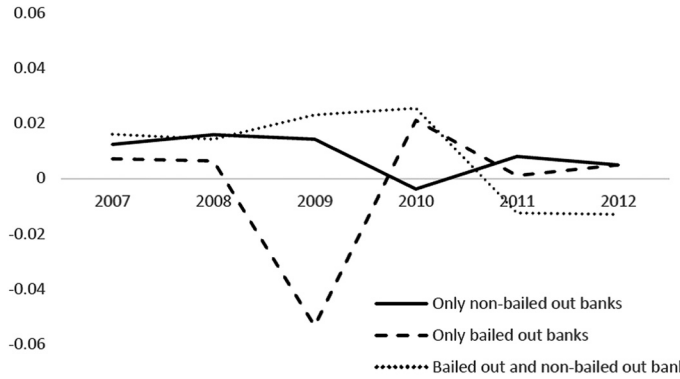
Notes: This figure plots total loans volumes considering 2008 as the reference year. We use Bankscope data for the four main Portuguese banks: Caixa Geral de Depósitos (CGD), Banco Comercial Português (BCP), Banco Português de Investimento (BPI), and Banco Espírito Santo (BES). Together these banks represent 60–70 percent of Portuguese corporate debt.

out in June 2012, and Banco Internacional do Funchal in December 2012 by the issuance of contingent convertible bonds (bought by the Portuguese government) which allowed these banks to comply with minimum capital requirements defined by European Banking Authority and by Banco de Portugal. This recapitalization operation was needed to reinforce banks' capital base, in a scenario of adverse macroeconomic conditions and compression of their net interest margins.

The depletion of capital is a long, slow process and it is likely that banks may have started to face problems as early as 2009. This would imply that bank lending has been affected since 2009. Figure 7 depicts the evolution of total bank loans granted by each of the four largest Portuguese banks, and shows that the only bank that was not bailed out (Banco Espírito Santo) was precisely the one which has restricted its lending by less.[4]

[4]Caixa Geral de Depósitos, the state-owned bank, exhibits a lending behavior similar to Banco Espírito Santo, but anecdotal evidence points out that Caixa

Figure 8. Evolution of Firms' Variation of Debt over Assets



Notes: This figure plots average values of the ratio year-on-year total debt difference over assets for (i) firms which during the considered period of time worked only with non-bailed-out banks (solid line), firms which during the considered period of time worked only with bailed-out banks (dashed line), and firms which worked with both type of banks during the considered period of time (dotted line). Banks which were bailed out: Banco Comercial Português, Banco Português de Investimento, Caixa Geral de Depósitios, and Banco Internacional do Funchal. Banks which were not bailed out: Banco Espírito Santo, Banco Santander, Banco Popular, Finibanco, Caixa de Crédito Agrícola, Banco Bilbao Viscaya, Barclays Bank, Montepio Geral, Fortis Bank, BNP Paribas, Caja de Ahorros, Deutsche Bank, Banco BIC, Banco Finantia, Banco Popular, ABN AMRO bank, Banco Privado, Banco Totta, Banco Best, and Credit Lyonnais. We exclude the 10 firms which have borrowed from Banco Português dos Negócios, since this bank was nationalized in 2010.

Sabi contains information about bank relationships for each individual firm. We divide our sample of firms into three distinct groups: (i) firms which worked only with non-bailed-out banks, (ii) firms which worked only with bailed-out banks, and (iii) firms which worked with both types of banks.[5] The reference period to build these three groups was 2006–12. Figure 8 plots the evolution of the

Geral de Depósitos has made a large effort to offset the decrease in aggregate bank lending after 2008.

[5]We assume that the bailed-out banks in 2012 were the banks with less capital in 2009, and we report the results when we divide the banks into two groups—the bailed-out and the non-bailed-out banks. Since the lending behavior of Caixa Geral de Depósitos was similar to the lending behavior of the non-bailed-out

average values of the total debt difference between two consecutive years (as a fraction of assets) for the three distinct groups considered. The debt of firms which only worked with bailed-out banks suffered a severe decrease in 2009, whereas the total debt of firms which worked exclusively with non-bailed-out banks remained almost constant over time.

