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The Impact of Finance on Trade and Determinants of Start-Up Innovations

Dissertation

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1. Introduction

In comparison to other countries in the rest of the world, Germany (as one of the industrialized countries) is characterized by relatively high living standards in terms of GDP per capita and wages. German politicians often argue that exports and innovation are important fields for the German economy to sustain these welfare achievements. According to the World Trade Organization (WTO), Germany has ranked as one of the three top exporters (in US value) since 1953 in their time series of trade statistics. Therefore, the exporting economy is important from a historical perspective. In addition, Germany achieves a high position (15th out of 141 countries) for the global innovation index in 2012, according to the World Intellectual Property Organization (2012).

In the following, this dissertation sheds light on the impact of finance on trade and the determinants of innovating activities within start-ups. The economic literature emphasizes an existing relationship between the innovating behavior of firms and their foreign operations. Many authors distinguish the participation in international trade between the probability of starting to export and the propensity (exports relative to total sales) of it in their analysis. Several empirical papers which examine this interrelation typically find a positive relationship between innovation and trading patterns of firms (e.g., Damijan et al. (2010), Roper and Love (2002), Sterlacchini (2001), Wagner (2001) or Wakelin (1998)) but the direction of causality remains unclear. Here, the focus is not on this explicit link between both fields but on different aspects within them.

Chapter 2 starts with the provision of a comprehensive and detailed literature review on finance and trade. In particular, we concentrate on various aspects which are relevant for the subsequent three chapters: the general differences between exporters and non-exporters, the interrelation between finance and trade flows and the literature on trade in services.

The following three chapters rely on a data set (MiMiK) which collects data on bank-firm relationships and is provided by Deutsche Bundesbank. The massive decline in international trade in 2008/09 (known as the 'Great Trade Collapse') is often attributed to the global deterioration in financial conditions after the bankruptcy of a US investment bank, Lehman Brothers. In a first step, Chapter 3 estimates the exporter premium in bank lending and highlights potential differences between exporters and non-exporters (independent of the financial crisis). We examine credit relationships in Germany, covering all loans of more than 1.5 million euro over the period from 2005 to 2010. The MiMiK data base itself provides only information about the (quarterly) credit exposure between borrower and lender. Therefore, we

establish a unique data match with another data set which is also provided by Deutsche Bundesbank, Ustan. It contains (yearly) balance sheet information of firms, including export sales.

Chapter 4 primarily focuses on the empirical importance of external (bank) finance for exporters during (and after) the financial crisis. The previous MiMiK-Ustan match is extended with bank balance sheet data from BAKIS. We use this information to identify banks which are especially 'affected' by the financial crisis. The chapter investigates in a descriptive manner whether a correlation between exports and credit supply exists and whether banks which are classified as 'affected' decreased their credit exposures. Finally, we perform a nearest neighbor matching to identify similar firms which engage in foreign operations. Then, we examine whether firms which have a relationship with a bank which is 'affected' by the financial crisis experienced a larger drop in exports compared to firms which receive external finance from a healthy financial institution.

Chapter 5 extends the previous analysis by estimating the exporter premium in bank lending for goods and service exporters separately. The MiMiK-Ustan match is enlarged with detailed transaction level data about service exports, the German International Trade in Services (SITS) statistics. Therefore, we are able to identify firms which primarily export services or goods and can evaluate our previous results on a more disaggregated level. First, we estimate the export premium in bank lending for goods exporters vs. non-exporters. Then, we examine whether service exporters depend more on external finance than goods exporters which would coincide with higher entry barriers for service exporters.

Furthermore, we analyze the determinants of innovations within start-ups in a separate section. Chapter 6 deals with the question whether entrepreneurs with technical education are more innovative than economists in high-tech industries. Until now, the field of entrepreneurship has been relatively unexplored due to data limitations. To analyze this question, we examine a novel data set (KfW/ZEW Start-Up Panel) which contains a random cross-section of German start-up companies for 2007 and 2008. It provides information about entrepreneurial characteristics, especially details about the subject that was studied prior to the foundation of the start-up. In addition, the KfW/ZEW Start-Up Panel was exclusively designed to analyze research questions in the field of innovation. For this reason it contains multiple proxies to measure the innovating behavior of entrepreneurs.

Finally, Chapter 7 provides a summary of the main results, highlights the essential contributions to the literature and proposes suggestions for future research.

2. Literature

This chapter provides a comprehensive literature review about issues closely related to finance and trade. We proceed in several steps to emphasize the most important findings for each of the following chapters.

First, we start with the literature about general differences between exporters and non-exporters because we estimate the so-called exporter premium in Chapter 3. From a theoretical perspective, the export premium was irrelevant for a long time period. The 'old' trade theory concentrates exclusively on trading patterns between countries and neglects the existence of firms at all. According to this, countries possess a comparative advantage and specialize in the production of particular goods when the relative opportunity costs are lower in comparison to the other country. The literature distinguishes between two main causes for the existence of comparative advantage: Ricardian models explain trading patterns across countries with differences in technologies (see Dornbusch et al. (1977)), while Heckscher-Ohlin models highlight differences in factor endowment as the main determinant for trade (see Heckscher and Ohlin (1991)). In contrast, the 'new' trade theory regards individual firms as decision makers but typically assumes a representative firm within a monopolistic competition framework (see Krugman (1979)). As a result, all firms export in equilibrium (see Bernard et al. (2007)). Consequently, neither the 'old' nor the 'new' trade theories are able to explain why we observe empirical differences between exporters and non-exporters. The first formalization of a theoretical model that is in line with the empirical observation of disparities among exporters and non-exporters is proposed by Melitz (2003). He assumes heterogeneous firms which differ in their firm productivity. In a first step, firms pay an entry cost and then draw their productivity from a distribution which is known to all firms. Then, they choose whether to operate only on the domestic market or whether to also sell their products abroad. Before firms participate in international trade, they have to bear fixed entry costs (in addition to variable costs which include transportation) and only firms which are highly productive (above a certain cut-off level) and able to cover these costs start exporting.

A (by now) sizable empirical literature identifies economically large and statistically significant differences between firms that export and firms selling exclusively on the domestic market. The first contribution which uses detailed firm-level data to estimate the export premium is provided by Bernard et al. (1995). They use detailed US plant-level data from the Census Bureau's Annual Survey of Manufactures (ASM) between 1976 and 1987. Their results highlight the fact that only a certain fraction of US firms engage in exports, which is true for different industries, and that the

average exporter pays higher wages (by about 14%). Furthermore, exporters use different input factors than non-exporters: they employ a higher capital intensity and undertake more investment per employee. Several studies re-examine and strongly confirm this finding for a broad range of indicators of firm activity. There are also a large number of papers which aim to replicate this observation for various countries, obtaining similarly affirmative results[1].

The literature which estimates the export premium is also applied in different contexts: one branch examines whether exporters are more productive than non-exporters before market entrance or whether exporting itself causes an increase in productivity. There is a large debate about the direction in which the causality actually moves. For instance, Bernard and Jensen (1999) argue that firms which start serving the foreign market are already more productive than firms selling exclusively on the domestic market. Nevertheless, exporting is beneficial because the probability of plant survival increases. In contrast, De Loecker (2007) suggests that exporting led to enhanced productivity for Slovenian firms between 1994 and 2000. Another branch highlights the difference between single and multi-product firms. Bernard et al. (2010) estimate the export premium for US manufacturing firms between 1987 and 1997. They show that exporting multi-product firms produce more output, are larger and more productive (in terms of labor productivity and total factor productivity) than single-product exporters. In addition, dynamic adjustments towards the market environment (e.g., the adding and dropping of products) are more present in multi-product firms. Finally, Lawless (2009) provides descriptive evidence and reveals that exporters differ in the number of destination countries. The number of markets which an exporter serves is positively related to firm size, productivity and average wages for Irish exporters between 2000 and 2004.

For Germany, our country of interest throughout this dissertation, Bernard and Wagner (1997) document sizable and robust exporter premia for various plant characteristics. Based on a regional sample of firms, they find that German exporting plants are more productive than non-exporters (with a premium of about 20%), have a higher capital intensity (by about 12%) and invest more per worker (about 8%) than non-exporters. Firms also employ more workers and pay higher wages, with the premia varying by the type of worker. Holding constant for the characteristics of both the worker and the workplace, Schank et al. (2007) estimate that employees working in a plant with an export-sales ratio of 60% earn about 1-2% more than similar employees in otherwise identical non-exporting plants. Finally, export activ-

[1]Given that relevant firm-level data sets often differ in design across countries and are not always readily accessible, few surveys seek to combine and summarize findings for various countries (see Mayer and Ottaviano (2007)).

ity is also associated with measures of firm performance and firm success. Fryges and Wagner (2010) argue that exporting has a positive causal effect on profitability. By contrast, the role of financial variables (which is a key interest in the following analysis) for firm export behavior was initially emphasized primarily in theory. Building on the assumption that entry into foreign markets involves sunk costs, it is hypothesized that only firms with (access to) sufficient financial resources are able to start exporting. Chaney (2005) and Manova (2008), among others, formalize this idea, adding liquidity constraints to a standard heterogeneous firm model of international trade (in the fashion of Melitz (2003)). Specifically, Chaney (2005, p. 5) argues that "one [additional] dimension of heterogeneity along which exporters may differ from non-exporters is their ability to access financial intermediaries", with less financially constrained firms being more likely to export.

The few empirical studies which aim to analyze the exporter premium for financial variables typically find evidence in support of this hypothesis[2]. However, since these studies often examine measures of the financial health of firms, such as firm liquidity, they seem to provide only limited insights. For one thing, financial health, which is the most comprehensive outcome measure of a firm's business policies, depends on many factors, including the decision to export itself. In fact, given the seemingly robust finding of significant differences in financial positions between exporters and non-exporters, the empirical analysis mainly focuses on causality, with mixed results. Analyzing a panel of British manufacturing firms over the period from 1993 to 2003, Greenaway et al. (2007) find that participation in export markets improves firms' financial health, while export starters display low liquidity. In contrast, Bellone et al. (2010) find for a sample of French firms that exporters are already more liquid before entry, with no further growth in financial variables relative to non-exporters in the following years. More notably, measures of financial health are only a very imperfect proxy for the variable of interest, access to external finance. For instance, a large stock of liquidity may reflect weak fundamentals rather than easy credit when firms are forced to hoard cash in times of financial constraints. As a result, the association between a firm's financial position and its access to external financial funds seems to be generally ambiguous.

Second, we review the relevant literature on trade and finance, which is the main focus of Chapter 4. In comparison to the proceeding, this literature does not con-

[2]A related literature in finance explores the capital structure decisions of firms, including the use of external finance. For instance, examining a broad range of financing sources, Beck et al. (2008) find that exporters tend to use more bank, leasing and supplier finance.

centrate on general differences between firms but tries to explain trade flows with financial variables. It delivers many different approaches and ideas to examine this potential interrelation. The special importance of external financial conditions for international trade activities has been highlighted in recent research on the 'Great Trade Collapse'. The sharp decline in world trade in 2008/09 is widely attributed to a drop in the provision of trade finance by troubled financial intermediaries in the aftermath of the recent financial crisis. Interestingly, this pattern does not only evolve aggregated world level but is also present in individual countries.

A recent formal attempt to analyze the effects of trade finance was undertaken by Schmidt-Eisenlohr (2011), who studies the optimal choice of payment contracts. He divides the payment contracts into three classes: exporter finance (open account), importer finance (cash in advance) and bank finance (letter of credit). Equilibrium contracts are then determined by financial market characteristics and the contracting environment. Specifically, it is shown that increased enforcement probabilities lead to more trade, whereas increased financing costs, which likely occur in the presence of a financial crisis, lead to fewer trade activities. Ahn (2011) proposes a related hypothesis from the bank's point of view, arguing that it is more costly for banks to monitor exporting companies. The uncertainty evolves from the fact that the bank cannot verify whether the firm which applies for the loan repays with a high or a low probability, since only the general distribution over all firms is known. The probability of repayment depends on the trading partners of this particular firm. Ahn (2011) suggests that an enterprise which trades with another firm in the same country provides a less noisy signal about its real type than a firm with a foreign trading partner because the bank is in a better position to receive information from the domestic trading partner. Due to these higher monitoring costs, an exporter receives exogenously a higher probability of default than a non-exporter, making the firm more vulnerable to a financial shock. Both papers link the exporting decision of a firm to the financial environment. Another attempt to formalize the idea why exporters face tighter credit constraints in comparison to domestic sellers is proposed by Feenstra et al. (2011) who extend the theoretical model by Melitz (2003) with the inclusion of a financial sector. One particular assumption is that firms rely on working capital for their production. The model stresses three reasons for potential differences between domestic sellers and exporters: longer time lag between production and sales for exporters, the general nature of higher risks in exporting (e.g., difficult contract enforcement across borders) and the additional fixed costs which an exporter has to bear by entering the foreign market. The authors use panel data from Chinese manufacturers between 2000 and 2008, which is

provided by China's National Bureau of Statistics. Their results confirm the hypothesis that exporters face tighter credit constraints compared to domestic sellers and that the recent financial crisis increased them even further. Finally, Eck et al. (2012) suggest a theoretical framework which aims to explain whether the provision of trade credit has an effect on international trade. Trade credit involves two forms of contracts between firms: cash in advance, where the importing firm first has to pay its bill before the good is shipped across borders, and supplier credit, where the firm first produces the good and receives the payment after a certain time period (typically between 30 and 90 days after the importer received the good), such that the importer is able to confirm the product quality. The model shows that trade credit averts information asymmetries and therefore fosters international transactions. The empirical findings confirm that the usage of trade credit contracts leads to higher exports and imports, using data from the Business Environment and Enterprise Performance Survey (BEEPS) for 1,196 German firms in 2004.

In the context of trade and finance not only the decision of firms to export but also of the bank to provide credit is an important determinant. We provide insights from the literature of relationship lending because we are dealing with bank-firm relationships in our empirical analysis. Berger et al. (2005) investigate whether organizational differences in banks lead to a comparative advantage in lending to specific firms. From a theoretical point of view, the likelihood that a relationship between a firm and its bank is an exclusive one should decrease with bank size (see Stein (2002)). The authors make use of two different US data sources: information about firm characteristics from the Federal Reserve's 1993 National Survey of Small Business Finance (NSSBF) and bank data from Consolidated Report of Condition and Income and the FDIC Summary of Deposits. The empirical findings indicate that the probability of a single lending bank decreases as firm size increases. Therefore, the larger the size of the firm the greater the number of banks it engages with and the larger the loans. Accordingly, exporters who are on average larger (approximated by firm size) should also hold multiple bank lending ties. Memmel et al. (2007) obtain another perspective and analyze whether information asymmetries can be mitigated by relationship banking and how the firm's credit quality influences the likelihood of selecting one particular (principal) bank. They employ the same data sets (MiMiK, Ustan and BAKIS), which we use in the later chapters, with German firm and bank balance sheet information from Deutsche Bundesbank[3]. The results suggest that small, young and R&D intensive firms as well as firms with a

[3]The main differences in the empirical implementation are the approach to match the data sets (MiMiK and Ustan) and the selection of years for the analysis.

high credit quality choose a relationship lender. Another proxy for the measurement of relationship lending is proposed by Bonis et al. (2010), who examine whether the length of banking relationships has an influence on the international operations of firms. The activities on foreign markets are defined as foreign direct investments, offshoring and exports. The authors employ Italian firm balance sheet data between 1998 and 2003 from the Survey of Manufacturing Firms (SMF) of Unicredit and bank balance sheet data from Banca d'Italia prudential statistical returns. The findings indicate that the length of banking relationships has a positive effect on foreign direct investments and offshoring. In contrast, the length does not influence the exports of Italian firms. Instead of focusing on the length of relationships, Ongena and Smith (2000) examine which firm characteristics are able to explain the number of (domestic) bank-firm relationships. They use survey firm-level data for 1996 from GlobalCash-Europe96 which covers 20 European countries and 1,079 firms. In contrast to previous results, the findings reveal that firms with larger exports are associated with a lower number of bank relationships (while domestic sales as possible proxy for firm size are positively correlated). The authors explain this observation with the argument that exporters have the possibility to switch to other financial institutions abroad. Other empirical papers focus on possible transmission channels of the recent financial crisis. For instance, Carvalho et al. (2011) investigate how relationship lending affects the lending costs of firms during financial shocks (e.g., especially from problems stemming from Bear Stearns and Lehman Brothers). According to theoretical ideas, firms which receive finance from one bank only are more dependent on this particular partner such that a financial shock leads to higher borrowing costs because the enterprises are not able to use other financial institutions as substitutes. The analysis is based on data from different sources: for publicly listed firms the authors employ loan data between January 2003 and December 2006 from Dealscan and stock return data for the borrowing firms from DataStream during July 2007 and October 2008. In general, the data set includes 1,564 non-financial borrowing firms from 34 countries. The findings reveal that the losses in stock returns are largest for firms which have just one relationship with a financial institution. Using more detailed information, Iyer et al. (2010) analyze how the financial crisis changes the credit supply for firms in Portugal. The authors use the Central Credit Register from the Portuguese Central Bank between the second quarter of 2007 and the second quarter of 2009 which covers all granted loans above the threshold of 50 euro. In addition, they match (monthly) bank balance sheet data with (yearly) firm balance sheet information. The dependence on the interbank market to refinance the bank's operations is used as a measure for

'affected' banks and the freeze of the interbank market in August 2007 is defined as the exogenous shock for the Portuguese banks. The estimates show that banks which rely more on funding from the interbank market cut credit supply to firms more than other financial institutions. Especially small and young firms with weak banking relationships face larger credit reductions in contrast to larger established companies.

Empirical studies generally provide two explanations for the recent decline in the world trade-to-GDP ratio: the decline in demand due to higher unemployment and/or lower income[4], and the worsening of financial conditions for the suppliers. However, it is unclear which of the two effects is quantitatively more important, with different papers providing different conclusions. In the following, we briefly summarize the most relevant findings from the recent literature.

Several studies explore historical evidence, aiming to establish a set of stylized facts that potentially help to deal with the effects of the recent financial crisis. For instance, Freund (2009) analyzes the effects of four global downturns on trade patterns, focusing in particular on the demand for goods. Using monthly data from the IMF BOP Statistics between January 1960 and March 2009 for 31 countries, the findings suggest that the large drop in exports can be partly explained by an increase in the elasticity of trade to GDP (from 2 to 3) over time. Thus, consumers nowadays react more strongly if a financial shock occurs. As a consequence, the demand component explaining the fluctuations has increased. In contrast, Iacovone and Zavacka (2009) focus on the supply conditions of exporters. They investigate the influence of banking crises on exports from manufactures between 1980 and 2006, identifying 23 banking crises. The analysis employs yearly aggregated export data from UN Comtrade for 21 countries and 81 industries. The methodology relies on Rajan and Zingales (1998) who identify the external financial dependence of industries. They use information from Standard and Poor's Compustat about balance sheet data from publicly listed firms in the US and define the dependence on external finance as the share of investment which cannot be financed by internal cash flows. Alternatively, they calculate the measure as capital expenditures minus operative cash flow divided by capital expenditures[5]. Iacovone and Zavacka (2009) argue that industries relying more on external finance exhibit larger export declines than other industries. Furthermore, not all financial channels are affected alike.

[4]Another channel which is closely connected to the decline in (final) demand is the drop in intermediate goods. If products which require many intermediate inputs (e.g., cars) are less demanded by consumers, a large number of firms will be affected because many car components are delivered from abroad (value chains of large corporations).

[5]One central assumption by Rajan and Zingales (1998) is that the dependence on external finance is constant over time.