Having in mind figures 7 and 8, we consider a sample of firms which obtained bank loans during the period 2006–12 exclusively from banks which were not bailed out. This strategy helps us identify the variation in investment which resulted from the impact of the credit shock on neighboring firms. Column 3 in table 5 reports the estimates of equation (1) for the restricted sample. The results in the subsample reinforce the results in the baseline regressions. On average, firms with strategic complementarities reduce their investment (as a fraction of assets) by 6.08 percentage points more than firms without complementarities following the 2009 credit crunch.

6.5.2 Demand Shocks

Another potential concern in our identification strategy is whether unobserved changes in investment opportunities may have biased our results. For example, if the demand for goods produced by firms with strategic complementarities has fallen after 2009, then these firms would find it optimal to reduce their production (and investment)—and such effect would not be related to the existence of spillover effects from strategic complementarities. Put more formally, our concern is that unobserved differences between both groups of firms trigger sharp contrasts in the post-crisis period because of changes in the environment other than spillover effects.

To address these concerns, we restrict our sample to exporting firms. The effect of the 2009 credit contraction on investment of exporting firms is very unlikely to be explained by a reduction in the internal demand for their products, since these firms have the means to offset this reduction.

Column 4 of table 5 shows the estimates of equation (1) when we restrict the sample to exporting firms which borrowed exclusively

banks, we moved Caixa Geral de Depósitos from one group to the other, repeated the same exercises, and confirmed that results were equivalent.

from non-bailed-out banks in the period 2006–12. The results are also statistically significant and with similar magnitudes to the baseline regressions. On average, firms with strategic complementarities reduce their investment (as a fraction of assets) by 3.12 percentage points more than firms without complementarities. Column 5 of table 5 considers all exporting firms (regardless of whether they borrowed from bailed-out banks or not), and broadly confirms the previous results.[6]

7. Counterfactual Matching Approach

Our main goal is to gauge how strategic complementarities affected firms in the aftermath of the 2009 credit shock. For this purpose we isolate the firms which benefit from strategic complementarities. We would like to compare their observed investment after 2009 (which was affected by spillover effects) with their *non-observed* investment *had their neighbors not been caught by the credit contraction.* Naturally, this is a difficult task. One way to tackle this problem is to estimate the difference between the investment actually observed in the data and a plausible counterfactual investment. Since firms without strategic complementarities are not affected by spillover effects from their neighbors, these firms provide a natural counterfactual.

We conduct our analysis combining a difference-in-differences approach with the use of a matching estimator. The idea behind this approach is to isolate firms with strategic complementarities and then, from the population of firms without complementarities, look for *control* observations that best *match* the observations on firms with complementarities. We are assuming that *if it were not for the existence of strategic complementarities*, both groups of firms

[6]There was a substantial fall in world trade during 2009, so using a sample of exporting firms may not be sufficient to control for demand effects. Indeed, within the subsample of exporting firms, those industries which saw their sales abroad fall in 2009 represent 16 percent of the firms in industries without strategic complementarities and 8 percent of the firms in industries with strategic complementarities. Yet, (i) the fall in exports is more pronounced for industries without strategic complementarities, which biases the results against our hypotheses, and (ii) exports later recovered, so more than 95 percent of the exporting firms in our sample belong to industries which see their sales abroad increase in the period 2009–12 relative to the period 2006–08. Taken together, these results suggest that our approach is appropriate.

would have behaved similarly. The matches are made so as to ensure that observations in both groups have identical distributions along some pre-specified dimensions.