Finally, the observed demand shocks seem to be independent of the financial conditions. Other contributions try to establish general facts between finance and trade flows. Beck (2003) investigates whether the development of financial markets within a country provides a comparative advantage for industries which depend more on external finance (according to Rajan and Zingales (1998)) than others. To analyze this question, he uses industry-level data from the COMTRADE data base for 36 industries and 56 countries. Furthermore, the World Development Indicators (WDI) from the World Bank serve as basis to deflate the nominal values. The results suggest that countries with a higher financial development (approximated by private credit relative to GDP, market capitalization or total capitalization) do indeed experience higher export shares in industries which depend more on external finance. In a similar fashion, Manova et al. (2011) examine whether credit constraints have an impact on international trade but they concentrate on the effect of ownership structure on exports. They use detailed Chinese customs data for 2005 which is reported to the Chinese Customs Office. They differentiate between various ownership structures: purely Chinese-owned firms, joint ventures with foreign companies and foreign-owned affiliates. According to the authors, firms which have access to other financing sources (such as joint ventures and foreign affiliates) should have a comparative advantage in exporting because they can use internal cash flows inside the corporation. In addition, this advantage is larger the more the sector depends on external finance. To analyze whether these two arguments indeed hold, they also employ the methodology used by Rajan and Zingales (1998) to measure the dependence on external finance for different sectors. The findings suggest that Chinese firms with a foreign ownership perform better than Chinese firms with a purely Chinese ownership. In addition, sectors with higher need of external finance have a larger comparative advantage than other industries.

Other studies highlight the importance of trade finance for developing countries. Berman and Martin (2010) focus on sub-Saharan African countries and examine whether these countries are affected differently by banking crises than others. Analyzing US industry import data (from the COMTRADE and CEPII data base) between 1976 to 2002, they find that the channel of trade finance ('disruption effect') is more important for explaining the vulnerability of these countries than the lower demand ('income effect') using a gravity approach. One possible explanation is that African countries are more dependent on trade finance compared to countries with a more developed financial system. In a similar fashion (but with other data sources), Kohler and Saville (2011) investigate the effect of trade finance on trading patterns of South Africa. They use monthly trade data between 2006 and 2009

from South Africa's Department of Trade and Industry with the 20 most important trading partners (measured by trade values). Trade finance is approximated by the monthly short-term interbank lending rate (see also Chor and Manova (2012)). The findings are in line with prior research: higher costs of trade finance which can be interpreted as tighter financial constraints lead to lower exports. Finally, Auboin (2007) follows a broader approach, aiming to identify similar patterns for developing countries in general (according to the WTO definition). Differences in the progress of the liberalization of goods and financial markets can lead to an excess demand of trade finance. If a financial shock occurs, these countries are particularly affected because there is only modest confidence in the banking system. Furthermore, developing countries lack the opportunity to attract new entrepreneurs by imposing high barriers of entry. Consequently, supply-side conditions seem to be more important for developing countries than demand factors.

The recent financial crisis in 2008 is also examined to identify the impact of finance on trade. Damijan and Kostevc (2011) provide a summary of recent empirical contributions about entering and surviving in the export market and the role of financial conditions. They conclude that, during a financial crisis, trade finance plays an important role for (especially) small firms. These firms face tighter requirements due to lower internal funds, and it is therefore harder for them to obtain credit compared to larger companies which also often have access to other sources. In addition, Chor and Manova (2012) use (aggregated) monthly US industry import data from November 2006 to October 2009 to identify channels that are responsible for the sharp decline in trade. Focusing on the cost of capital, which is approximated by the interbank interest rates, and distinguishing between industries, they argue that a higher dependence on external finance of the industry leads to a larger decline in trade during a financial crisis. Finally, Ahn et al. (2011a) provide suggestive evidence, showing that the prices of seaborne-shipped goods, which are likely to be most dependent on trade credit, rose relative to the prices of goods sent by alternative modes of transportation.

Other empirical studies analyze the economic importance of demand factors which could be responsible for the 'Great Trade Collapse'. For instance, Alessandria et al. (2010) examine whether inventory adjustments play a role. They propose a two-country general equilibrium model in which inventory holdings evolve endogenously towards a change in domestic and foreign financing costs. In their empirical analysis, the authors focus on the automobile industry because it experienced a large drop in exports during the recent financial crisis and it is relevant for industrialized countries from an economic point of view. Their data sources are from BEA (Bureau of Eco-

nomic Analysis) and the Ward's data base and provide information about domestic and foreign sales, the number of orders and the inventory holdings. The descriptive analysis shows that the drop in inventory holdings was lower than the drop in imports during the financial crisis. The findings suggest that trade itself is more volatile than trade-weighted production such that inventory holdings play an important role for this adjustment. Furthermore, the authors conclude that the trade dynamics in the current crisis are not unusual in comparison to prior recessions (but the magnitude is larger). Another idea is the consideration of global supply chains. Bems et al. (2010) provide a theoretical framework and empirical evidence that the drop in demand within the US and Europe after the bankruptcy of Lehman Brothers in September 2008 transmitted to other countries as well through lower trade volumes. The key idea of this argument is based on Yi (2003) who reveals that the vertical specialization of countries increased in the recent decades. The main problem of bilateral export data lies in the disregard of intermediate inputs which are imported from other countries in the presence of global supply chains. The authors use the GTAP 7 data base which is provided by the Global Trade Analysis Project at Perdue University. This data set covers bilateral trade volumes and input-output tables including 94 countries, 19 composite regions and 57 sectors in 2004. Furthermore, the IMF's Global Data Source, the OECD and national data sources are considered for the analysis. A very crucial assumption for the results is that different shares which are computed from the various data sources do not change over time and are also representative for the crisis period in 2008/09. The empirical results suggest that about 70% of the observed trade elasticity can be explained by their theoretical framework. Eaton et al. (2011) compare supply and demand conditions and evaluate which are responsible for the large drop in international trade during the recent financial crisis. They employ a general equilibrium framework and use different simulations for their analysis. The investigation relies on various data sources for 23 countries: bilateral trade data from the Global Trade Atlas Database, the OECD input-output country tables, the IMF International Financial Statistics database, DataStream, the OECD Structural Analysis Database (STAN) and the United Nations National Accounts and Industrial Statistics Database (UNIDO). The findings reveal that the decline in demand for durable goods accounts for 80% of the overall drop. In addition, increased trade frictions aggravate the situation in China and Japan. Gopinath et al. (2012) examine whether the sharp drop in international trade of the US economy was driven by price or quantity adjustments. The analysis is mostly based on descriptive evidence. The International Pricing Program (IPP) of the US Bureau of Labor Statistics from 1993 to 2009 with monthly import and export price data for

about 20,000 goods serves as data source. The results suggest that the decline in trade of differentiated manufacturing goods is explained by lower demand while the prices remain stable. In contrast, the prices of homogeneous manufacturing goods indeed decreased. Moreover, the prices of durable and non-durable manufacturing goods did not change. However, the demand for durable goods experienced a sharp decline. Finally, the authors provide evidence that during the financial crisis the frequency and size of price adjustment changed as well. Similarly, Haddad et al. (2010) itemize the decline in world trade for imports of Brazil, the European Union, Indonesia and the US along different dimensions: product entry and exit, adjustment in prices and quantities and the distinction between extensive and intensive margin. The trade data are available on a monthly basis between January 2007 and November 2009. Various data sources are employed for the different destinations: import data for Brazil are provided by the Ministry of Development, Industry, and International Trade (MDIC), for the European Union by Eurostat, for Indonesia by BPS-Statistics Indonesia (BPS) and for the US by the US International Trade Commission (USITC). The findings suggest that almost all countries face a drop in new products, an increase in product exit and a decline in quantities for products on aggregate level. Moreover, the intensive margin seems to be more important for explaining the drop in world trade than the extensive margin. However, the products are heterogeneously affected: for instance, the price drop is due to commodity goods. In addition, differences in the trading relationships among countries and the type of shipment are present. Altogether, the decline in (almost) all quantities shows that the drop in demand seems to be the most important factor in explaining the sharp drop in trade. Finally, Levchenko et al. (2010) provide descriptive evidence for the drop in US trade after the financial crisis. Aggregate trade (exports and imports) and production data are provided by the US National Income and Product Accounts (NIPA). In addition, the Bureau of Economic Analysis' Trade in Goods and Services Database reports trade flows and prices at sector level, while the US International Trade Commission's Tariffs and Trade Database differentiates between the trading partners (countries). The authors highlight that the recent collapse in trade is economically large in comparison to other crises. Furthermore, the results indicate that the drop in exports and imports was huge in the automobile sector, in durable industrial supplies and capital goods. Finally, the outcome suggests a strong support for the role of vertical linkages, as well as for compositional effects. In contrast, financial variables (e.g., trade credit) do not provide explanatory evidence for the decline in US trade. In addition to evidence from aggregate studies, other contributions try to establish a causal finance-trade relationship based on micro-

level evidence. The academic literature agrees that lower demand is able to explain a certain fraction of the sharp drop in trade flows. In contrast, there is mixed evidence concerning the supply conditions. For instance, Amiti and Weinstein (2011) use firm-level data from the database of unconsolidated corporate reports of Development Bank of Japan (DBJ) between 1986 and 1999. In addition, Nikkei NEEDS FinancialQuest provides firm information from 2003 to 2010. Bank data is obtained from the Pacific Basin Capital Markets database for the early years (1986 to 1999) and from Nikkei for the recent period (2003 to 2010). The authors are able to match micro data from banks and companies in Japan due to the Japan Company Handbook which reports linkages between enterprises and financial institutions. They define the largest bank as the main reference bank which most probably undertakes the provision of finance for international transactions. The findings suggest that a worsening in financial conditions can explain (and even cause) the large drop in relative trade flows. In contrast, Paravisini et al. (2011) analyze matched micro data from Peru and compute the elasticity of exports. The authors use bank and firm information from Peruvian bank regulator Superintendence of Banking, Insurance, and Pension Funds (SBS) between July 2007 and June 2009. Furthermore, customs data are obtained from the Peruvian tax agency (Superintendence of Tax Administration). The shortage in credit supply is able to explain only 15% of the decline in exports. Other studies do not incorporate the bank dimension in their analysis. Behrens et al. (2010) analyze the export behavior of Belgian companies using annual balance sheet data from Business Registry and monthly export and import reports of firms from Intrastat (intra-EU trade) and Extrastat (extra-EU trade) of the National Bank of Belgium (NBB). The authors compare the change in exports before the crisis in the first season (S1-2007 to S1-2008) with the first season after the crisis (S1-2008 to S1-2009). The focus on the first half is justified by potential seasonality problems that could arise otherwise. The results reveal that the sharp drop in trade relative to GDP is mainly due to the intensive margin. In contrast to Amiti and Weinstein (2011), financial conditions are not the most important factor for explaining this observation. The reduction in demand is much more influential. Finally, domestic suppliers are as affected as exporters by the financial shock. That is why the authors argue that there is no trade crisis but an overall output crisis. In a similar manner, Bricongne et al. (2012) use monthly export information from French Customs and data about credit constraints (from the FiBEn database of Banque de France) of French companies between January 2000 and April 2009. They aim to explain how financial health, external finance and the extensive/intensive margin help to explain the decline in exports. The results illus-

trate that lower demand and the intensive margin for large firms are found to be the most important determinants. In addition, credit constraints aggravate the trade environment. Another approach is to analyze individual contracts. Antràs and Foley (2011) analyze transaction data from one exporting firm in the US which exports frozen agricultural products to about 140 countries from 1996 to 2009. They have detailed information about the financing mode (cash in advance, open account and letter of credit) of each transaction and can evaluate how the financial crisis affected the choice of contracts. The use of letters of credit is rather low in the whole data set because they incorporate additional costs for the trading partners[6]. Consequently, the authors conclude that the financial shock affects the mode of trade finance: more cash in advance contracts are observed between the trading partners after the financial crisis. However, the effect of bank finance on trade does not seem to be as strong as other researchers suggest (at least for this particular company). Overall, the empirical findings for different countries seem to be mixed. Whereas for Japan the supply-side conditions play an important role for explaining the large drop in exports, companies from France, Belgium and Peru appear to be much less affected. As a result, country-specific factors possibly affect the underlying results. Another line of research investigates the effect of guarantees. Badinger and Url (2012) examine which kind of firms engage in usage of export credit guarantees and whether the guarantees provide a positive influence on export performance. They obtain a cross section for 178 Austrian firms in 2008 from Österreichische Kontrollbank (OeKB) which is the Austrian export credit agency. This survey consists mostly of small and medium-sized enterprises where the effects of financial constraints are expected to be tight. According to the estimations, domestic firms which engage in R&D activities and undertake risky projects apply for the export credit guarantees. Furthermore, the guarantees indeed foster exports (increase of about 100% to 130%). For Germany, Felbermayr and Yalcin (2011) investigate whether public export guarantees (provided by EulerHermes) have an effect on trade flows, especially during the financial crisis in 2008. They use Hermes guarantees on sectoral level from 2000 to 2009 and employ bilateral export data from the world trade BACI database from CEPII Paris. The findings illustrate that the provision of public export guarantees boosts trading activity, especially during the financial crisis in 2008. However, the economic effect is relatively small compared to previous results in the literature.

[6]The low usage of letters of credit does not need to be representative. Auboin (2007) argues that some forms of bank insurance or guarantees are used in 90% of all trade transactions.

Finally, we provide a literature review which covers the topic of trade in services, which is the main focus of Chapter 5. This chapter deals with differences between goods and service exporters, especially whether service exporters rely more on external (bank) finance and face stricter entry barriers. Standard textbooks of international trade (mostly) do not cover trade in services because services are defined as non-tradable products. Hill (1977) provides a detailed overview about fundamental differences between goods and services. Theoretical trade models, which are discussed in the literature, deal with the exchange of goods between countries. A service itself cannot be exchanged or be put in stock, in comparison to goods which are storable. Furthermore, services can influence the conditions of goods (e.g., the repair of a car) and the mental conditions of persons (e.g., provision of health services). Taken together, goods and services are not complementary due to these fundamental differences. Hill (1977) concludes that theoretical trade models need to consider the fundamental differences between goods and services.
In the recent past, services have become more tradable due to technological progress. For instance, Freund and Weinhold (2002) provide empirical evidence by showing that the provision (and prevalence) of the Internet has indeed fostered trade in services, especially in the US since 1995. They use aggregate trade statistics from the US International Transactions Accounts, which are provided by the Bureau of Economic Analysis, as starting point for their analysis. Other empirical contributions also rely on this kind of data and aim to investigate the determinants of trade in services. Lennon (2009) examines the differences of determinants for trade in goods and services using a standard gravity approach for 28 OECD countries between 1999 and 2002. She employs data from the OECD database on bilateral trade in services. The findings suggest that bilateral trust, better contract enforcement, networks, labor market regulations and variables denoting technology of communication seem to be more important for trade in services in comparison to goods. This kind of analysis is also conducted for other countries as well. Karam and Zaki (2012) investigate the determinants of trade in services for the Middle East and North African (MENA) region between 2000 and 2009. They extend the standard gravity equation by including WTO membership and WTO commitments as main explanatory factors. Different data sources are used for the analysis: the WTO dataset, 'Trade Map' by the International Trade Center (ITC), the World Development Indicators database, the CEPII data and the Doing Business dataset by World Bank. The outcome reveals that both WTO membership and the number of commitments have a positive effect on the amount of trade in services. Moreover, they provide descriptive evidence for heterogeneity among different countries.

Instead of dealing with these aggregated trade statistics, the recent empirical literature uses detailed transaction-level data to understand the underlying mechanisms of service trade patterns. Most of these empirical studies contribute to the literature by providing some descriptive stylized facts about the nature of trade in services. For instance, Ariu (2012) compares firm characteristics of goods exporters with service exporters from Belgium between 1995 and 2005, using data from the National Bank of Belgium. He concludes that firms which export services are different to goods exporters (in quantitative terms). The participation rate among service exporters is lower, which implies higher fixed costs that have to be covered. Nevertheless, goods exporters and service exporters share some qualitative similarities: only a small fraction of firms participate in trading activities and firm heterogeneity plays a key role to explain this observation. Due to these reasons, trade models with heterogeneous firms (like Melitz (2003)) seem to be a good starting point for investigating trade in services further from a theoretical perspective. Similarly, Breinlich and Criscuolo (2011) examine goods and service exporters for the UK between 2000 and 2005. They employ two data sets: the Annual Respondent Database (ARD) and the International Trade in Services Inquiry (ITIS) which are provided by the UK Office for National Statistics (ONS). Many findings for manufacturing firms (see Bernard et al. (1995)) are also present for service firms. Trade in services is concentrated among the largest firms and the average service exporter is larger (in terms of employment), pays higher wages and is more productive than a firm in the service sector which does not participate in international transactions. As a result, the authors recommend that heterogeneous trade models, which focus on the exchange of goods, are also useful for the analysis of trade in services. In addition, Federico and Tosti (2012) examine Italian manufacturers and service firms between 2008 and 2009. The Bank of Italy provides information based on a survey. The authors confirm previous results that trade in services (exports and imports) are concentrated among few firms. Moreover, they describe the composition of trade: most firm-level variation in trade is explained by the intensive margin, while the extensive margin and standard gravity variables (market size, distance) account for the country-level variation.

The analysis in Chapter 5 relies upon German trade in services transaction-level data from Deutsche Bundesbank. Previous empirical papers also employ this data set and match it with the Micro Database Direct Investments (MiDi), which provides information about foreign affiliates[7]. Biewen et al. (2012) examine the determinants of

[7]The implementation of this match is unproblematic because both data sets share the same firm identifier.

service offshoring for German multinationals between 2003 and 2008. Their findings reveal that firms do not start importing services in the presence of cost pressures. In contrast, existing linkages are intensified with higher cost pressure. Finally, the authors argue that firms which participate in service trade are less dependent on external finance and that financial constraints do not explain service imports. Kelle et al. (2012) study the choice of export mode (cross-border trade vs. foreign affiliate) for 2005 using the same matched data set as Biewen et al. (2012). The most productive firms[8] export via foreign affiliate to circumvent policy barriers (e.g., tariffs). In addition, firms tend to trade services with high-wage countries, while high wages in the importing country foster cross-border trade.

The recent literature in trade and finance, which we reviewed above, debates whether financial conditions of firms are able to explain the large (worldwide) drop in trade flows. One important question evolving from this discussion is whether trade in services is differently affected than trade in goods. Borchert and Mattoo (2009) illustrate evidence that services were indeed crisis-resilient after the financial shock in 2008. The authors argue that the drop in demand for services was less pronounced than the decline in goods. Accordingly, service exporters are less dependent on external finance than exporting manufacturers. The potential explanation lies in the nature of the non-storage property of services and that certain services are also demanded during an economic crisis. Subsequent to the literature review, which provides the most important insights for the following chapters, we start with the examination of the export premium in bank lending.

[8]Firm productivity is measured by the number of foreign markets that is served by the firm.

3. Extra Credit: Bank Finance and Firm Export Status in Germany[9]

3.1. Motivation

The dramatic decline in world trade in 2008/09 after the bankruptcy of Lehman Brothers ('Great Trade Collapse') has led to a growing interest in the procedures of trade financing, highlighting the role of financial factors for trade activity. The recent literature on international trade documents (and emphasizes) sizable trade-related differences across firms. Firms not only vary strongly by trade activity. Typically, only a small fraction of a country's firms engage in exports and imports. More notably, firms that export also differ significantly from non-exporters in (almost) all other relevant firm characteristics. Exporters are larger in size, more productive and pay higher wages than non-exporters (see Bernard et al. (2007)). Exporters also tend to produce a wider range of products and are less likely to cease operations (see Bernard and Jensen (2007)).

In this chapter, we examine the difference between exporters and non-exporters along another dimension: access to (and use of) bank credit. We aim to describe the association between finance and cross-border trade in further detail, analyzing empirically to what extent the provision of bank loans is affected by firm-specific characteristics, including the firm's export status. Our analysis is based on a novel data set of firm-bank relationships in Germany. Specifically, we match information from the German credit register (which covers the credit exposure of banks towards individual borrowers) with detailed balance sheet data on the borrower. This data set serves as the foundation for the subsequent chapters where we extend it with additional data sources about banks (see Chapter 4) and firms (see Chapter 5). The resulting, newly-compiled data set has, for our purposes, three key advantages. First, the database covers all large-scale credit relationships in Germany. Since lenders are required by law to report their credit exposure with a borrower exceeding a certain threshold to the German central bank, the Deutsche Bundesbank, our results are derived from a full sample of bank-firm credit linkages. Second, due to the pair-wise structure of the credit register, the lender is properly identified. This structure allows controlling directly for bank-specific features of credit provision such as differences in lending policies or profitability. Third, the balance sheet data covers, along with other firm data, information on the borrowers' foreign sales. Based on this data, we compute measures of a firm's (aggregate) export activity. Previewing our results,

[9]This chapter is mainly based on a revised version of Goldbach and Nitsch (2013b).

we find large exporter premia in bank lending. Our estimates indicate that German exporting firms take on average 15% larger loans than non-exporters, holding constant for other factors. To the extent that we properly control for firm-specific determinants of access to external finance, these findings appear to provide broad support for the trade finance channel between banks and exporters, which suggests that exports are particularly sensitive to financial conditions. For instance, Amiti and Weinstein (2011) emphasize that international trade involves higher default risk and higher working capital requirements. Exporters rarely properly evaluate default risk (turning instead to banks to provide insurance) and need more working-capital financing because of long delivery times.

The remainder of this chapter is organized as follows: Subsection 3.2 describes the data set, defines the main variables of interest and provides summary statistics, followed by a presentation of the empirical results in Subsection 3.3. Finally, Subsection 3.4 summarizes the main results.

3.2. Data and Summary Statistics

To analyze bank-firm relationships in Germany, we use two different data sets, provided by Deutsche Bundesbank. For reasons of confidentiality, the micro data require a special status: the data are accessible, often in anonymized form, only at the Bundesbank headquarters in Frankfurt. We begin by describing the data sources in detail.

Our main source of data is the Bundesbank's credit register, named MiMiK, which was established in 1993. The register contains information on all loans in excess of 1.5 million euro granted by banks in Germany to firms worldwide. According to section 14 of the German Banking Act (*Kreditwesengesetz*), banking institutions based in Germany are required to report their large exposures on a quarterly basis to allow the central bank to monitor indebtedness. Schmieder (2006) provides a more detailed description of the database[10]. For each bank-firm relationship, the size and composition of the credit exposure (both on and off balance sheet) is provided, along with the name and address of the borrower as well as information on the lender. The frequency of the data is quarterly, with information provided at the end of the quarter. Our sample covers the period from 2005 to 2010.

The second source of information is the corporate balance sheets database of the Bundesbank, Ustan. The Bundesbank has collected, mainly for refinancing pur-

[10]The German credit register was initially established in 1934, but reporting requirements were occasionally adjusted to take account of inflation (raising the regulatory reporting threshold) and structural changes in banking and financing techniques (e.g., adding credit derivatives to the definition of credit exposure).

poses, extensive data on individual firms[11]. The data are often taken from financial statements, but may also have been obtained from a mandatory questionnaire, based on balance sheet and profit and loss accounts data[12]. Most notably for our purposes, the database includes information on firms' export sales. The balance sheets data is on an annual basis. We merge the data with our information from the credit register by the corresponding year (such that annual firm data is matched with the loan data in each of the four quarters in a given year).
Unfortunately, the firm identifiers differ between the two data sets. Therefore, we develop a propensity score matching algorithm, based on the name of the firm, its legal form and its location. In the practical implementation of this matching procedure, we use a cut-off minimum score of 90%. In total, the matching quote between the two data sets is approximately 55%. In the following, we provide more detailed information about the matched data set.

3.2.1. Definition of Variables

Before we estimate the exporter premium in bank lending, Table 3.1 illustrates a brief description of the variables (and the data source). These include mostly bank-firm specific variables (credit exposure, on balance sheet credit exposure and off balance sheet credit exposure) from MiMiK and firm characteristics from Ustan.

[11]The Deutsche Bundesbank extended this data set over time by adding commercial data from Hoppenstedt and Creditreform.

[12]As Stöss (2001, p. 132) notes, these accounts are used for an examination of the creditworthiness of parties to bills of exchange, since the Bundesbank Act requires the central bank to purchase bills "backed by parties known to be solvent".

Table 3.1: Description of Variables

Variable	Description	Mnemonic	Source
Credit exposure	Total liabilities (including on balance sheet credit exposure, off balance sheet credit exposure, derivatives, and debt guarantees) at the end of the quarter	gesamt	MiMiK
On balance sheet credit exposure	Liabilities that have to be reported on balance (e.g., credits, bonds)	forderungen	MiMiK
Off balance sheet credit exposure	Liabilities that do not have to be reported on balance (e.g., securitized assets)	außerbilanziell	MiMiK
Exports	Export sales	AP30	Ustan
Export Share	Share of foreign activity on overall turnover	AP30/AP144	Ustan
Sales	Total sales (without value added tax and after sales deduction)	AP144	Ustan
Employment	Average number of employees during the business year (or, alternatively, at the date of account)	AP34	Ustan
Productivity	Value added (gross profit minus rental and lease expenses minus other operating expenses minus taxes) divided by the number of employees	(AP153-AP161-AP162-AP159)/AP34	Ustan
Age	Year of financial statement minus establishment year	AGJ-AP7	Ustan
Multi-plant firm	Annual financial statement is included in a consolidated financial statement	AP36	Ustan
Foreign equity holdings	Foreign equity capital	AP32	Ustan
Equity	Equity capital	AP137	Ustan
Debt	Total debt (sum of short-term debt and long-term debt)	AP111+AP128	Ustan
Assets	Total assets (balance sheet total)	AP88	Ustan
Industry	Industry classification (WZ 2003) at the 2-digit level	AP20	Ustan
Legal form	Legal form	ARECHT	Ustan
State	Federal state (by postal code of firm headquarter)	plz	MiMiK

Notes: The table describes the definitions of the variables and their data sources. All data are obtained from Deutsche Bundesbank. MiMiK is the credit register, while Ustan is the corporate balance sheet statistics.

3.2.2. Descriptives

Table 3.2 presents a brief overview of the data. In total, the Bundesbank's credit register contains information on almost one million bank-firm pairs for the 24 quarters from 2005 through 2010. For the large majority of the 14,800 loan-taking firms in the data set, we also have complementary information on firm characteristics. In fact, we lose only about 20% of the total number of (loan-quarter) observations through our matching procedure. Most notably, the matched data set does not differ significantly from the full credit register data. For instance, the pair-wise credit exposure consistently averages at about 8 million euro.

Table 3.2: Data Sets

	MiMiK	MiMiK-Ustan
Loan-quarter pairs	933,612	799,104
Firms	14,854	14,545
of which: Exporters		5,839
Banks	2,275	2,170
Mean loan value (1,000 euro)	8,145	8,148
Median loan value (1,000 euro)	2,250	2,305
Sales (bn. euro)		8,190
of which: Exports (bn. euro)		2,162

Notes: The table describes samples based on the German credit register and a matched data set to which information on borrowers is added. The data cover the period from 2005 to 2010 in quarterly frequency. All data are obtained from Deutsche Bundesbank. MiMiK is the credit register, while Ustan is the corporate balance sheet statistics.

Table 3.3 presents the summary statistics of the MiMiK-Ustan match which we use for the estimation of the export premium in bank lending. For (almost) all variables we have approximately 800,000 observations[13]. The average bank-firm credit exposure features 8 million euro, while a large part of it (6 million euro) reflects classical debt instruments which enter the balance sheet. In addition, exports account on average for a modest part (42%) of overall total sales although only a certain fraction of all firms in the data set actually export (34%). However, the average export share on firm-level dimension is much lower (13%). The mean firm employs 2,630 employees and receives 2.698 million euro as value added per employee. We cover mostly large firms which are established in their industry (mean age of 50 years), and many belong to a larger cooperation (about 59%). Moreover, the balance sheet data

[13]The only exception is firm productivity because we exclude negative values in our analysis.

illustrate that the average firm finances itself primarily through debt (68%). The high standard deviations indicate a large variation among bank-firm relationships.

Table 3.3: Summary Statistics of Variables

Variable	Obs	Mean	Std. Dev.
Credit exposure	799,104	8,147	35,990
On balance sheet	799,104	6,103	25,351
Off balance sheet	799,104	1,825	21,871
Exports	799,104	434,986	3,592,742
Export Share	799,104	0.131	0.239
Sales	799,104	1,034,939	5,733,372
Employment	799,104	2,630	15,031
Productivity	763,272	2,698	32,273
Age	799,104	50.32	77.09
Multi-plant firm	799,104	0.591	0.492
Foreign equity holdings	799,104	966	11,172
Equity	799,104	793,789	4,238,876
Debt	799,104	1,691,438	7,098,630
Assets	799,104	2,485,228	10,800,000

Notes: The table provides number of observations, mean and standard deviation of the relevant variables. All data are obtained from Deutsche Bundesbank.

We aim to describe trade-related bank-firm relationships in more detail. To identify possible differences in bank lending between exporters and non-exporters, we run regressions of the following general form:

$$ln(Loan_{ijkt}) = \alpha + \beta Exporter_{ijt} + \sum \gamma X_{ijt} + \phi_j + \eta_t + \sigma_k + \nu_i + \epsilon_{ijkt} \qquad (3.1)$$

where $Loan_{ijkt}$ is a measure of the credit exposure of bank k to firm i in industry j at time t, $Exporter_{ijt}$ is a measure of the firm's export activity, typically a dummy variable that takes the value of one if a firm has positive foreign sales (and zero otherwise), X_{ijt} covers a number of other firm characteristics, ϕ_j are industry-specific, η_t time-specific, σ_k bank-specific and ν_i firm-specific fixed effects and ϵ_{ijkt} is the residual. Bernard et al. (2007) use a similar approach to quantify exporter premia for other firm characteristics. As potentially relevant firm-specific variables for lending other than export status, we consider firm size (approximated by total sales and the number of employees), firm age, equity, foreign equity holdings, and whether the firm belongs to a larger corporation. In addition, we experiment with the inclusion of controls for firm location (federal state), the legal form of the firm, and the lending entity (bank). In our most demanding specification, we also use a

comprehensive set of firm-specific fixed effects, thereby identifying the association between exports and lending from the variation in a firm's export status over time only.

3.3. Empirical Results

3.3.1. Baseline Regressions

Firm-specific information on large-scale loans by financing entities allows us to directly identify the exporter premium in external finance. Benchmark estimation results are tabulated in Table 3.4. Each of the four columns reports the results of a different regression specification of equation (3.1), gradually increasing the number of additional explanatory variables to control for differences in bank lending across firms.

Column (1) presents our basic specification, in which we regress the log value of a bank's credit exposure to a firm on the export status of the borrower, holding constant for differences in lending relationships across (two-digit) industries and over time. The estimated β coefficient on the exporter dummy takes a significantly positive sign and the effect is economically large. According to our most parsimonious specification of equation (3.1), the point estimate of β indicates that being an exporter tends to increase the credit exposure of a firm by about 37%.

The next two columns show that about one-half of this effect is explained by firm characteristics other than export participation. In column (2), we control for firm size, firm age and structure of the firm (whether the firm belongs to a corporate group, foreign asset holdings and firm equity). We additionally include fixed effects for the location and legal form of the firm as well as lender-specific fixed effects in column (3). While the estimated γ coefficients on the auxiliary variables assume the expected sign and are statistically and economically significant, with larger and older firms taking more loans while multi-plant firms and firms with access to foreign capital (or capital within a firm group) often use alternative sources of financing, the estimated β coefficient falls to about 0.15. These estimates suggest that exporters take about 15% larger loans than non-exporters, holding other things constant.

In a final perturbation, we add to our specification a comprehensive set of firm-specific fixed effects. Since this estimator takes account of all time-invariant firm characteristics and exploits only variations in factors over time, the association between external finance and trade is exclusively identified from switches in a firm's trade activities. Unfortunately, there are only few changes in the exporter status of firms in our sample. We observe 23,626 episodes (of bank-firm pairs) in which

a firm starts exporting and 19,797 export stops (representing in total a fraction of 5.4% of our sample of about 800,000 observations). Still, the estimate of β remains positive and significant, again indicating that foreign sales are positively associated with bank lending. Specifically, the point estimate of 0.02 implies that a financial institution tends to increase its credit exposure to a firm that becomes an exporter by about 2%[14].

Table 3.4: Exporter Premium in Bank Lending

	(1)	(2)	(3)	(4)
Variables	ln(Loan)	ln(Loan)	ln(Loan)	ln(Loan)
Exporter	0.369***	0.165***	0.154***	0.024**
	(0.008)	(0.008)	(0.008)	(0.010)
ln(Sales)		0.060***	0.070***	0.046***
		(0.001)	(0.001)	(0.004)
ln(Age)		0.163***	0.142***	0.003
		(0.003)	(0.003)	(0.029)
Multi-plant		-0.478***	-0.413***	0.023**
		(0.006)	(0.006)	(0.010)
ln(Fdi)		-0.018***	-0.009***	-0.011***
		(0.002)	(0.002)	(0.002)
ln(Equity)		0.183***	0.173***	-0.015***
		(0.001)	(0.002)	(0.003)
Industry FE	Yes	Yes	Yes	Yes
Time FE	Yes	Yes	Yes	Yes
State FE	No	No	Yes	Yes
Legal FE	No	No	Yes	Yes
Bank FE	No	No	Yes	Yes
Firm FE	No	No	No	Yes
Observations	799,104	799,104	799,104	799,104
R^2	0.052	0.103	0.194	0.730

Notes: OLS estimation. Robust standard errors in parentheses. *** denotes significance at 1%, ** significance at 5% and * significance at 10%.

3.3.2. Robustness Checks

We perform extensive sensitivity analyses. The columns tabulate the result of a different regression specification, corresponding exactly to those of Table 3.4.

[14]If we employ yearly data (e.g., mean values of bank-firm relationships or just keep the data for the forth quarter) instead of the quarterly frequency we receive the same results regarding the signs, magnitudes and levels of significance. The only difference is an insignificant coefficient in column (4) due to the lower variation of the switches.

We begin by varying our measure of export activity, replacing the plain export dummy with the log share of foreign sales in total sales[15]. Using the export share as explanatory variable takes the importance of exporting into account. The findings can be obtained from Table A.1. Neither sign nor significance change in comparison to our baseline results. According to our most parsimonious specification, an increase in the export share by 1% increases the credit exposure by more than 1%. This effect is statistically and economically highly significant. The elasticity becomes weaker (0.4%) as soon as further control variables are considered. However, even in our most demanding specification in column (4) the export share remains positive and highly significant. The signs of all control variables remain the same in comparison to Table 3.4.

We also experiment with using employment instead of sales as our proxy for firm size. Table A.2 provides the estimation parameters. The choice of this other proxy has no qualitative effect on our results. The signs and magnitudes are almost the same as before. The only difference is reflected in the last column because the export dummy now becomes (only) weakly significant.

Previous literature finds a positive correlation between firm size and firm productivity. Therefore, several empirical papers (e.g., Ahn et al. (2011b)) only include firm size as explanatory variable for exporting because they cannot measure productivity (due to lack of data). In addition, to control directly for firm size, we add a separate control for firm productivity[16]. Table A.3 reports the results. We find similar signs and magnitudes for our export dummy variable compared to our baseline regression. Again, the exporter dummy becomes only weakly significant in the last column, similar to Table A.2, where we use employment as proxy for firm size. Firm productivity is positively correlated with the amount of credit exposure. This coefficient becomes negative and highly significant only in the last column. Overall, the prior results of a positive exporter premium (of about 15%) are confirmed.

Next, we split the sample into two sub-periods. Table A.4 presents the export premium before the collapse of Lehman Brothers in September 2008 (Q3/2008), while Table A.5 focuses on the crisis period. We show that the exporter premium has become smaller since the beginning of the financial crisis (from about 18% to 12-14%). However, while the magnitude of the decline depends on the exact regression specification, our finding that exporters take out significantly larger loans

[15]Before taking logs, we increase foreign sales by the value of one to deal with the problem of zero entries. Therefore, the number of observations remains constant.

[16]We compute a productivity measure from accessible firm-level information in the Bundesbank's corporate balance sheet statistics (see Müller and Buch (1986)). Note that the number of observations decreases because we exclude negative firm productivity from our sample.

than otherwise identical non-exporters remains consistently unchanged. We also split our sample along other lines. To investigate whether censoring plays a critical role or not, we choose a loan volume of 2 million euro as splitting threshold[17]. Table A.6 reports the coefficients below this threshold, whereas Table A.7 illustrates the outcome for firms with a larger credit exposure. The point estimates of β turn out to be particularly strong for firms with low credit exposure while for firms above the threshold they become smaller. In addition, columns (2) and (3) in Table A.7 even hint to a negative export premium. Consequently, for firms with large credit exposure the evidence seems to be mixed. Overall, the findings indicate that censoring should not be an issue.

Similarly, we divide the total credit exposure into direct credit debt (see Table A.8) and off balance sheet liabilities (see Table A.9). The results become slightly less robust. Table A.8 reveals that a positive exporter premium is present for classical credit debt between 4-8%. However, the estimates in Table A.9 (of about 33-54%) indicate that the overall exporter premium in bank lending from the baseline regression is mainly due to an exporting firm's access to a wider range of financing instruments (e.g., derivatives and guarantees).

The specification seems to become even more demanding, with mixed estimation results, when we use credit shares instead of credit values as dependent variable[18]. We use credit exposure relative to total debt (from the balance sheet data) and relative to total assets to further incorporate potential firm size effects. Table A.10 presents the outcome relative to total debt, Table A.11 focuses on total assets. If we do not consider any control variables, we find a negative and highly significant export premium. However, the inclusion of additional firm characteristics, state-fixed effects, legal-fixed effects and bank-fixed effects leads to a positive coefficient for the exporter dummy. All in all, the results hint at a positive (but economically small) relationship.

Moreover, we want to attenuate the potential of reverse causality. Instead of arguing that exporters are more dependent on external finance, more financial resources could cause engagement in foreign market. We use lagged explanatory variables to address this problem with a time lag of one period (year)[19]. The results can be obtained from Table A.12. The evidence suggests that our benchmark estimates remain essentially unaffected.

[17] This threshold is chosen because it lies near the reporting limit and the median value in the sample.

[18] In particular, it should be noted that our data set covers credit exposure at the bank-firm level.

[19] All explanatory variables are provided on annual basis.

Finally, we allow for time-variant industry and bank-fixed effects. It might be argued that banks which are chosen primarily by non-exporters have been differently affected by the financial crisis than banks which provide finance primarily to exporting firms. To deal with the extremely large number of fixed effects, we apply the algorithm used by Guimaraes and Portugal (2010). Table A.13 offers the outcome for this regression. Again, the results remain unchanged and hint at a positive export premium in bank lending.