We employ the propensity score matching estimator of the "average effect of the treatment on the treated" proposed by Leuven and Sianesi (2003), using observed characteristics (such as assets, sales, cash flow, number of employees, and being an exporting firm or not) as inputs in a probit regression where the dependent variable is the dummy variable SC_i which identifies firms with strategic complementarities.[7] For each firm with strategic complementarities, the procedure finds the firm without complementarities with the closest propensity score. Once the assignment has been done, we can measure the difference-in-differences in investment between both groups.

Table 6 shows that, on average, firms with strategic complementarities reduce their investment (as a fraction of assets) by 3.26 percentage points more than firms without complementarities. The magnitude of this estimate is comparable to the magnitude of the most demanding estimate obtained with sample splits (that is, when the sample is restricted to exporting firms which worked exclusively with non-bailed-out banks), with the advantage of having a number of observations which is substantially larger.

8. The Propagation Mechanism of Economic Shocks

It is hard to disentangle loan supply effects from loan demand effects. On the one hand, a decline in economic activity induces a decline in loan demand because (i) firms voluntarily reduce their investment, or (ii) banks curtail credit because firms have less profitable investment opportunities. Lower investment reduces production externalities and productivity. Since productivity is a key determinant of

[7]We could have applied the Abadie and Imbens (2011) estimator, which minimizes the Mahalanobis distance between the vector of observed covariates across treated and non-treated firms to find control firms. This estimator produces exact matches on categorical variables, but the matches on continuous variables are not exact. Given the relatively limited size of our sample, exact matches are sometimes unavailable. One way to deal with the problem of dimension in this setting is to use propensity score matching.

Table 6. Counterfactual Matching Approach

	Before the Shock	After the Shock	Difference	No. Obs.
Without SC	0.0595	0.0631	0.0036	69
With SC	0.0595	0.0302	−0.0293	298
DiD	0	−0.0329	−0.0329*	367
DiD Matching Estimator (ATT)			−0.0326**	1,103

Notes: This table shows the difference-in-differences of firm investment before and after the credit crisis with difference-in-differences estimator (DiD) and DiD matching estimator. For the DiD we consider the most demanding sample-split with exporting firms which worked exclusively with non-bailed-out banks, without control variables but controlling for firms' fixed effects and standard errors clustered at the firm level. For the DiD matching estimator we employ the propensity score estimator of the "average effect of the treatment on the treated" proposed by Leuven and Sianesi (2003). *, **, and *** denote statistical significance at the 10 percent, 5 percent, and 1 percent levels, respectively.

investment, there is endogenous variation in investment opportunities. It is thus likely that investment will fall substantially in firms belonging to industries with strong strategic complementarities.

On the other hand, a negative shock to bank loan supply reduces firm investment, thus reducing the spillover effects on productivity. Since spillover effects are heterogeneous across industries, productivity will be mostly affected in those industries with strong strategic complementarities.

But, as is clear from the previous two paragraphs, the propagation mechanism through which loan demand shocks get transmitted to individual firms is the same as the propagation mechanism of loan supply shocks. Both negative demand shocks and negative supply shocks to some firms will propagate to other firms within industries with strategic complementarities and will penalize the productivity of each individual firm even if that individual firm does not experience the shock directly.

The goal of this paper is to identify *the propagation mechanism based on industry spillover effects*. In other words, we are mostly concerned with the identification of the endogenous variation in investment opportunities rather than with the identification of the

exogenous shock. Knowing the source of the shock may be less relevant for this purpose, as both demand and supply shocks cause the same endogenous variation in investment opportunities.

In sections 3 and 6.5.1, we provide evidence favorable to the hypothesis that the reduction in bank credit observed in 2009 was caused by a reduction in loan supply. Yet, one might be interested in knowing how conclusions regarding spillover effects would change, if the reduction in bank credit depicted in figure 1 were rooted in loan demand. The short answer is that our conclusions would not change significantly, as the propagation mechanism would be the same as in loan supply shocks. For both types of shock, much of the observed variation in bank credit is the result of endogenous variation in investment opportunities (i.e., the propagation mechanism) rather than the result of the specific source of the economic shock.

Hence, there is an observational equivalence in the propagation of both loan supply and demand shocks. The relationship between investment and spillover effects across firms is similar regardless of whether spillover effects are the result of loan supply shocks, demand shocks, or a combination of the two. One may interpret this result as a warning that loan supply by itself does not imply the existence of spillovers, since demand factors have similar effects and may be important empirically. For our purposes, however, the result has a positive message: the existence of heterogeneous industry spillover effects—the subject of our paper—is common to both loan supply and demand shocks.

Despite the controversy surrounding the identification of the source of the economic shock, we prove that industries responded heterogeneously to the economic shock that occurred in the Portuguese economy in 2009—this shock had a stronger impact on the investment opportunities of firms belonging to industries with strong strategic complementarities. In other words, we establish the existence of a propagation mechanism based on industry spillover effects.

Establishing the causal link between economic shocks, firm investment, and heterogeneous spillover effects is important for two reasons. First, the observational equivalence between the final effects of loan supply and demand shocks means that our exercise is useful for forecasting. As soon as government authorities

detect a decline in investment or in economic activity, they can anticipate a substantial fall in productivity in those sectors with strong strategic complementarities. Government authorities do not need to know the actual source of the shock, since both demand and loan supply shocks cause endogenous variation in investment opportunities.

Second, the result provides a justification for the existence of sectoral policies. A common justification for this type of selective policy is that it aims at reallocating resources toward sectors that are most productive. Yet, government authorities have tried this type of selective policy to an extent not widely appreciated. Our work suggests that policies such as investment subsidies should carefully weigh the benefits and the risks of transferring resources to firms in sectors with strong complementarities. On the one hand, stimulating these firms has a multiplier effect, since the transferred resources will create external scale economies. These firms become more influential in the process of economic recovery, as suggested by Sákovics and Steiner (2012). On the other hand, authorities will be transferring resources to sectors where productivity falls abruptly during economic downturns, thus mitigating the final effects of their policy tools.

9. Conclusion

We study the impact of the 2009 Portuguese credit crunch on firms with strategic complementarities. More specifically, we study the role of spillover effects on firms' investment decisions in industries which benefit from intra-industry localization externalities.

We find that corporate investment declines significantly following the onset of the credit crunch, controlling for firm fixed effects. On average, annual investment as a fraction of assets declined by 3.71 percentage points in the aftermath of the credit shock, which compares with the unconditional mean of 5 percent.

Consistent with a causal effect, the decline is greatest for firms with intense strategic complementarities. In our baseline regression, we estimate that annual investment (as a fraction of assets) declines by 2.12 percentage points more for firms with strategic complementarities.

To address selection bias and endogeneity concerns, we restrict our sample to exporting firms which established banking relationships exclusively with banks which did not restrict their credit. Our goal is to isolate spillover effects among those firms which did not see their credit restricted and suffered no change in investment opportunities. The estimate of the differential impact increases to 3.12 percentage points and continues to be statistically significant.

In a final step, we conduct our analysis combining a difference-in-differences approach with the use of matching estimators. We estimate that firms with strategic complementarities reduce their investment (as a fraction of assets) by 3.26 percentage points more than firms without strategic complementarities following the onset of the credit shock. The magnitude of this estimate is comparable to the magnitude of the most demanding estimate obtained with sample splits (that is, when the sample is restricted to exporting firms which worked exclusively with non-bailed-out banks), with the advantage of having a number of observations which is substantially larger.

Evidence of spillover effects after credit shocks (for industries with complementarities) has important implications not only for borrowers but also for policymakers (as emphasized by Bebchuk and Goldstein 2011, Philippon and Schnabl 2013, and Jorge and Rocha 2016). For example, Sákovics and Steiner (2012) suggest that firms which benefit from strategic complementarities are more influential in the process of economic recovery, and investment subsidies should thus be targeted at these firms (thereby providing a rationale for the existence of sectoral credit policies).