3.4. Summary

The sudden drop in world trade after the collapse of Lehman Brothers in September 2008 has led to growing interest in procedures of trade finance. A growing body of evidence seems to suggest that export-related activities of firms do indeed depend disproportionately on finance from external sources.

This chapter contributes to this recent literature by examining differences in bank lending between exporters and non-exporters. Examining a novel data set of credit relationships in Germany covering all loans of more than 1.5 million euro over the period from 2005 to 2010, we find that exporting firms take on average about 15% larger loans than non-exporters, holding constant for a wide range of other firm and bank characteristics.

The sensitivity of export activities to the availability (and the cost) of external capital has clear policy implications. A reduction in access to trade credit (and a tightening of credit conditions) is likely to hit hard on financially vulnerable export industries. As a result, policy measures and interventions that improve the strength of the domestic banking and financial sector and thereby help avoiding financial market disruptions are expected to have a measurable impact on a country's international trade.

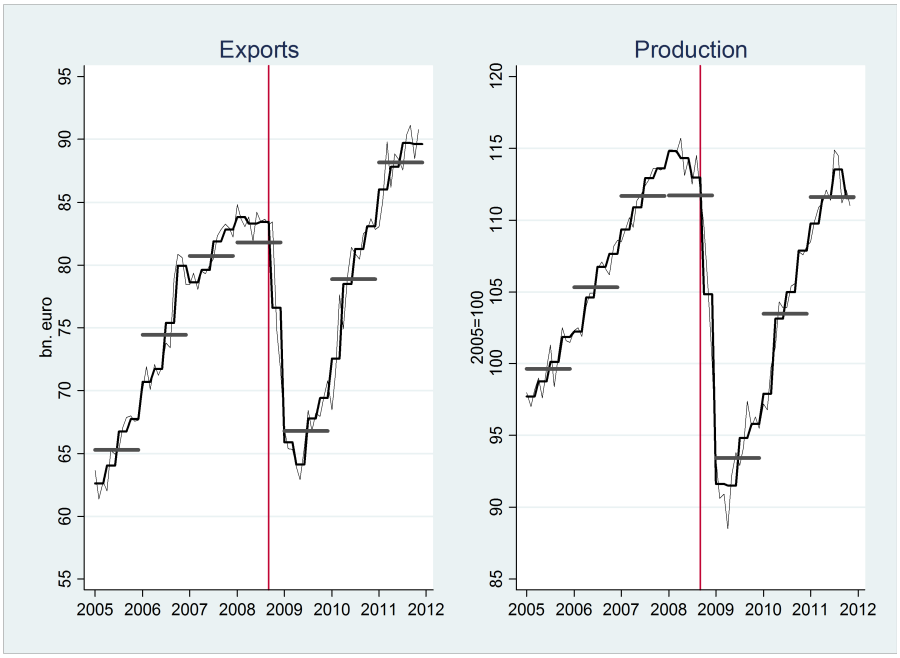
Despite their overall consistency, our estimation results are still subject to limitations. For instance, a potential issue might be omitted variables bias. Trade finance could be obtained from financial markets abroad. Unfortunately, we are not able to identify these bank-firm relationships. The estimated exporter premium may be mainly due to characteristics of the exporting firm (some of which are potentially unobserved) rather than the nature of the export activities, a critique that appears to be generally less relevant for our specification which includes firm fixed effects. Another obvious issue, open for future research, is to establish causality. The next chapter concentrates on the effect of the financial crisis (instead of general differences between exporters and non-exporters) on trade flows.

4. Cutting the Credit Line: Evidence from Germany[20]

4.1. Motivation

As highlighted above, the massive decline in world trade in the fourth quarter of 2008 ('Great Trade Collapse') has led to a growing interest into the procedures of trade financing. Figure 4.1 illustrates the sharp drop in economic activity in Germany after the collapse of Lehman Brothers.

Figure 4.1: Exports and Production in Germany, 2005-2011



Notes: The graphs plot seasonally adjusted monthly data as well as quarterly and yearly averages. Aggregate data is provided by Deutsche Bundesbank.

With the bankruptcy of Lehman Brothers, financing conditions deteriorated dramatically. Now, we investigate whether this financial shock is able to explain the immense drop in trading activities for German firms. If external finance is of greater relevance for exports than for domestic sales, this asymmetry may explain why trade has fallen more than GDP.

Based on this reasoning, a number of papers have recently examined empirically the link between financial factors and trade activity. Amiti and Weinstein (2011) find that the deterioration of the financial position of Japanese banks caused a decline in their client firms' exports relative to their domestic sales. At industry level,

[20]This chapter is mainly based on a revised version of Goldbach and Nitsch (2013a).

Bricongne et al. (2012) and Chor and Manova (2012) conclude that the decline in exports was stronger in sectors which are more heavily dependent on external finance. Finally, Ahn et al. (2011a) argue that trade financing needs differ by mode of transportation, with external financing being particularly important for shipments by sea. Their results suggest that goods shipped by sea did indeed experience an increase in prices relative to goods shipped by air or land during the crisis period.
From a theoretical point of view, Ahn (2011) provides a first formalization of the idea that cross-border trade transactions are particularly sensitive to financial shocks. Specifically, he argues that international trade finance loans are riskier than domestic trade finance loans. In the model, the banks' screening tests for a borrower, the borrower's domestic trading partners and its foreign trading partners differ in precision levels (or, more precisely, costs). As a result, "international transactions are subject to higher default risks than domestic transactions because the screening test for foreign firms is more likely to misclassify bad firms as good." (Ahn (2011, p. 17))
In this chapter, we examine empirically various assumptions concerning the association between financial conditions (the firm's access to external finance) and firm activity (especially exports). We make use of the same data set (MiMiK-Ustan) which matches detailed information on pair-wise bank-firm relationships from the Bundesbank's credit register with information on lender and borrower characteristics. Moreover, we consider additional information from banks using another data set, BAKIS, to identify banks on the micro-level which were especially 'affected' by the financial crisis.
Previewing our main results, we find that finance has an effect on domestic and total sales but not on exports for German firms. In addition, banks which were strongly 'affected' by the financial crisis indeed lowered their credit exposure. Finally, exporting firms which receive finance from 'affected' banks do not experience a larger export decline compared to firms which participate in international trade and finance their operations through healthy financial institutions.
The remainder of this chapter is structured as follows. Subsection 4.2 provides a detailed description of the additional data source. The heart of this chapter is Subsection 4.3, which motivates our empirical methodology and presents the results. Finally, Subsection 4.4 briefly summarizes the main implications.

4.2. Data and Summary Statistics

This chapter relies on the previous MiMiK-Ustan match, which we described in Chapter 3, and extends it with the prudential information system on banks, BAKIS.

This data set contains information on a wide range of bank characteristics (e.g., equity and total assets), mainly taken from financial statements and quantitative audit reports. Reports to the Bundesbank (as a German supervisory authority) are mandatory for banks, often with a monthly frequency. BAKIS data are reported with an annual frequency, reaching back to 1993.

4.2.1. Definition of Variables

The main focus in this section is the definition of what an 'affected' bank means. There is no consensus in the academic literature as to which variable is the most suitable to classify banks as strongly influenced by a financial shock. Paravisini et al. (2011) use the share of foreign funding as identification strategy for Peruvian firms. If a bank receives much funding from abroad (defined as above the mean value of all financial institutions one year before the recent financial crisis occurred) it is declared to be 'affected'. For Peru this method seems reasonable because it is a small open economy where firms mostly receive funding from one or two banks and shocks from outside have an impact on the decision making of firms. For German banks this approach seems not reasonable because the institutional settings are completely different. We observe that German firms receive finance from multiple institutions and Germany is highly integrated within Europe[21]. Another approach undertaken by Rose and Wieladek (2011) is to use a bank-by-bank Google search with bank name and 'nationalization, nationalize or privatize' as identification strategy. In total, they classify approximately 150 banks as 'affected' in Great Britain.
Due to the fact that there is no academic consensus on how to define an 'affected' financial institution, we employ six different measures (four dummy variables and two continuous variables) and analyze whether the results are strongly influenced by our definitions. The first strategy is to classify banks as 'affected' which received governmental help by the fund SoFFin (Financial Market Stabilization Fund). This fund was established in October 17th, 2008 with the purpose of stabilizing the financial system in Germany. The main instruments it provides are guarantees, recapitalization and resolution agencies. The first column of Table 4.1 gives an overview of which banks received governmental help[22]. As second measure we em-

[21]Germany is known for its Three Pillar banking system consisting of private institutions, savings and cooperatives. The market share in the provision of credit supply is especially large among the savings and cooperatives (about 70%) because they are also present in regions with low population density. Furthermore, within both these pillars the regional principle applies: savings within a special region are not allowed to compete with our savings institutions (and the same is true for cooperatives). Krahnen and Schmidt (2004) provide a detailed description of the German financial system.

[22]The data set does not contain the names of the financial institutions but only bank identifiers

ploy the SoFFin list including the bank's subsidiaries. The third attempt to define 'affected' banks uses financial institutions which are part of the stress tests of the European Banking Authority (EBA) in London. Column (2) of Table 4.1 illustrates which banks are regarded as important/systematic by EBA. Some financial institutions occur on both lists but the EBA sample covers more banks. The forth proxy considers again the subsidiaries, but now from the EBA list.

Table 4.1: SoFFin and EBA

SoFFin	EBA
Aareal Bank	BayernLB
BayernLB	Commerzbank AG
Commerzbank AG	Dekabank
Corealcredit Bank AG	Deutsche Bank AG
Düsseldorfer Hypothekenbank	DZ Bank AG
HSH Nordbank	Helaba
Hypo Real Estate	HSH Nordbank
IKB Deutsche Industriebank	Hypo Real Estate
Volkswagen Bank	Landesbank Berlin
WestLB	LBBW
	NordLB
	WestLB
	WGZ Bank

Notes: The table describes recapitalized German banks using the Financial Markets Stabilization Fund (SoFFin) and German banks covered by the European Banking Authority (EBA) stress test exercise. The banks are sorted in alphabetic order.

Another idea to describe banks which are especially hit by the financial crisis is to use bank's balance sheet measures. Our fifth identification strategy employs the leverage ratio (defined here as equity ratio as in other empirical papers). Federico and Vazquez (2012) use Bankscope data and show that a larger leverage ratio (or equivalently a lower equity ratio) increases the probability of default for a set of European banks. We use the leverage ratio with a time lag of one year[23]. The last measure is non-performing loans. Higher write-offs are associated with banks that were especially hit by the financial shock. We use the non-performing loans also with a time lag of one year.

for external researchers. Fortunately, we received the information on which bank identifiers are on the SoFFin list (the same holds true for EBA).

[23]The drawback of this measure is that the portfolio risk is not considered. It is possible that banks operate with a high leverage ratio but the institution holds mostly safe assets with low risk of default.

4.2.2. Descriptives

Table 4.2 provides an overview of the various combinations of matched data sets. In total, the Bundesbank's credit register contains information on almost one million bank-firm pairs for the 24 quarters from 2005 to 2010. For the large majority of the 14,000 firms and 2,000 banks in the data set, we also have complementary information on firm and bank characteristics. While the number of observations decreases by about a fifth in the matched data sets, the number of firms and banks is often considerably more robust[24]. Most notably, the subsamples based on the matched data sets do not differ significantly from the raw data. The pair-wise credit exposure consistently averages at about 8 million euro.

Table 4.2: Data Sets

	MiMiK	MiMiK-Ustan	MiMiK-Ustan-BAKIS
Loan-quarter pairs	933,612	799,104	698,280
Firms	14,854	14,545	14,380
of which: Exporters		5,839	5,787
Banks	2,275	2,170	1,590
Mean loan value (1,000 euro)	8,145	8,148	7,584
Median loan value (1,000 euro)	2,250	2,305	2,170
Sales (bn. euro)		8,190	7,936
of which: Exports (bn. euro)		2,162	2,098

Notes: The table describes samples based on matched data sets. All data are obtained from Deutsche Bundesbank. MiMiK is the credit register. Ustan is the corporate balance sheet statistics. BAKIS is the prudential information system on banks.

Figure 4.2 shows that financing conditions did indeed deteriorate in Germany after the fourth quarter in 2008. After a strong expansion in previous quarters, total credit measurably declined in 2009. The number of loans continued to increase, but at a much smaller pace. Appendix B provides more details about the evolution of bank-firm credit relationships in our sample (see Figure B.1).

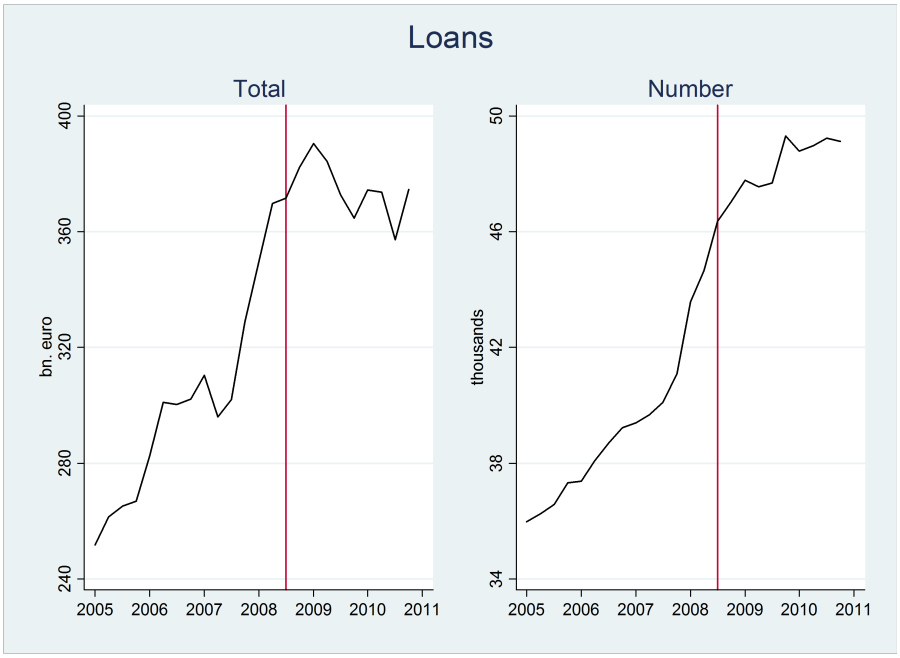
In addition, Figure 4.3 shows that our firm-level data follows aggregate developments quite well[25]. There is a (remarkably) close match between total exports and foreign sales in our matched micro data sets.

Finally, we provide summary statistics about the different definitions of 'affected'

[24]We observe a drop in the number of banks (about a quarter) between the MiMiK-Ustan and MiMiK-Ustan-BAKIS match. The reason for this is the consolidation of savings and cooperatives (and merging of other private institutions, e.g. Commerzbank and Dresdner Bank).

[25]This observation is astonishing because the reporting of the export sales is voluntary.

Figure 4.2: Bank-Firm Credit Relationships in Germany, 2005-2010



Notes: The quarterly data are taken from the Bundesbank's credit register for loans of 1.5 million euro or more.

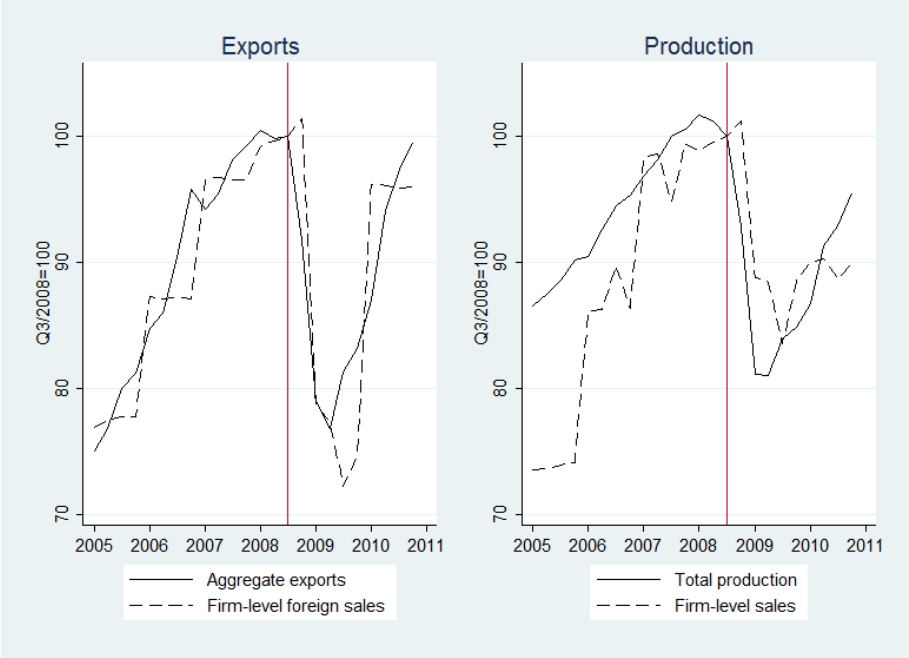
Table 4.3: Summary Statistics of Definitions

Variable	Obs	Mean	Std. Dev.
SoFFin	698,280	0.188	0.391
SoFFin (w/subsidiaries)	698,280	0.252	0.434
EBA	698,280	0.301	0.459
EBA (w/subsidiaries)	698,280	0.448	0.497
$Equity_{t-1}$	584,318	0.024	0.030
NPL_{t-1}	584,318	3,760,328	5,092,733

Notes: The table provides number of observations, mean and standard deviation of the definitions of 'affected' bank. All data are obtained from Deutsche Bundesbank.

bank in Table 4.3. The first four variables are approximated as dummy variables. The data set contains about 19% of bank-firm relationships related to banks which are on the SoFFin list. Accordingly, the ten banks (out of about 1,600) provide credit to multiple firms and are important from an economic point of view. This share increases if we extend the SoFFin list with its subsidiaries. Then, about 25% of all observations are defined as 'affected'. The EBA list contains more banks, which

Figure 4.3: Firm-Level and Aggregate Data



Notes: The graphs are based on quarterly data from the Bundesbank's credit register matched with the Bundesbank's corporate balance sheet statistics.

is also reflected in the higher share (30%) of bank-firm relationships. If we enlarge this list with its subsidiaries, 46% of all observations are 'affected'. These statistics suggest that the data set provides enough variation in the treatment variable. In addition, the equity ratio of about 2.4% is relatively low (high leverage ratio), while the non-performing loans are relatively high (over 3 billion euro).

4.3. Empirical Results

4.3.1. Baseline Regressions

In our empirical analysis of bank-firm relationships in Germany, we proceed in steps. First, we examine the association between credit supply and exports in more detail. As starting point, we investigate the data set in its full dimensions (time, bank and firm)[26]. In particular, we aim to analyze whether the sharp decline in world trade is explained by a deterioration in the financing conditions of (exporting) firms[27]. In addition, we compare these results with the relationship between credit and domes-

[26]The robustness checks section reduces the complexity of the data set with its three dimensions by eliminating one of those.

[27]This descriptive approach is similar to Paravisini et al. (2011).

tic/total sales. To estimate the first step, we use the following model:

$$\Delta ln(Y_{ijt}) = \alpha + \beta \Delta ln(Loan_{ik,t-1}) + \phi_{jt} + \sigma_k + \nu_i + \epsilon_{ijkt} \tag{4.1}$$

where Y_{ijt} is export sales (or export share), domestic sales or total sales of firm i in industry j at time t (year), $Loan_{ik,t-1}$ is the credit exposure of bank k to firm i at time $t-1$ and we include a full set of industry-time specific (ϕ_{jt}), bank-specific (σ_k) and firm-specific (ν_i) fixed effects. Equation (4.1) considers the bank-firm level where multiple (annual) bank-firm relationships[28] are present.

Table 4.4 reveals the regression results. Column (1) is defined as our baseline specification which only includes the industry-time specific fixed effect as control variable. The estimated coefficient of -0.047 is insignificant and implies that the change in credit exposure has no impact on the change in export sales. In column (2), we use the log of export share (defined as export sales relative to total sales) to consider the importance of foreign operations relative to firm size. Reassuringly, the estimation results remain virtually unchanged. In contrast, columns (3) and (4) indicate positive and significant results if we use the change in domestic and total sales as dependent variables. Consequently, a reduction in credit supply does not affect export sales (or export share) but indeed lowers domestic and total sales. Moreover, the descriptive analysis considers different fixed effects. The inclusion of firm-specific fixed effects does not change the results, as the fifth column illustrates. Furthermore, we distinguish between total sales for exporters and non-exporters to examine whether both types of firms are differently affected in overall operations. Columns (6) reveals that total sales of non-exporters decline more if credit provision is reduced in comparison to exporters which obtain a less significant estimate and a smaller magnitude in column (7). Altogether, there seems to be no correlation between credit supply and exports, while the credit exposure has indeed an impact on domestic and total sales.

[28]Our original data set MiMiK is based on quarterly data with information about the credit exposure. We aggregate this quarterly credit exposure on an annual basis by calculating the mean value if a bank-firm relationship persists several quarters within a year. In addition, the fourth quarter was tested for robustness checks but the results remain unchanged.

Table 4.4: Credit Exposure and Exports, Domestic Sales, Total Sales

Variables	(1) $\Delta ln(Exports_{ijt})$	(2) $\Delta ln(Export\ Share_{ijt})$	(3) $\Delta ln(Domestic_{ijt})$	(4) $\Delta ln(Total_{ijt})$	(5) $\Delta ln(Exports_{ijt})$	(6) $\Delta ln(Total_{ijt})$ (Non-Exporter)	(7) $\Delta ln(Total_{ijt})$ (Exporter)
$\Delta ln(Loan_{ik,t-1})$	-0.047	-0.001	0.013***	0.011**	-0.056	0.013**	0.007*
	(0.033)	(0.001)	(0.004)	(0.004)	(0.041)	(0.005)	(0.004)
Industry-Time FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Firm FE	No	No	No	No	Yes	No	No
Observations	13,740	13,740	35,950	35,999	13,740	22,259	13,740
R^2	0.007	0.012	0.025	0.031	0.290	0.015	0.106

Notes: OLS estimation. Robust standard errors in parentheses. *** denotes significance at 1%, ** significance at 5% and * significance at 10%.

Second, we examine whether banks which are classified as 'affected' , according to the definitions we described above, lowered their credit exposure after the bankruptcy of Lehman Brothers in September 2008. To analyze this question, we run the following regression:

$$\Delta ln(Loan_{ikt}) = \alpha + \beta affected_k \cdot crisis_t + \eta_t + \sigma_k + \nu_i + \epsilon_{ikt} \tag{4.2}$$

where $Loan_{ikt}$ is the credit exposure of bank k to firm i at time t, $affected_k$ is a dummy variable that indicates whether the bank is 'affected' or not, $crisis_t$ is a dummy variable that equals one when the year is at least 2008 and η_t are time-specific, σ_k bank-specific and ν_i firm-specific fixed effects and ϵ_{ikt} is the residual.
Table 4.5 illustrates the regression results for equation (4.2). Each column represents a different definition of 'affected' financial institutions. Our baseline measure is shown in column (1), which uses the SoFFin list. According to the estimation, banks on the SoFFin list did indeed lower their credit exposures by 12% after the financial shock. The consideration of SoFFin subsidiaries in column (2) does not change the significance level but the coefficient becomes economically smaller (6.3%). Column (3) presents the results for banks which are part of the EBA stress test exercise. Again, β is statistically highly significant which indicates that 'affected' banks restrict their credit supply by about 10.8%. The inclusion of EBA subsidiaries does not have an impact on the qualitative result, but again the estimate is lower (about 7%). Column (5) shows that banks with higher leverage ratio (lower equity ratio) in the past increase their lending positions (1.8%). This result is surprising because we would expect that banks with a high leverage ratio prior to the bankruptcy of Lehman Brothers in 2008 have to abandon some positions from their portfolio[29]. Finally, banks which experienced higher write-offs cut their credit positions, as column (6) suggests. As a result, we observe that banks which are defined as 'affected' (with the only exception of the leverage ratio) engage less in lending operations after the financial crisis.

[29] As noted before, we do not know whether the risk of the portfolio is adjusted.

Table 4.5: Bank Health and Lending

	(1)	(2)	(3)	(4)	(5)	(6)
Variables	$\Delta ln(Loan_{ikt})$					
SoFFin·crisis	-0.120***					
	(0.025)					
SoFFin (w/subsidiaries)·crisis		-0.063***				
		(0.022)				
EBA·crisis			-0.108***			
			(0.021)			
EBA (w/subsidiaries) ·crisis				-0.069***		
				(0.019)		
$Equity_{t-1}$					-1.80***	
					(0.690)	
NPL_{t-1}						-7.48e-09**
						(3.41e-09)
Time FE	Yes	Yes	Yes	Yes	Yes	Yes
Bank FE	Yes	Yes	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes
Observations	138,490	138,490	138,490	138,490	138,490	138,490
R^2	0.382	0.382	0.382	0.382	0.382	0.382

Notes: OLS estimation. Robust standard errors in parentheses. *** denotes significance at 1%, ** significance at 5% and * significance at 10%.

While correlations between variables may be interesting, we are particularly interested in the direction of causality in the relationship. Instead of credit affecting exports (investment due to fixed costs), the causality may also run the other way around (exporters have characteristics which are attractive for banks, e.g. high profitability). The key difficulty with the reported measure of credit exposure is that it represents an equilibrium outcome. An agreed credit line is the result of matched credit supply and credit demand between a lender and a borrower. To deal with this endogeneity, we make use of the financial crisis as an exogenous shock which affects the provision of credit because the bankruptcy of Lehman Brothers in September 2008 was unexpected. Now, we aim to understand whether firms which receive credit from 'affected' banks export less than similar firms which have a relationship with a healthy institution after the financial crisis. We employ propensity score matching as estimation strategy[30], which is the subject of growing interest in the recent empirical literature. The idea is to identify an optimal counterfactual in non-experimental data in the sense that both exporters are identical in several characteristics and only differ in the outcome variable (change in exports) and the treatment (whether the firm receives funds from 'affected' financial institutions). In a first step, we estimate the probability of treatment using a probit estimator. To determine the score, we use the same time (third quarter of 2008)[31], industry, firm size (approximated by the number of employees) and credit exposure. Then, we employ nearest neighbor matching[32]: the absolute difference between the probabilities of one firm which is treated and another that is non-treated is minimized. We choose the SoFFin list as baseline measure for 'affected' banks[33] in the following. The empirical implementation of this estimation procedure requires the bank dimension to vanish from our bank-firm data set[34]. Due to this fact, we now define firms as 'affected' instead of banks. We employ three different definitions for 'affected' firm: at least one bank is 'affected', only firms with one bank-firm relationship (and this bank is 'affected') are kept in the data set and the share of credit exposure from 'affected' banks is larger than 50%. After identifying the optimal counterfactual, we pool all industries to-

[30]It was first proposed by Rosenbaum and Rubin (1983) in the context of medicine.

[31]Exports, domestic and total sales are reported on an annual basis. Accordingly, the drop in operations can only be observed for 2008 because in 2009 the world economy recovered.

[32]Becker and Ichino (2002) provide an overview about different approaches to estimate the average treatment effect.

[33]The experimentation with the other definitions provides similar insights. We employ dummy variables for leverage ratio and non-performing loans and define banks as 'affected' if the equity ratio is lower than the 25% percentile and if the non-performing loans are greater than the 75% percentile in 2007.

[34]The time panel structure is excluded by focusing exclusively on Q3/2008. In addition, we aggregate the credit exposure at firm-level.

gether and compare the change of exports, domestic and total sales between control and treatment group in 2008 (compared to 2007 before the financial crisis). Table 4.6 illustrates the results for the different definitions of 'affected' firm. According to economic theory, $\Delta ln(Exports)$ should be negative and statistically significant. However, we do not find any evidence for differences between control and treatment group. This also holds true for domestic sales in column (2) and for total sales in column (3) as dependent variables. This finding reveals that exporting firms which receive credit from 'affected' institutions do not experience larger drops in exports than firms which have a relationship with a healthy bank. As a result, the supply conditions do not seem to be the main driving force for the explanation of the 'Great Trade Collapse' for Germany[35].

Table 4.6: Propensity Score Matching

	(1)	(2)	(3)		
Definitions	$\Delta ln(Exports)$	$\Delta ln(Domestic)$	$\Delta ln(Total)$	Treatment	Control
At least one	-0.037	-0.021	-0.020	4,211	2,076
bank 'affected'	(0.064)	(0.021)	(0.021)		
Firms with one	-0.069	-0.025	-0.029	693	568
bank-firm relation	(0.133)	(0.049)	(0.047)		
Share of 'affected'	-0.052	-0.041	-0.039	1,693	1,413
$> 50\%$	(0.089)	(0.028)	(0.028)		

Notes: Propensity score matching (nearest neighbor). Robust standard errors in parentheses. *** denotes significance at 1%, ** significance at 5% and * significance at 10%.

4.3.2. Robustness Checks

In the following, we use the same equations as before but reduce the complexity by eliminating different dimensions. Again, we start with the association between credit and exports[36]. We approximate the (overall) firm-level debt as explanatory variable, for which we aggregate the (annual) credit exposures of all banks into one variable. Therefore, every firm receives only one value as level of (overall) debt and equation (4.3) omits the bank dimension (which was labeled as k). The regression model takes the following form:

$$\Delta ln(Exports_{ijt}) = \alpha + \beta \Delta ln(Loan_{i,t-1}) + \phi_{jt} + \nu_i + \epsilon_{ijt} \tag{4.3}$$

[35]We also experimented with different estimation methods (radius, kernel and stratification matching). The results remained the same.

[36]Now, we only consider exports because the main focus of this chapter is the analysis of foreign operations. The results for domestic and total sales remain unchanged.

where $Exports_{ijt}$ is exports of firm i in industry j at time t, $Loan_{i,t-1}$ is the aggregated credit exposure of firm i at time $t-1$, while ϕ_{jt} are industry-time-specific and ν_i denote firm-specific fixed effects and ϵ_{ijt} is the residual. Table B.1 provides the estimated coefficients. The first column includes only industry-time fixed effects as additional control variable. β remains insignificant and confirms our previous findings. Column (2) shows that the bank-specific fixed effects also do not have an impact on the significance level. Consequently, we find no evidence for a correlation between the change in exports and in credit exposure.

Next, we repeat the examination of whether 'affected' banks lowered their credit exposure. Now, we aggregate the granted loans of banks and omit the firm dimension (which was labeled as i). A formal representation is given in the following equation:

$$\Delta ln(Loan_{kt}) = \alpha + \beta affected_k \cdot crisis_t + \eta_t + \sigma_k + \epsilon_{kt} \tag{4.4}$$

where $Loan_{kt}$ is the credit exposure of bank k at time t, $affected_k$ is a dummy variable that indicates whether the bank is 'affected' or not, $crisis_t$ is a dummy variable that equals one if the year is at least 2008, η_t are time-specific and σ_k bank-specific fixed effects and ϵ_{kt} is the residual.

Table B.2 provides the regression results for equation (4.4). The column structure is in line with Table 4.5 where every column reflects a different definition of 'affected' financial institution. As before, column (1) suggests a negative and highly significant impact of being on the SoFFin list but the economic effect is higher (19%) compared to the disaggregated case (12%). Adding the subsidiaries in column (2) changes the results slightly. The effect is still negative but now with a lower significance level and a higher magnitude (28%). Moreover, banks on the EBA list lowered their credit exposure by 9.7%, as column (3) highlights. Again, the consideration of subsidiaries in column (4) leads to a weaker significance and a higher coefficient. In contrast to our previous findings, columns (5) and (6) offer insignificant results. Therefore, banks with lower equity ratio (higher leverage ratio) and higher non-performing loans do not adjust their credit positions in comparison to other financial institutions. Altogether, the majority of definitions (SoFFin, SoFFin with subsidiaries, EBA and EBA with subsidiaries) confirm our previous estimates.

Finally, the last robustness check concerns the propensity score matching. A possible explanation for the insignificant findings in the baseline regression is the presence of heterogeneity among industry sectors which we cover in the whole data set. For this reason, we repeat the propensity score matching and report the findings for each industry separately. The robustness check employs the SoFFin list as measure for

'affected' banks, just as in our baseline analysis[37]. Tables B.3 and B.4 illustrate the outcome for the first definition of 'affected' firm (at least one bank in the portfolio is 'affected'). In the following, we discuss only the differences in changes of exports because they are the main focus of this chapter. The majority reveals insignificant results which largely confirms the prior findings. However, we find some exceptions, where disparities between control and treatment group actually occur. 'Affected' firms in industries 14 (other mining and quarrying) and 23 (manufacture of coke, refined petroleum products and nuclear fuel) export more after the financial crisis, but the significance level is weak. Moreover, in industry 51 (wholesale trade and commission trade, except of motor vehicles and motorcycles) this positive difference is highly significant. These findings suggest that German firms export more basic materials and especially benefit from wholesale trade. In contrast, industries related to chemistry suffer from the financial crisis. The drop in exports is weakly significant for industry 21 (manufacture of pulp, paper and paper products), while more significant for industry 24 (manufacture of chemicals and chemical products).
To generalize these insights, Tables B.5 and B.6 employ the second definition of 'affected' firms which keeps merely firms with one bank relationship in a subsample. Unfortunately, different results emerge. We find that industries 25 (manufacture of rubber and plastic products) and 63 (supporting and auxiliary transport activities) export more, but this difference is only weakly significant. In contrast, firms in industry 52 (retail trade, except of motor vehicles and motorcycles) export less, while the significance level is stronger for industry 29 (manufacture of machinery and equipment).
At last, Tables B.7 and B.8 provide the results for the third definition (the share of 'affected' credit exposure exceeds 50% of the complete portfolio). Now, we only find positive and significant results for industries 32 (manufacture of radio, television and communication equipment) and 34 (manufacture of motor vehicles, trailers and semi-trailers). Altogether, heterogeneity among the different industries and definitions for 'affected' firm is indeed present. However, we do not find any significant differences for the majority of industries which confirms our baseline results.

4.4. Summary

The sudden drop in world trade after the collapse of Lehman Brothers in September 2008 is often labeled as the 'Great Trade Collapse'. Puzzled by this dramatic and unexpected decline in cross-border trade activity, a number of recent papers aim

[37]We also employ the other five measures. The insights from these additional robustness checks remain unchanged.

to explain this pattern, applying different data sources. For instance, Amiti and Weinstein (2011) identify a causal link between trade and financial conditions for Japanese firms. The deterioration in financial conditions of banks can partly explain the large drop in trade flows. In contrast, Behrens et al. (2010) conclude that financial conditions are not the most important factor for explaining the trade pattern for Belgian firms. They suggest that the fall in demand has had a much stronger impact. Bricongne et al. (2012) argue that lower demand and the intensive margin for large firms are the most important determinants. As a result, empirical findings appear generally mixed. Based on three matched micro data sets (MiMiK-Ustan-BAKIS) from the Deutsche Bundesbank, we identify various linkages between firms and banks in Germany. In addition, we are able to classify financial institutions as 'affected' by the financial crisis.

First, the results suggest that there is no correlation between exports and credits. However, the credit exposure has a positive impact on other operations (domestic and total sales). Differentiating the total sales for exporters and non-exporters reveals that total sales of non-exporters are more affected by the provision of finance. This descriptive analysis illustrates that German exports are not that much influenced by the changing environment of the (domestic) financial market.

Second, we provide six different measures which define 'affected' bank and show that 'affected' financial institutions indeed lowered their credit exposures after the financial crisis. This outcome is not trivial because the overall development of the financial market (see Figure 4.2) illustrates that the aggregate credit exposure does not drop by about 20% (as exports do) between 2008 and 2010, while the number of bank-firm relationships even increases after the bankruptcy of Lehman Brothers in September 2008.

Finally, the propensity score matching leads to the insight that German exporting firms which have a relationship with an 'affected' bank do not export less than comparable firms which obtain finance from healthy institutions. Even if we consider each industry separately (instead of pooling all results together) the same picture emerges.

The findings are not surprising for the following reasons: we observe an increase in the number of bank-firm relationships after September 2008. The majority of them appears between banks and exporters. One possible explanation is that exporters are seen as valuable borrowers (due to different firm characteristics) to financial institutions. Alternatively, the cause lies in the general institutional structure of the German financial system. Although large (and mostly private) banks lowered their credit exposure, more savings and cooperatives stepped into the market to

help German firms. Altogether, we conclude that (trade) finance does not influence foreign operations in Germany. Therefore, other factors (e.g., lower demand from abroad) seem to explain the large drop during the 'Great Trade Collapse'. This result is in line with other European countries such as Belgium (see Behrens et al. (2010)) or France (see Bricongne et al. (2012)) and Peru (see Paravisini et al. (2011)). However, the results have to be interpreted with some caution. We do not know how the firms actually use the credit they receive from banks. Therefore, we have to assume that some part of the credit exposure finances foreign operations. In addition, the credit exposure can change for various reasons: there is no information about the interest rate which is paid for different credits, about the number of loans which are granted from a particular bank and about the duration of credit lines. Finally, we do not observe foreign bank-firm relationships (e.g., a firm could export some goods to India and uses an Indian branch of a German financial institution). Nevertheless, our data set is a good starting point for investigating the link between the financial characteristics of banks and the real economy.

The previous analysis in Chapter 3 dealt with the estimation of export premia in bank lending and found positive evidence (in the sense that exporters depend more on external finance than non-exporters). In the following chapter, we want to extend this investigation by distinguishing between goods exporters and service exporters.

5. Export Premium in Germany: Goods vs. Services

5.1. Motivation

The share of services in the overall value creation (GDP) and the employment force has risen in many industrialized countries during the last decades[38]. Due to this observation, the economic impact of services receives more attention in the scientific debate because they differ fundamentally from the characteristics of goods. An important aspect within this discussion is the role of services in the recent trade literature. According to standard textbooks, services are non-tradable products because they possess high transportation costs. The consumption of several services needs proximity to customers (e.g., a haircut or health services by a doctor). Based on this reasoning, the textbooks on international trade do not cover theories or empirics about services at all. However, the recent development of trade flows indicates that more and more services nowadays are indeed traded across borders. Francois and Hoekman (2010) emphasize that technological progress (e.g., the spread of the Internet) leads to a decrease in trade costs of services, which boosts foreign operations. For Germany, we also observe the growing importance of services in international transactions[39]. Figure 5.1 illustrates the (monthly) evolution of aggregated trade flows for goods and services exports from 2005 to 2013. Using January 2005 as reference point, services indeed experienced a larger increase than trade in goods (in relative terms). Moreover, service exports are characterized by a seasonal component: a peak emerges every year in December (which is not due to a higher transaction number between Germany and other countries[40]). In addition, we observe that trade in services did not experience such a large drop during the recent financial crisis in comparison to exports of goods. Figure C.1 illustrates that heterogeneity among service sectors is present (e.g., the cyclical overall pattern is dominated by the financial service sector and other services while other sectors reveal different developments). As a result, the analysis of trade in services across countries is highly relevant from an economic point of view. Until now, we do not know much about the determinants of service exports[41].