It would have been interesting to conduct a separate analysis for the publicly traded firms using their stock returns. We expect that (i) firms in agglomerated industries have higher covariance in their stock returns, and (ii) the 2009 credit shock led to a sharper decline in their stock prices compared with firms in non-agglomerated industries. Still, there were only 51 firms listed in the Portuguese stock market in 2009, and most of these firms did not belong to industries with a clear definition in terms of agglomeration. Only one of the 1,224 firms in our sample is publicly traded, thus preventing us from performing the exercise with stock returns.

Appendix

The DM Index

The DM index accounts for the amount of spatial concentration of an industry which can be related to that industry's specific spillovers. For a detailed account of the DM index, consult Guimarães, Figueiredo, and Woodward (2007, pp. 758–63). Here, we provide a simple explanation about the construction of this index.

Conventional measures of the geographical concentration of economic activity—based, for example, on the Gini coefficient—quantify the discrepancy between the distribution of regional employment in a particular industry against the regional distribution of overall employment. Yet, conventional measures are unable to control for the concentration in location decisions which is driven solely by chance. To overcome this difficulty, the most recent literature is based on microeconomic models of location choice. More specifically, Ellison and Glaeser (1997) and Guimarães, Figueiredo, and Woodward (2007) start with McFadden's (1974) random utility maximization (RUM) model of location choice, in which firms choose location to maximize profits. This model explains the spatial distribution of firms and takes into account idiosyncratic factors that may interfere with individual location decisions.

Many measures of geographical concentration distinguish between two types of agglomerative forces:

(i) Industry spillover effects, resulting from external scale economies that follow from the spatial concentration of firms of a particular industry in a given region and that are internalized by firms of that particular industry. It is not possible to disentangle industry-specific spillovers from *region-specific advantages for a specific industry*. Region-specific advantages for a specific industry are often rooted in natural advantage, such as the case of California for the wine industry or the case of coastal regions for shipbuilding. Geographic concentration by itself does not imply the existence of industry spillovers, since natural advantage has similar results. For this reason, we exclude those industries for which location depends on natural resources.

(ii) Regional advantage, resulting from the existence of cheap factors of production or urbanization economies (but excluding industry-specific natural advantage).

The purpose of the indexes proposed by Ellison and Glaeser (1997) and Guimarães, Figueiredo, and Woodward (2007) is to identify the first agglomerative force, i.e., the industry spillovers effects. The index proposed by Ellison and Glaeser (1997) uses exclusively measures of employment at the industry and regional levels, which leads to peculiar situations. For example, the index yields similar results for an industry with 10 plants (each with 10 employees) located in a single region and for an industry with a single plant (with 100 employees). To overcome this difficulty, Guimarães, Figueiredo, and Woodward (2007) derive an estimator which relies on the count of the number of plants.

Consider a reference industry which has n_j plants located in each region j, and $n = \sum_{j=1}^{J} n_j$ represents the total number of plants in this industry. Firms choose locations that yield the highest profits. The profit of firm i in region j equals

$$\log \pi_{ij} = \log \overline{\pi}_j + \varepsilon_{ij},$$

where $\overline{\pi}_j$ is a random variable reflecting the profitability of locating in region j for a typical firm in the reference industry, and represents observable and unobservable characteristics that make region j unique (both industry spillovers and regional advantage). Variable ε_{ij} is an additional random component reflecting factors that are idiosyncratic to firm i (and which are identically and independently distributed across firms).

Consider the vector of random variables $\overline{\pi} = \{\overline{\pi}_1, \ldots, \overline{\pi}_J\}$. Each realization of the vector $\overline{\pi}$ identifies one single industry. Applying McFadden's (1974) RUM model, one obtains the probability

$$p_{j|\overline{\pi}} = \frac{\overline{\pi}_j}{\sum_{i=1}^{J} \overline{\pi}_i}$$

that a firm in the reference industry locates in region j. A region j with industry spillovers or regional advantage should have high profits and a large probability $p_{j|\overline{\pi}}$. Guimarães, Figueiredo, and Woodward (2007) let the expected location probabilities $p_{j|\overline{\pi}}$ be

approximated by the share of plants of the reference industry in each region $\frac{n_j}{n}$.

Given the distribution of the vector of random variables $\overline{\pi}$, the unconditional expectation $E[p_j]$ (i.e., integrating across all industries) denotes the probability of a firm locating in region j in the absence of industry spillovers. A region j with regional advantage should have a large value for $E[p_j]$, but industry-specific spillover effects do not influence $E[p_j]$, as the unconditional expectation removes this type of effect.

The discrepancy between the conditional probability $p_{j|\overline{\pi}}$ and the unconditional probability $E[p_j]$ reflects the influence that region j's industry spillover effects play in the location decisions of firms in the reference industry.

Ellison and Glaeser (1997) and Guimarães, Figueiredo, and Woodward (2007) let the expected location probabilities for each region $E[p_j]$ be approximated by the region's share of total manufacturing employment. Writing x_j for the share of aggregate manufacturing employment in region j, they use x_j as an estimate of $E[p_j]$.

The value of the share of employment x_j provides a natural benchmark for the ratio $\frac{n_j}{n}$. The larger the discrepancy between the value x_j and the ratio $\frac{n_j}{n}$ for the reference industry in region j, the larger the influence of industry spillovers on the location of firms in the reference industry. That discrepancy is captured by parameter γ_C. Defining the "raw concentration index" as

$$G_C = \sum_{j=1}^{J} \left(\frac{n_j}{n} - x_j \right)^2,$$

one obtains the following estimator:

$$\widehat{\gamma}_C = \frac{nG_C - \left(1 - \sum_{j=1}^{J} x_j^2\right)}{(n-1)\left(1 - \sum_{j=1}^{J} x_j^2\right)}.$$

Since industry spillovers were not taken into account in the construction of $E[p_j]$, then the discrepancies between the value x_i and the ratio $\frac{n_j}{n}$ are due to these effects. Hence, $\widehat{\gamma}_C$ estimates the importance of industry-specific spillover effects in the reference industry.

Guimarães, Figueiredo, and Woodward (2007) achieve additional efficiency gains by using the statistical distribution for the counts of

plants that is compatible with the assumptions in the model of location. Accordingly, they compute the multivariate distribution for the counts of plants:

$$P\left(n_1, n_2, \ldots, n_J | n\right) = \frac{n!\Gamma\left(\gamma^{-1}-1\right)}{\Gamma\left(\gamma^{-1}+n-1\right)} \prod_{j=1}^{J} \frac{\Gamma\left[\left(\gamma^{-1}-1\right)x_j + n_j\right]}{\Gamma\left[\left(\gamma^{-1}-1\right)x_j\right] n_j!},$$

where $(n_1, n_2, \ldots, n_J)$ is the distribution of plants for the reference industry, and $\Gamma(.)$ denotes the gamma function. Maximizing the above expression with respect to γ yields the maximum-likelihood estimator $\widehat{\gamma}_{DM}$. This estimator is consistent and asymptotically efficient, and is labeled as the Dirichlet-multinomial index (DM index).

Table A.1. Industries with Strategic Complementarities

Industry Code	Industry Description
171	Preparation and Spinning of Cotton-Type Fibers
172	Cotton-Type Weaving
173	Bleaching and Dyeing
176	Manufacture of Knitted and Crocheted Fabrics
183	Tanning and Dressing of Fur
192	Manufacture of Luggage, Handbags, and the Like, Saddlery, and Harness
193	Manufacture of Footwear
223	Reproduction of Sound Recording
244	Manufacture of Basic Pharmaceutical Products or Medicaments
247	Manufacture of Man-Made Fibers
263	Manufacture of Ceramic Tiles
296	Manufacture of Hunting, Sporting, or Protective Firearms and Ammunition
323	Manufacture of Television and Radio Receivers, Sound or Video Recording
332	Manufacture of Instruments for Measuring Electricity, Gas, Water, and Other Fluid
334	Manufacture of Optical Non-ophthalmic Instruments
341	Manufacture of Motor Vehicles
354	Manufacture of Motorcycles and Bicycles
362	Manufacture of Filigree
363	Manufacture of Musical Instruments