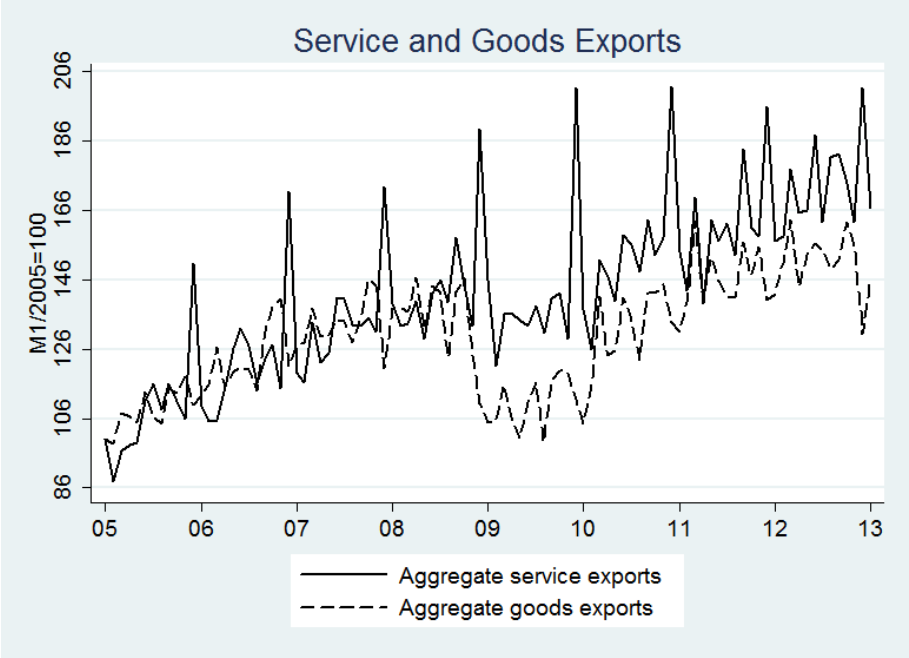
[38] Jensen (2011) provides an extensive description of the development of services for US data.

[39] Germany is known for its strong export economy. According to the balance of payments, Germany has a trade surplus in goods but a trade deficit in services, meaning that Germany imports more services from abroad than exports. However, this deficit in services has become weaker over time.

[40] This argument is based on the SITS transaction data of service exports which we use in this chapter.

[41] In recent years, trade in services transaction level data were made accessible for different countries.

Figure 5.1: Evolution of Goods and Services Exports



Source: Aggregate monthly trade statistics by Deutsche Bundesbank.

Especially the role of external finance for service exporters is unclear. Recent contributions (see Ariu (2012)) argue that a lower participation rate in exports of service firms in comparison to manufactures hints at higher entry barriers. On this account, service exporters depend more on external finance to cover the fixed entry costs. We do not know any single paper which addresses this problem directly.

This chapter examines whether service exporters are indeed more dependent on external finance than goods exporters. We extend our previous MiMiK-Ustan match with another data set which is provided by Deutsche Bundesbank, the International Trade in Services Statistics (SITS). This new data set identifies service exporters and quantifies the value of service exports. The findings reveal that goods exporters receive on average 16% larger credit exposures from financial institutions compared to non-exporters. In addition, service exporters are more dependent on external finance with a premium of about 17% relative to goods exporters.

This chapter proceeds as follows: Subsection 5.2 provides information on the extended data match and summary statistics. Subsection 5.3 covers the baseline regression results and several robustness checks, while Subsection 5.4 highlights the main insights.

5.2. Data and Summary Statistics

We merge our MiMiK-Ustan match from Chapter 3 with another data set, which is the German International Trade in Services (SITS) statistics and is also provided by Deutsche Bundesbank, to identify service exporters[42]. SITS covers all trade transactions (exports and imports) above a defined threshold (12,500 euro) and is part of the Balance of Payments (BoP) system in Germany. Section 26 of the Foreign Trade and Payments Act (*Außenwirtschaftsgesetz*) and Section 56a ff and 59ff of the Foreign Trade and Payments Regulation (*Außenwirtschaftsverordnung*) serve as legal basis for the mandatory reporting of firms. The General Agreement on Trade in Services (GATS) defines four different modes of trade in services: cross-border trade (mode 1), consumption abroad (mode 2), commercial presence (mode 3) and presence of natural persons (mode 4). All modes are included in SITS with only one exception: mode 3 is part of the Micro Database Direct Investments (MiDi). SITS was made available recently for research purposes. Biewen et al. (2013) provide an overview of the data set and some stylized facts (e.g., whether trade in services increased through the extensive or intensive margin over time). Unfortunately, the SITS data set only covers export (and import) values, product classification, destination country and firm identifier on a monthly frequency. It does not contain further firm characteristics which could explain the determinants of trade in services[43]. As for the MiMiK data set, the firm identifier in SITS and Ustan are not the same due to different (independent) data generating processes.
First, we match SITS with Ustan by using again a propensity score matching procedure, taking the firm's name and place of headquarters into account. Fortunately, the Ustan firm identifier for the MiMiK-Ustan and the SITS-Ustan match are identical. For this reason the implementation of a MiMiK-Ustan-SITS match is generally unproblematic, once the SITS-Ustan match is conducted. Altogether, we are able to identify 1,155 firms with detailed information about their relationships to banks and detailed services trade data. For the estimation of the export premium of service exporters, we only match the service export transaction data and neglect the import transactions as mentioned before.

[42]The data set also reports information about service imports. However, we do not use this here because we want to compare the findings with our previous results.

[43]The only exception, which was mentioned before in the literature review, is the interrelation between SITS and MiDi. Both employ the same identifiers for the firms such that matching these two data sets is unproblematic.

5.2.1. Definitions of Variables

The main focus in this section is the definition of service exporter. We observe detailed (quarterly)[44] information about exports in services due to the reporting threshold of 12,500 euro, which is mandatory in SITS, and (annual) total exports which is provided voluntarily by Ustan. Unfortunately, Ustan does not report detailed information about the nature of the export sales. For this reason we have to impose certain assumptions for the following empirical section: a firm with positive service exports from SITS is defined as service exporter, even if the reporting entry of export sales in Ustan equals zero. One potential problem with this definition is that manufacturing firms, which generate a huge part of their revenues from the export of goods (e.g., the seller of a PC may also provide custom services like an IT support), are also classified as service exporters. A possible solution is to calculate the (annual) share of service exports on overall export sales and impose different thresholds (25% percentile, median or 75% percentile) to examine whether the findings change significantly[45]. In contrast, a firm is classified as goods exporter if the firm reports positive export sales to Ustan but does not belong to SITS.

5.2.2. Descriptives

We admit that two problems could arise from the definition above: first, the firm exports services but does not report the transaction to Deutsche Bundesbank because the transaction value is below the threshold of 12,500 euro. Due to the findings of the recent literature (e.g., trade in services is concentrated among the largest enterprises), we do not think that this problem poses a large endogeneity issue. Second, the propensity score matching procedure does not match the firm based on firm name, location and legal form. Figure 5.2 presents the comparison between the SITS and the matched SITS-Ustan[46] data set. Both graphs show similar developments over time. Therefore, we argue that the SITS-Ustan match provides a reasonable representation for the overall development of trade in services in Germany. In the following, we use a combination of the SITS-Ustan data set with the MiMiK-Ustan match.

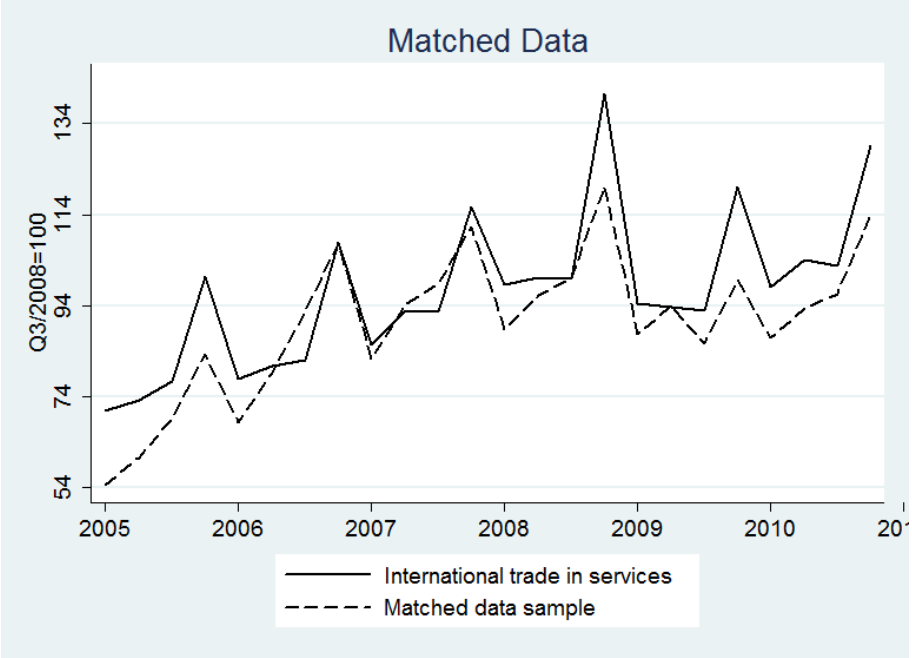
Table 5.1 illustrates the characteristics of this MiMiK-Ustan-SITS match in compar-

[44] SITS is reported on monthly basis but we aggregate the data on a quarterly frequency.

[45] We impose these different definitions and re-estimate the service exporter premium. Neither the level of significance nor the sign or the magnitude change much. For this reason, we use the least restrictive definition and do not impose any threshold for the share of service exports on overall foreign sales in the following regressions.

[46] The SITS-Ustan match reveals a matching quote of about 20%. Nevertheless, a large fraction of the overall transaction value is obtained through the match.

Figure 5.2: Transaction Data and Match



Notes: The graphs are based on quarterly data from the Bundesbank's SITS data set matched with the Bundesbank's corporate balance sheet statistics Ustan.

Table 5.1: Data Sets

	MiMiK	MiMiK-Ustan	MiMiK-Ustan-SITS
Loan-quarter pairs	933,612	799,104	105,212
Firms	14,854	14,545	1,155
of which: Exporters		5,839	1,155
Banks	2,275	2,170	1,309
Mean loan value (1,000 euro)	8,145	8,148	16,418
Median loan value (1,000 euro)	2,250	2,305	3,517
Sales (bn. euro)		8,190	2,960
of which: Exports (bn. euro)		2,162	1,157
of which: Service exports (bn. euro)			9,258

Notes: The table describes samples based on matched data sets. All data are obtained from Deutsche Bundesbank. MiMiK is the credit register. Ustan is the corporate balance sheet statistics. SITS is the transaction information on trade in services.

ison to our previous MiMiK-Ustan match from Chapter 3. The loan-quarter pairs drop to about 105,212 observations and we observe only 1,155 service exporters. About half of all observations (55,721) also reveal positive export sales from Ustan.

The mean and median credit exposure illustrate that there seems to be some selection bias towards large firms. For the empirical analysis in the next section, we append the unmatched firms from MiMiK-Ustan to the MiMiK-Ustan-SITS data set. Altogether, we again have a data set with 799,104 observations but with the additional information whether a firm is classified as service exporter and the value of service exports.

5.3. Empirical Results

5.3.1. Baseline Regressions

In this section, we aim to reveal whether service exporters depend more on external finance in comparison to goods exporters. We proceed in two steps and run the same regressions of the following general form as before:

$$ln(Loan_{ijkt}) = \alpha + \beta Goods_{ijt} + \sum \gamma X_{ijt} + \phi_j + \eta_t + \sigma_k + \nu_i + \epsilon_{ijkt} \qquad (5.1)$$

where $Loan_{ijkt}$ is a measure of the credit exposure of bank k to firm i in industry j at time t, $Goods_{ijt}$ is a dummy variable indicating whether the firm is a goods exporter[47] or not exporting at all, X_{ijt} covers the same set of firm characteristics as in Chapter 3, ϕ_j are industry-specific, η_t time-specific, σ_k bank-specific and ν_i firm-specific fixed effects and ϵ_{ijkt} is the residual. For the estimation of equation (5.1) we only consider goods exporters and non-exporters. In the second step, we are interested in the following relationship:

$$ln(Loan_{ijkt}) = \alpha + \beta Service_{ijt} + \sum \gamma X_{ijt} + \phi_j + \eta_t + \sigma_k + \nu_i + \epsilon_{ijkt} \qquad (5.2)$$

where $Service_{ijt}$ is a dummy variable indicating whether the firm is a service exporter (then the dummy takes value one) or a goods exporter and all other variables are defined as in equation (5.1). Therefore, equation (5.2) reflects the premium of service exporters in comparison to goods exporters. The estimation structure is identical to Chapter 3 which focused exclusively on the general difference between exporters and non-exporters. The strategy which we employ in this chapter has the advantage to compare the findings directly with previous results.
Table 5.2 provides the estimation results from equation (5.1). We include additional control variables in each specification as before. Column (1) presents the benchmark result if we only use the goods exporter dummy variable, industry-specific and (quarterly) time fixed effects. The β coefficient is positive and statistically

[47] The definition of 'goods exporter' can be obtained from the prior section.

highly significant hinting at a goods exporter premium of about 32% relative to non-exporters. About one half of this premium vanishes by including other firm characteristics, as column (2) indicates. The findings illustrate that larger firms (in terms of sales), older firms and firms with more equity receive more bank finance, while firms that belong to a corporate group or possess foreign asset holdings use different financial sources. The consideration of locational, legal and bank-fixed effects does not have any qualitative effect on the results. Column (3) shows a positive and highly significant goods exporter premium of about 16%. Even if we include firm-specific fixed effects, the level of significance and the sign do not change (but the magnitude drops to about 3%). Altogether, we find a positive and robust export premium for goods exporters. The results are qualitatively and quantitatively in line with our estimations from Chapter 3. Even the control variables possess equal signs and almost equal magnitudes.

Table 5.2: Exporter Premium for Goods Exporters vs. Non-Exporters

	(1)	(2)	(3)	(4)
Variables	ln(Loan)	ln(Loan)	ln(Loan)	ln(Loan)
Goods	0.325***	0.160***	0.164***	0.033***
	(0.008)	(0.008)	(0.008)	(0.010)
ln(Sales)		0.065***	0.076***	0.045***
		(0.001)	(0.001)	(0.004)
ln(Age)		0.144***	0.129***	-0.007
		(0.003)	(0.004)	(0.030)
Multi-plant		-0.534***	-0.444***	0.028***
		(0.007)	(0.007)	(0.010)
ln(Fdi)		-0.012***	-0.004*	-0.005*
		(0.002)	(0.002)	(0.003)
ln(Equity)		0.183***	0.172***	-0.016***
		(0.002)	(0.002)	(0.003)
Industry FE	Yes	Yes	Yes	Yes
Time FE	Yes	Yes	Yes	Yes
State FE	No	No	Yes	Yes
Legal FE	No	No	Yes	Yes
Bank FE	No	No	Yes	Yes
Firm FE	No	No	No	Yes
Observations	694,351	694,351	694,351	694,351
R^2	0.061	0.111	0.197	0.742

Notes: OLS estimation. Robust standard errors in parentheses. *** denotes significance at 1%, ** significance at 5% and * significance at 10%.

Table 5.3: Exporter Premium for Service Exporters vs. Goods Exporters

	(1)	(2)	(3)	(4)
Variables	ln(Loan)	ln(Loan)	ln(Loan)	ln(Loan)
Service	0.539***	0.168***	0.171***	0.002
	(0.012)	(0.013)	(0.012)	(0.022)
ln(Sales)		0.052***	0.061***	0.086***
		(0.002)	(0.002)	(0.018)
ln(Age)		0.243***	0.186***	0.060
		(0.005)	(0.006)	(0.065)
Multi-plant		-0.317***	-0.352***	0.052***
		(0.010)	(0.010)	(0.016)
ln(Fdi)		-0.025***	-0.017***	-0.008***
		(0.002)	(0.002)	(0.003)
ln(Equity)		0.135***	0.139***	-0.012**
		(0.002)	(0.003)	(0.005)
Industry FE	Yes	Yes	Yes	Yes
Time FE	Yes	Yes	Yes	Yes
State FE	No	No	Yes	Yes
Legal FE	No	No	Yes	Yes
Bank FE	No	No	Yes	Yes
Firm FE	No	No	No	Yes
Observations	321,073	321,073	321,073	321,073
R^2	0.030	0.060	0.178	0.695

Notes: OLS estimation. Robust standard errors in parentheses. *** denotes significance at 1%, ** significance at 5% and * significance at 10%.

Next, we discuss the estimation results from equation (5.2) which are reported in Table 5.3. Again, we find a positive and significant β coefficient in the first column which is also economically large (about 54%) and means that service exporters depend more on external finance than goods exporters. This effect persists if we control for other firm characteristics, but the magnitude becomes smaller. The control variables in column (2) show the same (expected) signs as before. The service export premium itself drops to about 17%. The inclusion of additional location-specific, legal-specific and bank-specific fixed effects in column (3) does not have an impact on the outcome. The service export premium remains robust at about 17%. In contrast, the most demanding specification, which considers firm-specific fixed effects, leads to an insignificant service export premium. This last finding is not surprising because we observe only few switches of service exporters becoming goods exporters and vice versa (only 7,408 of overall 321,073 observations

which corresponds to about 2%)[48]. Overall, the findings suggest a positive service exporter premium of about 17% compared to goods exporters.

5.3.2. Robustness Checks

We perform exactly the same sensitivity analyses as in Chapter 3. The columns tabulate the result of a different regression specification, corresponding exactly to those in Table 5.2 and Table 5.3.

We start with the discussion of the goods exporter premium relative to non-exporters. We vary the measure of export activity and use the log share of foreign sales in total sales. The regression results can be obtained from Table C.1 which confirm the findings of the baseline specification. An increase in the export share by 1% increases the credit exposure by more than 1%. This elasticity becomes weaker as soon as further control variables are included in the following two columns. Even the consideration of firm-specific fixed effects in column (4) does not change the sign and the level of significance.

Again, we also use employment as proxy for firm size. Table C.2 provides the estimation parameters. The choice of this other proxy has no qualitative and quantitative effect on our results. The signs and magnitudes are almost the same as for the benchmark case.

Table C.3 reports the regression results if we control directly for a productivity measure. We obtain the same signs and magnitudes for all four columns compared to our baseline regression. The previous outcome of a positive goods exporter premium (of about 16%) is confirmed.

Next, we split the sample into two sub-periods. Table C.4 presents the goods export premium before the collapse of Lehman Brothers in September 2008 (Q3/2008), while Table C.5 focuses on the crisis period. Again, the exporter premium becomes smaller after the crisis. Taking firm-specific fixed effects into account, the difference between goods exporters and non-exporters even vanishes, as the last column of Table C.5 reflects.

As before, we consider the threshold of 2 million euro to evaluate whether censoring matters for the findings. Table C.6 provides the results below this threshold, whereas Table C.7 illustrates the outcome for firms with a larger credit exposure. In comparison to previous findings, the evidence is mixed for goods exporters. All four columns provide positive and highly significant results for loans below 2 million euro. In contrast, the goods export premium becomes negative for the majority of

[48]The argument is that both types of exporters do not adjust their management strategy in the short-run, even if we use the least restrictive definition of being a service exporter.

columns above this threshold. Similarly, we divide the total credit exposure into direct credit debt and off balance sheet liabilities. Table C.8 reveals that goods exporters possess higher classical credit debt than non-exporters. This relationship is strong and robust among all four specifications. In addition, the estimates in Table C.9 indicate that a larger part of the overall goods exporter premium in bank lending stems from the firm's access to a wider range of financing instruments (e.g., derivatives and guarantees). The magnitudes of these coefficients are larger but become insignificant if we include firm-fixed effects.