Table A.2. Industries without Strategic Complementarities

Industry Code	Industry Description
242	Manufacture of Pesticides and Other Agro-chemical Products
268	Production of Abrasive Products and Manufacture of Bituminous Mixtures
271	Manufacture of Basic Iron and Steel and of Ferro-alloys
272	Manufacture of Steel Tubes
273	Cold Rolling of Narrow Strip and Cold Forming or Folding and Wire Drawing
274	Aluminum, Lead, Zinc, Tin, Copper, and Other Non-ferrous Metal Production
283	Manufacture of Steam Generators, Except Central Heating Hot-Water Boilers
294	Manufacture of Portable Handheld Power Tools, Other Metalworking Machine Tools
297	Manufacture of Electric and Non-electric Domestic Appliances
311	Manufacture of Electric Motors, Generators, and Transformers
322	Manufacture of Television and Radio Transmitters
333	Manufacture of Industrial Process Control Equipment
335	Manufacture of Watches and Clocks
353	Manufacture of Aircraft and Spacecraft
364	Manufacture of Sports Goods
365	Manufacture of Games and Toys

Table A.3. List of Applied Exclusions

	No. Firms	**No. Obs. (Panel)**
Firms in Selected Industries	8,852	
Firms with Balance Sheet Information	5,304	
Firms with >= 10 and < 250 Employees	1,945	
...With Information on Assets, Investment, and Sales	1,901	13,401
...Between 2006 and 2012	1,392	7,875
...Excluding Industries which Depend on Natural Resources	1,224	7,644

Note: Industries excluded because they may depend on natural resources are as follows: 232—petroleum refining, 351—shipbuilding and repairing, 152—sea products processing, 160—tobacco, and 372—recycling of nonmetallic products.

Table A.4. Variables' Definitions and Sabi Codes

Variable Name	Description	Sabi Codes
	Firm Fiscal Number	
	Industry (CAE Rev. 2.1)	
SC	Firms with SC Identification	
	Balance Sheet Year	
	Number of Employees	747
η_t	Time Dummy for 200i, i:6–12	
CC	Credit Contraction Dummy	
	Assets	706
	Tangible Fixed Assets	734
	Tangible Fixed Assets over Assets	734/706
	Capital (TF Assets + Depreciation)	734 + 745
	Capital Assets over Assets	(734 + 745)/706
	$(\text{TF Assets} + \text{Depreciation})_t - (\text{TF Assets})_{t-1}$	$(734 + 745)_t - (734)_{t-1}$
	Investment over Assets	$((734 + 745)_t - (734)_{t-1})/706$
	Total Debt (Long-Term Debt + Loans)	738 + 729
Debt/Assets	Debt over Assets	(738 + 729)/706
	$\text{Debt}_t - \text{Debt}_{t-1}$	$(738 + 729)_t - (738 + 729)_{t-1}$
	VarDebts over Assets	$((738 + 729)_t - (738 + 729)_{t-1})/706$
	Cash Flows	717
CashFlows/Assets	Cash Flows over Assets	717/706
Exporter	Dummy (1 if Firm i is Exporter)	
	Sales	727
Sales	Net Sales Growth Rate	86
DebtIndustry	VarDebt over Assets of the Industry	
Debt/Assets06	Debt over Assets in 2006	
CC.SC	Interaction Term (d_withscxDC09)	
DSC_Di	Interaction between d_withsc and Di	
	Interaction Term (d_withscxVarDebt_Assets)	
DebtIndustry.SC	Interaction Term (d_withscxVardebt_assets_cae)	
Trade Credit	Creditors	740
Trade Credit/Assets	Creditors over Assets	740/706

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