Moreover, we use credit exposure relative to total debt (from the balance sheet data) and relative to total assets to further incorporate potential firm size effects. Table C.10 presents the outcome relative to total debt and hints at a positive goods exporter premium. The only exceptions are the first column with a negative significant result and column (4) with no significant difference. Table C.11 focuses on total assets and provides exactly the same findings as Table C.10.

In addition, we want to attenuate the potential of reverse causality and use lagged explanatory variables to address this potential endogeneity. The outcome from Table C.12 suggests that our benchmark estimates remain essentially unaffected with the exception of column (4) which reveals insignificant results.

Finally, we allow for time-variant industry and bank-fixed effects. Table C.13 offers the outcome for this regression. Again, the results remain unchanged and hint at a positive export premium. Altogether, we can conclude that most results of Chapter 3 are confirmed for goods exporters.

Now, we compare the robustness checks of service exporters relative to goods exporters in the following. Instead of the export share, we employ the service export share on overall reported exports[49]. The regression results from Table C.14 shows weak results compared to previous findings of a positive exporter premium. Only the first column reveals a positive and significant coefficient.

Table C.15 provides the estimation parameters if we use employment as proxy for firm size. The choice of this other proxy has no qualitative and quantitative effect on our results compared to the baseline coefficients. The signs and magnitudes remain on equal levels.

Adding productivity as further explanatory variable has also no effect on the outcome as Table C.16 illustrates.

In contrast, the financial crisis reveals an impact on the service export premium: we found a decreasing premium for goods exporters relative to non-exporters after

[49]The number of observations drops because we do not observe reported export sales in Ustan for all service exporters (only for about half of them).

the crisis. However, Tables C.17 and C.18 present an increasing service exporter premium in the aftermath of the bankruptcy of Lehman Brothers.
Furthermore, the split across the threshold of 2 million euro shows contrasting findings: while the service export premium below the threshold seems to be negative according to Table C.19, we observe a positive service export premium for loans above 2 million euro in Table C.20. Therefore, the findings reveal that the censoring threshold delivers mixed results.
Aside from this observation, the use of classical credit debt, which is shown in Table C.21, is less relevant for service exporters than for goods exporters. These differences are robust among all four specifications. Instead, Table C.22 illustrates that service exporters engage primarily in off balance sheet financing instruments. Again, these findings are strong and robust.
The consideration of credit exposure relative to total debt (from the balance sheet data) and relative to total assets to further incorporate potential firm size effects. Tables C.23 and C.24 show similar patterns. The majority of specifications hint at a negative and significant service export premium.
The outcome from Table C.25 provides the coefficients for the lagged explanatory variables. Again, the signs and magnitudes do not change compared to the baseline results. As a result, reverse causality does not pose a problem for the analysis.
Finally, we allow for time-variant industry and bank-fixed effects. Table C.26 offers the outcome for this regression. The results remain unchanged and hint at a positive service export premium. All in all, we conclude that service exporters are indeed more dependent on external finance in comparison to goods exporters. However, they mainly use alternative financing instruments in the form of derivatives and guarantees, while goods exporters rely more on classical debt financing.
In a non-reported robustness check, we also experiment with the inclusion of the number of products and the number of destination countries (e.g., firms which export to multiple countries need to cover additional fixed entry costs, as Lawless (2009) shows). Unfortunately, we only have this information for the service exporters and not for the goods exporters. For this reason, we impose the assumption of one product and one country for all goods exporters. The consideration of these two additional control variables does not change the baseline results.

5.4. Summary

Services have received more attention in the recent literature. The share of services in the overall value creation (GDP) and the employment force has risen in many industrialized countries during the last decades. One important aspect of this discussion is the role of services in the recent trade literature. According to standard textbooks, services are non-tradable products because they possess high transportation costs. Francois and Hoekman (2010) emphasize that technological progress (e.g., the spread of the Internet) led to a decrease in trade costs of services, which boosts foreign operations. For Germany, we also observe the growing importance of services in international transactions.

This chapter examines the role of external finance for service exporters in covering the fixed entry costs. We extend our previous MiMiK-Ustan match with another data set which is provided by Deutsche Bundesbank, the SITS. This data set identifies service exporters and quantifies the value of service exports.

The findings illustrate that goods exporters receive on average 16% larger credit exposures from financial institutions compared to non-exporters. In addition, service exporters are more dependent on external finance with a premium of about 17% relative to goods exporters. We observe that service exporters engage more in off balance sheet activities and less in traditional debt contracts.

The analysis reveals some limitations which have to be kept in mind: potential problems may arise from the matching procedure. Although the data match represents the evolution of service exports and of total exports quite well, we cannot rule out whether a possible selection bias is present or not. In addition, the robustness checks reveal that censoring could be a potential problem for the service export premium[50]. Finally, the same shortcomings as in Chapter 3 are present, e.g. the establishment of causality. Nevertheless, we think that the analysis provides important insights into the nature of service exporters, which serve as a good starting point for research in the future. According to our results, service exporters depend more on external finance, which reflects higher entry barriers in comparison to goods exporters, which contrasts with various recent contributions (see Ariu (2012) and Biewen et al. (2012)). Now, we shed light on the determinants of innovating behavior within start-ups. The literature on innovation and exports, which was mentioned in the motivation, hints at the observation that a start-up does not export immediately and has to be innovative in a first step. We discuss this issue in the last chapter because it covers a smaller part of the dissertation.

[50] In contrast, the results for censoring in Chapter 3 were more robust.

6. Education and Innovation: Is there a 'Nerd Effect'?[51]

6.1. Motivation

Policy makers are interested in fostering economic growth and employment. They argue that education (see Barro (1991)) is one important factor in achieving these goals. Indeed, a large macroeconomic growth literature shows that human capital is positively correlated with economic growth[52]. In contrast, it is less well known through which channels education supports economic growth. One potential channel is technological change in the form of innovative products or processes. Hasan and Tucci (2010) show that innovation is essential, especially for industrialized countries. In the recent literature, small ventures meet with growing interest because start-ups have a comparative advantage in fostering break-through innovations (see Acs and Audretsch (2005)) in contrast to large corporations, which mostly enforce incremental changes (see Baumol (2005)). These insights contradict earlier contributions to the literature (see Schumpeter (1942)) where large corporations are the only agents who can sustain R&D expenditures through market power. Therefore, it is important to understand how innovation can be fostered in an effective way.

This chapter investigates the transmission effect of education on innovating activities within start-ups. We want to understand whether entrepreneurs with technical education are indeed more innovative in high-tech industries compared to economists[53]. We focus on the high-tech industries because we know that not every start-up is innovative (see Reynolds (2005)) and because entrepreneurs are more likely to engage in innovating behavior in these industries compared to others. We label the potential advantage of individuals with technical education as the 'nerd effect' throughout this chapter. The investigation of this transmission channel is essential because it specifies the role of entrepreneurs within start-ups: does the education of the entrepreneur determine innovating behavior or do other factors matter (e.g., employing the required workforce)?

We examine a novel data set (KfW/ZEW Start-Up Panel) which contains a random cross-section of German start-up companies for 2007 and 2008. Two independent regressions are conducted for entrepreneurs[54], one for university degree and one for

[51] This chapter is mainly based on a revised version of Goldbach (2012).

[52] Krueger and Lindahl (2001) provide a literature overview on this topic.

[53] Economics ('Wirtschaftswissenschaften') is here defined as overall study category. It contains two disciplines: business administration ('BWL') and economics ('VWL'). The term 'economics' specifies the overall category in the following.

[54] The education classifications for technical university degree (three categories) and technical

apprenticeship as highest qualification. Having controlled for several entrepreneurial and firm characteristics, we find evidence for a 'nerd effect' for entrepreneurs possessing a university degree in natural science (higher probability of about 11-15% for conducting R&D and about 25-29% for conducting higher-scope innovations) but not for individuals with an apprenticeship. Our findings reveal that the transmission channel within start-ups is relatively complex, since the 'nerd effect' depends on the underlying definition of innovating behavior and on the organizational structure (single vs. team entrepreneurship).
The chapter proceeds as follows: Subsection 6.2 reviews the relevant literature. Subsection 6.3 describes the data set, definitions and provides summary statistics. Subsection 6.4 presents the regression results and several robustness checks. Subsection 6.5 summarizes the main results.

6.2. Literature

First, we highlight the interdependence of innovation and education in the economic literature. Krueger and Lindahl (2001) provide a literature review about the role of education on economic growth from different perspectives: the microeconomic literature concentrates on private returns and quantifies the 'return to education'. More years of schooling (which are interpreted as approximation of better education) result in higher productivity, which translates into higher earned wages. By contrast, the macroeconomic growth literature discusses the importance of social returns and what kind of positive externalities higher education implies. Especially, endogenous growth models highlight this argument. Romer (1990) shows that economies with a skill abundant labor force generate higher growth due to more ideas. Hence, technological change in the form of innovation is regarded as one possible externality. Rauch (1993) and Acemoglu and Angrist (2001) estimate this positive externality and quantify it between 3% to 6% of income growth. A more recent model by Aghion et al. (2009) extends this approach and distinguishes the transmission channel between technological innovation and imitation to investigate the education-growth relationship. The authors assume that innovation requires more highly educated individuals compared to imitation. Their empirical evidence suggests that innovation generates positive externalities[55]. However, not only the amount of education seems to matter but also the studied subject. To illustrate this aspect, Murphy et al. (1991) introduce two sectors in their theoretical growth model which contains

apprenticeship (one category) differ to some extent. For this reason we regress them separately.

[55]They regress patents per thousand persons on spending in education (US states) and find a positive correlation.

human capital: one sector stimulates rent-seeking, the other promotes economic growth. The authors define college students enrolled in engineering as persons who initiate technological progress, while those registered in law are characterized as rent seekers. According to their estimates, more engineers boost economic growth, while more lawyers decrease it. Based on this reasoning, individuals with an engineering degree foster technological change in comparison to others. All demonstrated arguments show that education is highly relevant for economic growth, while innovation itself can be understood as one important channel for achieving it.

Second, we review the recent literature that describes the determinants of innovation. Several papers analyze the role of education as an essential driver but there is no consensus about it. Baumol (2005) proposes anecdotal evidence that most breakthrough innovations were discovered by individuals without higher education (e.g., Thomas Edison and Bill Gates). However, he argues that the minimum requirement for future innovation increases over time because the complexity of products and processes rises as well. Empirical evidence based on data is provided by Keizer et al. (2002). They analyze Dutch small and middle sized enterprises (SMEs) and do not find an influence of higher education on innovation efforts in the metal-electro sector. In contrast, other contributions provide different empirical results. For instance, Koellinger (2008) finds a positive relationship between the amount of education and innovating behavior for 30 countries between 2002 and 2004. Furthermore, de Mel et al. (2009) concentrate on years of schooling and find that these play an important role in explaining innovation (besides ability, which is measured by IQ), using data from Sri Lanka for 2008. Other studies employ the type of education as main determinant for innovation: Toivanen and Väänänen (2011) investigate whether an engineering degree has a positive influence on the registration of patents. This is indeed valid for Finnish data between 1988 and 1996. Moreover, Romero and Martínez-Román (2012) report a positive relation between business education and product/process innovation for Andalusian SMEs in 2007.

Third, the analysis in this chapter relies on a data set containing only entrepreneurs. For this reason we discuss the relevant literature on the market entry decision of start-ups as entrepreneurs differ in comparison to employees[56]. The main determinants of the literature to explain market entrance are education and skills. For instance, Lazear (2005) provides one central contribution for skills by introducing the so-called Jack-of-all-trades hypothesis. According to this, entrepreneurs have to possess diversified skills compared to a specialist. It is not sufficient to propose

[56]Due to data limitations we can only investigate innovating behavior of start-ups (but not of established companies).

an idea for a new product or a new production line which operates more efficiently (process) but also to manage the main operations (e.g., marketing, hiring or accounting). MBA alumni data from Stanford Business School confirm this described hypothesis. However, Lazear (2005) is not able to discriminate between different fields of study[57]. His hypothesis is also tested for other countries. Two versions are provided by Wagner (2003) and Wagner (2006), who examine a German random sample for 1998 and 1999, which confirm the hypothesis. In contrast, Silva (2007) uses a panel of Italian households and argues that this supportive finding is due to the cross-sectional nature of the data sets used by the researchers. He concludes that the balanced skills do not matter once fixed effects are included, while general ability seems to be a more important determinant to explain market entrance. Åstebro and Thompson (2011) provide an alternative view on the balanced skills of entrepreneurs: using data on 830 Canadian inventors, their analysis reveals that entrepreneurs receive utility from a greater variety of skills. The results confirm those of Lazear (2005), although the skills themselves are not interpreted as investments. In addition, Hartog et al. (2010) establish that some abilities are more valuable for entrepreneurs compared to employees. Entrepreneurs exhibit higher mathematical, social and technical abilities[58].

Until now, the entrepreneurship literature which deals with education concentrates more on start-up performance than on innovating behavior itself. Again, the literature defines education in various ways. For instance, Parker and van Praag (2006) use years of schooling for Dutch start-ups in 1994. Their findings provide evidence for a direct (higher expertise) and an indirect effect (fewer capital constraints) of more education on performance. Alternatively, Davidsson and Honig (2003) differentiate human capital into explicit (formal education) and tacit knowledge (know-how). Using Swedish data, the authors find that the two types of education do not influence performance[59]. Another interpretation of education is a quality signal. Backes-Gellner and Werner (2007) explore whether eduction serves as such a signal for banks and employees for German start-ups in 1998 and 1999. The authors emphasize a potential disparity between high-tech and non-high-tech start-ups. The evaluation of high-tech start-ups with innovative technological ideas is much more uncertain because the comparison with other established companies is not possible. The results indeed suggest positive signal effects in the high-tech industry but

[57]The specialization is measured only within business courses: number of courses in finance, accounting, ...

[58]Independent from the entrepreneurial entrance decision, Caner and Okten (2010) investigate the career choice determinants of Turkish students in 2002. They conclude that male students with high ability have a higher probability of studying engineering.

[59]In contrast, the entry decision is affected by both variables.

not in the traditional industries. Finally, Dutta et al. (2011) distinguish education in specialized and diversified knowledge and analyze entrepreneurship alumni data between 1988 and 2008 from public universities in Northeast USA. Specialized knowledge is defined as entrepreneurship courses which are explicitly designed for nascent entrepreneurs. In contrast, diversified education describes the attendance of courses which are not necessarily related to entrepreneurship. Both types of knowledge have no impact on profits.

All in all, many studies hint at a positive relation between education and performance. However, performance and innovating behavior are not identical. Empirical studies illustrate a positive correlation between performance and innovation but its magnitude is much smaller than one[60]. As a consequence, being innovative does not always coincide with being successful in a monetary sense. This finding can be interpreted as patents with a zero business value. Moreover, Gilbert and Newbery (1982) argue that companies can register a patent without ever using it. This decision is strategically motivated because these firms want to prohibit competition and maintain their market power.

The reviewed literature supports our central argument in this chapter[61]: entrepreneurs with technical education are more innovative in high-tech industries compared to economists.

6.3. Data and Summary Statistics

We use a novel data set (KfW/ZEW Start-Up Panel) which is a random sample that contains data for German start-ups in 2007 and 2008. The start-ups are identified using a larger data set which is provided by Creditreform. In general, the KfW/ZEW Start-Up Panel is designed as a panel. However, only the cross-sections for 2007 and 2008 can be used due to data limitations[62]. We focus on the high-tech industries because innovating activity is more crucial to them in comparison to non high-tech industries. Fryges et al. (2010) describe further details regarding the data generating process. The KfW/ZEW Start-Up Panel defines an entrepreneur as someone who belongs to the group of persons who established the start-up. We begin with the definitions of the variables of interest.

[60] For instance, Gompers et al. (2005) show that the R&D elasticity of output is less than one.

[61] We emphasized that Romero and Martínez-Román (2012) report a positive correlation between business education and innovation. However, they provide no comparison with a technical reference category. We are able to distinguish between different fields of studies in a manner similar to that of Toivanen and Väänänen (2011).

[62] The complete data set contains information on start-ups between 2005 and 2008. Unfortunately, our central variable of interest (innovating behavior) was not measured in 2005 and 2006.

6.3.1. Definitions of Variables

The literature discusses different methods and strategies for measuring 'innovation'. Acs and Audretsch (2005) argue that innovation and technological change is a process which is not easily tractable. They mention attempts to measure innovation more accurately by using independent experts in the technological field who are able to evaluate the overall quality of innovations (or whether an innovation is indeed present). The most common approximations in the empirical literature are input and output variables. One agreeable feature of the KfW/ZEW Start-Up Panel is its original purpose of examining innovating behavior of entrepreneurs. For this reason the data set is well suited for this study. We approximate innovating activity across different dimensions. Nevertheless, the potential problems of measuring innovation, which are present in the economic literature, cannot be ruled out completely. The basic measures for innovation are two binary variables: the first indicates whether R&D was conducted (*r&d*) and the second provides information on whether something new has been released on the market since the foundation (*mrel*). In addition, we define four other proxies of innovating activity for the robustness checks. To compare our findings with prior empirical evidence, we employ R&D expenditures per worker (*expend*). This variable has the advantage of quantifying innovating activity in an objective way, as opposed to a potential bias resulting from more subjective self-reported measures. Another definition of innovating activity is the scope of the market release (*new*). It takes value one if there is no new market innovation, for value two the innovation is present at a regional level, for value three at a national level and for value four at a worldwide level. Finally, two dummy variables specify whether a product (*prod*) or a process (*proc*) innovation was achieved. These indicators concentrate on the output type of innovation[63]. The main explanatory variable in this chapter is education. It is divided along two dimensions: the amount is measured by the dummy variable *uni*, which takes value one if the entrepreneur has a degree from a university and zero if the person completed vocational training[64]. The second dimension describes the field of study. We generate dummy variables for each category: business or economics (*econ*), natural science (*nat*), mathematics or informatics (*mathinf*), engineering (*eng*) and other subjects (*other*). These categories are only available for entrepreneurs with a university degree[65]. Practi-

[63]Klepper (1996) argues that product innovation is more important for start-ups, while process innovation typically occurs at later stages of the product life cycle.

[64]If an individual has completed an apprenticeship and received a degree from a university, only the university degree is considered. The data set reports only the highest degree that was obtained.

[65]If an entrepreneur studied two subjects in different fields (e.g., economics and natural science) both dummy variables *econ* and *nat* have value one. A commercial computer scientist ('Wirtschaftsinformatiker') is categorized as information scientist, while an industrial engineer

cal education specifies its categories slightly in a different way. We examine the determinants of innovation for university degree and apprenticeship separately due to these differences. Apprenticeship obtains the following categories: commercial (*comm*), technical (*tech*), social (*social*), other services (*othserv*) and other professions (*other_job*). The complete educational background of all entrepreneurs (the foundation of a start-up can be established by multiple individuals) is available in the data. However, all other personal characteristics are only maintained from the person that was interviewed.

Romero and Martínez-Román (2012) stress in their empirical analysis that the entrepreneur's personal traits are important for innovation. To control for them, we include nationality (*german*) and sex (*male*) as dummy variables. Moreover, we consider experience, prior employment situation and foundation motivation. Experience is present as a categorical variable[66]: less than seven years (*exp7*), more than seven and less than 13 years (*exp7_13*), more than 13 and less than 20 years (*exp13_20*) and more than 20 years (*exp20*). The employment situation immediately before the establishment of the venture is approximated by dummy variables as well: an entrepreneur was either self-employed (*sit_e*), employed (*sit_em*), registered as unemployed (*sit_unem*) or not working (*sit_ne*). The main motivation why the start-up was established also seems to be an important determinant of innovation. Sauermann and Cohen (2010) emphasize the role of incentives in this context. Motives are important but they differ in their effects: intellectual challenge and independence show a strongly positive effect, while job security and responsibility seem to have a negative impact. Romero and Martínez-Román (2012) confirm this finding and emphasize the role of intrinsic motivation on innovation within start-ups. They provide evidence for a positive correlation between intrinsically motivated entrepreneurs and process innovation. We generate for the categorical variable motivation dummy variables in the following way: working independently (*ind*), realizing a business idea (*idea*), improper employment opportunities (*improper*), escape from unemployment (*escape*), encouragement by former employer (*encourage*) or tax incentives (*tax*).

Beside the described personal traits, several firm characteristics also determine innovating behavior. We consider whether the start-up was founded by a single entrepreneur or by a team (*team*). We keep start-ups with team entrepreneurs in the data set and compare the regression results with a subsample where team entrepreneurs are excluded in one robustness check. Differences between single and team entrepreneurs are present, which the empirical literature confirms (e.g., Müller

('Wirtschaftsingenieur') belongs to the group of economists.

[66] In the following, we generate dummy variables for all categorical variables.

(2009) shows differences for the success of academic spin-offs and Cantner and Stützer (2010) find disparities for the establishment of social capital). Romero and Martínez-Román (2012) show that firm size affects product and process innovation in a positive manner. We approximate firm size as the number of employees (*employment*). In addition, we measure the quality of the labor force[67]: the number of employees with no apprenticeship (*sh_l*) and the number of employees who completed an apprenticeship (*sh_m*) or received a university degree (*sh_h*). Schumpeter (1942) argues that competition structure may affect innovative activity because only large corporations are able to bear the costs of R&D. "... the evidence on the relationship between innovation and competition is also ambiguous" as Tang (2006, p. 69) points out. The competition intensity can take different forms: low competition (*comp_l*) when the start-up faces less than six other companies as direct competitors, medium competition (*comp_m*) when between six and twenty competitors are present and high competition (*comp_h*) is defined as more than twenty competitors. Furthermore, we include two dummy variables which contain information on whether the firm depends on external finance (*external*) or whether it received public support in the form of funding (*support*). Finally, we also use firm age (*fage*) as control variable.

Table 6.1: Industry Classifications

High-technology industries
Cutting-edge technology manufacturing
High-technology manufacturing
Technology-intensive services
Software
Non-high-tech industries
Non-high-tech manufacturing
Skill-intensive services (non-technical, consulting services)
Other business-oriented services
Consumer-oriented services
Construction
Wholesale and retail market

Notes: The table provides industry classifications from ZEW.

ZEW categorizes firms into high-tech and non-high-tech industries. We adopt their definition, which can be found in Table 6.1, for the following analysis. As we are interested in high-tech industries, we keep only start-ups which belong to this group.

[67]This number is only available for a part of the overall employment pool: full-time, part-time and mini jobber.

6.3.2. Descriptives

We start with the description of some stylized facts based on the sample. As mentioned above, we have two cross-sections for German start-ups which were founded in 2007 and 2008, with approximately 4,500 observations. Table 6.2 provides an overview of the six proxies for innovation[68]. The basic measures show that about 37% of all start-ups are temporarily or permanently engaged in R&D and 28% released a market innovation since the foundation. Both variables illustrate only a small part of the complete innovation process. The other proxies describe further aspects. The average start-up invests 6,084 euro per employee in R&D. The high standard deviation suggests a remarkable fraction of start-ups which invest no money at all. The average innovation is relatively small in scope, as the low value of *new* shows. 42% of start-up innovations result in product innovation compared to only 28% in process innovation.

Table 6.2: Summary Statistics of Proxies for Innovating Activity

Variable	Obs	Mean	Std. Dev.	1%	99%
r&d	4,585	0.377	0.485	0	1
mrel	3,123	0.281	0.450	0	1
expend	4,277	6,084.18	25,791.83	0	90,000
new	3,123	1.58	1.01	1	4
prod	3,308	0.421	0.493	0	1
proc	3,322	0.284	0.451	0	1

Notes: The table provides the number of observations, mean, standard deviation, the 1% and the 99% percentile of all innovation measures. The statistics are obtained from the ZEW/KfW Foundation Start-Up Panel.

Now, we present the distribution of personal traits in Table 6.3. First, we describe education in more detail. Approximately 53% of all entrepreneurs possess a university degree as highest education. 15% studied natural science, 18% mathematics or informatics, 57% engineering, 20% economics and 7% another subject. According to these statistics, almost three quarters of all start-ups are founded by individuals with a technical orientation. We compare these numbers with individuals who completed an apprenticeship: most have either a commercial (18%) or technical (68%) background. Some studied social science (15%), while other services (2%) and other jobs (3%) are almost not present in the high-tech industry. Figure D.1 illustrates the distribution of education among the four high-tech industries for

[68]Minimum and maximum values are not reported due to provision restrictions. However, these values are usually identical compared to the reported 1% and 99% percentiles.

start-ups with a university degree (see Appendix D). Natural scientists are mostly represented in the cutting-edge manufacturing industry. The majority of engineers enter the cutting-edge manufacturing, the high-technology manufacturing and the services industry. In contrast, most mathematicians/computer scientists operate in the software industry (as expected). The other fields of study and economists reveal an even distribution among all four industries. Moreover, we illustrate the type of apprenticeship among the industries in Figure D.2. Entrepreneurs with technical vocational training prefer the high-tech manufacturing, services and software industry. Surprisingly, the social scientists engage in the cutting-edge manufacturing sector. Other services and other jobs are evenly distributed (with low shares), while the majority of entrepreneurs with a commercial degree join the software industry.
Next, we shed light on the entrepreneurial characteristics. 95% of the entrepreneurs are German and 87% are male. Prior experience is almost equally distributed, as *exp7* to *exp20* demonstrate[69]. Most entrepreneurs (60%) were employed in a firm prior to the start-up, while 27% were self-employed. The most relevant motives for establishing the start-up are working independently (43%), followed by realizing a business idea (35%). All other categories seem to be of less relevance.
Finally, we report the firm characteristics in Table 6.4. 34% of the ventures were founded by teams. The average start-up employs three to four employees. The number of employees with vocational training is highest (1.75), followed by university degree (0.880) and no degree at all (0.469). 56% face intense competition in their environment. A low fraction of start-ups is financed with external capital (22%), while slightly more receive public support (34%). The firm age of the average start-up is above one year.

[69] All four categories possess a mean value of approximately 25%.

Table 6.3: Summary Statistics of Entrepreneurial Characteristics

Variable	Obs	Mean	Std. Dev.	1%	99%
A. Education					
uni	4,586	0.529	0.499	0	1
nat	2,405	0.149	0.356	0	1
mathinf	2,405	0.181	0.385	0	1
eng	2,405	0.567	0.496	0	1
econ	2,405	0.199	0.399	0	1
other	2,405	0.076	0.265	0	1
comm	2,323	0.183	0.387	0	1
tech	2,323	0.683	0.466	0	1
social	2,323	0.147	0.354	0	1
othserv	2,323	0.022	0.145	0	1
other_job	2,323	0.034	0.181	0	1
B. Other personal traits					
ger	4,575	0.951	0.216	0	1
male	4,586	0.869	0.337	0	1
exp7	2,182	0.222	0.416	0	1
exp7_13	2,182	0.276	0.447	0	1
exp13_20	2,182	0.291	0.455	0	1
exp20	2,182	0.210	0.407	0	1
sit_e	4,570	0.276	0.447	0	1
sit_em	4,570	0.600	0.490	0	1
sit_unem	4,570	0.127	0.333	0	1
sit_ne	4,570	0.107	0.309	0	1
ind	4,373	0.454	0.498	0	1
idea	4,373	0.367	0.482	0	1
improper	4,373	0.066	0.248	0	1
escape	4,373	0.081	0.273	0	1
encourage	4,373	0.022	0.147	0	1
tax	4,373	0.010	0.098	0	0

Notes: The table provides the number of observations, mean, standard deviation, the 1% and the 99% percentile of entrepreneurial characteristics. All data are obtained from the ZEW/KfW Foundation Start-Up Panel.

Table 6.4: Summary Statistics of Firm Characteristics

Variable	Obs	Mean	Std. Dev.	1%	99%
C. Firm characteristics					
team	4,584	0.344	0.475	0	1
employment	4,586	3.35	6.70	0	33
sh_l	3,455	0.469	1.69	0	7
sh_m	3,454	1.75	3.65	0	13
sh_h	3,455	0.880	2.54	0	14
comp_l	2,140	0.252	0.434	0	1
comp_m	2,140	0.185	0.388	0	1
comp_h	2,140	0.563	0.496	0	1
external	2,182	0.223	0.416	0	1
support	4,581	0.341	0.474	0	1
fage	4,586	1.23	0.964	0	3

Notes: The table provides the number of observations, mean, standard deviation, the 1% and the 99% percentile of firm characteristics. All data are obtained from the ZEW/KfW Foundation Start-Up Panel.

6.4. Empirical Results

6.4.1. Baseline Regressions

We derived the central hypothesis in the previous literature section: entrepreneurs with technical education are more innovative in high-tech industries than entrepreneurs with an economics degree. Accordingly, we use *r&d* and *mrel* as dependent variables in our baseline regressions. *r&d* can be interpreted as the input and *mrel* as the output variable of innovation. As highlighted before, the KfW/ZEW Start-Up Panel was originally designed to examine innovating behavior. We use the four other proxies that were described in the former section for robustness checks. Table 6.5 presents the correlation among the dependent variables. The variables are correlated to some extent but multicollinearity can be ruled out. The only exception is the high correlation between *mrel* and *new*. The reason for this observation is that the first variable is approximated by the second one. Moreover, the positive correlation among different definitions indicates that the different proxies capture various aspects from the complete innovation process.

To establish a relationship between innovation and education, we estimate the following equation:

$$Innovation_i = \alpha + \beta Education_i + \gamma \sum X_i + \epsilon_i \tag{6.1}$$

Table 6.5: Correlation Matrix

Variable	r&d	mrel	expend	new	prod	proc
r&d	1.00					
mrel	0.340	1.00				
expend	0.398	0.208	1.00			
new	0.383	0.921	0.259	1.00		
prod	0.224	0.273	0.069	0.271	1.00	
proc	0.191	0.131	0.124	0.127	0.322	1.00

Notes: The table provides the correlations between the different innovation measures. All data have been obtained from the ZEW/KfW Foundation Start-Up Panel.

where $Innovation_i$ is the proxy for innovation of start-up i, $Education_i$ covers the main explanatory variables (in this case the dummy variables for education), X_i represents the control variables (other entrepreneurial traits and firm characteristics) and ϵ_i is the error term. We estimate two independent probit regressions, one for university degree and one for apprenticeship as highest qualification[70]. Ideally, we would be able to reveal the relation between education and innovation experimentally[71], meaning that the entrepreneurs should be randomly endowed with different types of education. Since the implementation of such an experiment is obviously impossible, we have to approximate such a situation as best we can. All estimations include robust Huber-White standard errors. We start the examination of entrepreneurs who possess a university degree.

Table 6.6 presents the coefficients with *r&d* as dependent variable. The first column uses only the education dummies as explanatory variables, while *team* and industry dummies serve as controls. The reference group which is not included in this regression is entrepreneurs who possess a degree in economics. Accordingly, we can interpret the results in relative terms (compared to the outside option). We find a positive and highly significant coefficient for *team*, which means that foundations by teams are more likely (by about 8%) to conduct R&D. Moreover, natural scientists are more likely (with a probability of about 12%) to behave in an innovative manner than economists. The second column includes other personal traits as additional control variables. These are experience, the main motive for foundation, gender, nationality and the situation prior to the foundation of the start-up. Again, we need

[70]We regress the equations separately due to different education classifications among both education types as explained before.

[71]The data generating process itself is random. However, not all start-ups which are drawn from this process answer the questionnaire (between 20 and 25 percent).

to choose reference groups for all categorial variables and exclude experience less than 7 years (*exp7*), working independently (*ind*) and not working (*sit_ne*) from the regression. Now, *team* becomes insignificant compared to before. In contrast, the effect of natural science on innovation is still positive and significant. Furthermore, intrinsic motivation seems to matter because the realization of a business idea influences R&D positively (by about 20%). All other variables do not exhibit significant effects. The last column appends firm characteristics, such as firm age, whether the start-up received public support, whether it is financed with external funds, firm size, the quality of the employment pool and the competition structure. We exclude the share of employees with no apprenticeship (*sh_l*) and low pressure from competition (*comp_l*) and select them as reference categories. The findings suggest that natural science remains positive, albeit only weakly significant. The effect of the realization of a business idea does not change. In addition, competition suggests a strong determinant of innovating behavior: high intensity is negatively correlated with R&D. As a result, we indeed find a 'nerd effect' for natural scientists which persists even if we control for further entrepreneurial and firm characteristics.

Table 6.7 illustrates the findings if we employ market release (*mrel*) as proxy for innovation. We impose the same column structure as before to compare the results with R&D and include further control variables in each step. Again, the first column uses only education as explanatory variable (besides *team* and the industry dummies). Start-ups founded by teams (about 7%) and natural scientists (about 7%) are more likely to release output on the market. However, the results are weaker compared to before due to the lower level of statistical significance. The *team* effect becomes insignificant once we control for other entrepreneurial characteristics, while the significance of natural science remains on its level (and becomes economically larger to about 9%). In addition, the intrinsic motivation of realizing a business idea is an important determinant for output. Even if we add firm characteristics, the importance of this motivation holds. Again, an intense competition structure is negatively correlated with innovating activity. In contrast to our prior results, all education variables become insignificant in column (3), which means that there is no difference between technical background and economics. According to market release, we find only weak evidence for a 'nerd effect' for natural scientists.

Next, we re-estimate equation (6.1) for persons with apprenticeship as highest qualification. The results change, as Table 6.8 illustrates. Column (1) shows that team entrepreneurs conduct more R&D than single entrepreneurs which coincides with the previous findings. In contrast, we observe that individuals with technical (8%) and social (22%) vocational training are less likely to conduct R&D than subjects

Table 6.6: R&D and Education (University)

	(1)	(2)	(3)
Variables	r&d	r&d	r&d
team	0.079*** (0.020)	0.015 (0.034)	0.008 (0.034)
nat	0.122*** (0.033)	0.150** (0.049)	0.114* (0.050)
mathinf	0.058 (0.032)	0.080 (0.047)	0.078 (0.046)
eng	0.010 (0.027)	0.026 (0.040)	0.032 (0.039)
other	-0.023 (0.041)	-0.062 (0.060)	-0.060 (0.058)
exp7_13		-0.084 (0.043)	-0.075 (0.043)
exp13_20		-0.049 (0.043)	-0.057 (0.043)
exp20		-0.073 (0.047)	-0.062 (0.048)
idea		0.197*** (0.030)	0.150*** (0.031)
improper		-0.146* (0.068)	-0.144* (0.069)
escape		-0.107 (0.060)	-0.088 (0.060)
encourage		-0.084 (0.094)	-0.084 (0.100)
tax		-0.069 (0.128)	-0.029 (0.123)
ger		-0.047 (0.065)	-0.045 (0.066)
male		0.045 (0.040)	0.042 (0.040)
sit_e		0.044 (0.042)	0.046 (0.042)
sit_em		-0.013 (0.041)	-0.016 (0.042)
sit_unem		-0.060 (0.059)	-0.049 (0.060)
fage			-0.010 (0.019)
support			-0.014 (0.032)
external			0.056 (0.038)
employment			0.006 (0.005)
sh_m			-0.013 (0.007)
sh_h			0.011 (0.009)
comp_m			-0.102* (0.043)
comp_h			-0.160*** (0.034)
Industry FE	Yes	Yes	Yes
Observations	2,401	1,058	1,033
Log-likelihood	-1,542.17	-641.47	-609.65

Notes: Probit regressions. Marginal effects reported at the mean values. Robust standard errors in parentheses. *** denotes significance at 1%, ** significance at 5% and * significance at 10%.

with commercial background. If we control for entrepreneurial characteristics these effects become less significant but the signs do not change. Again, only the intrinsic motivation of realizing a business idea has a positive effect on innovation, which persists when firm characteristics are included in the regression. Almost all education variables become insignificant in the last column, the only exception being social apprenticeship, which is negative and weakly significant. We confirm the previous

Table 6.7: Market Release and Education (University)

	(1)	(2)	(3)
Variables	mrel	mrel	mrel
team	0.071** (0.023)	-0.023 (0.033)	-0.043 (0.032)
nat	0.074* (0.037)	0.089* (0.045)	0.076 (0.044)
mathinf	-0.008 (0.037)	-0.019 (0.044)	-0.020 (0.042)
eng	0.018 (0.031)	0.024 (0.037)	0.032 (0.035)
other	0.024 (0.046)	-0.017 (0.057)	-0.001 (0.056)
exp7_13		-0.077 (0.042)	-0.076 (0.041)
exp13_20		-0.036 (0.042)	-0.062 (0.041)
exp20		-0.047 (0.046)	-0.037 (0.044)
idea		0.224*** (0.029)	0.151*** (0.030)
improper		-0.018 (0.072)	-0.029 (0.071)
escape		-0.040 (0.063)	-0.068 (0.063)
encourage		0.061 (0.086)	0.032 (0.089)
tax		0.000 (0.000)	0.000 (0.000)
ger		0.070 (0.071)	0.048 (0.071)
male		-0.020 (0.039)	-0.021 (0.038)
sit_e		0.029 (0.040)	0.019 (0.039)
sit_em		0.053 (0.040)	0.045 (0.039)
sit_unem		-0.039 (0.059)	-0.029 (0.060)
fage			0.002 (0.018)
support			-0.047 (0.031)
external			0.077* (0.036)
employment			0.014* (0.005)
sh_m			-0.009 (0.007)
sh_h			-0.019* (0.008)
comp_m			-0.097* (0.037)
comp_h			-0.248*** (0.029)
Industry FE	Yes	Yes	Yes
Observations	1,617	1,032	1,008
Log-likelihood	-988.06	-596.70	-540.75

Notes: Probit regressions. Marginal effects reported at the mean values. Robust standard errors in parentheses. *** denotes significance at 1%, ** significance at 5% and * significance at 10%.

results for competition structure: entrepreneurs who face intense competition are less likely to conduct R&D. Moreover, we find that external funding has a positive effect on innovation. All in all, there is no evidence for a 'nerd effect'.

Finally, Table 6.9 presents the estimated coefficients for market release as proxy for innovation. The same picture emerges as before: team entrepreneurs are more innovative, but this effect vanishes with the inclusion of additional control variables.

Table 6.8: R&D and Education (Apprenticeship)

	(1)	(2)	(3)
Variables	r&d	r&d	r&d
team	0.132*** (0.018)	0.077* (0.034)	0.037 (0.035)
tech	-0.082*** (0.025)	-0.079* (0.036)	-0.061 (0.036)
social	-0.223*** (0.041)	-0.165** (0.059)	-0.151* (0.060)
other_serv	-0.026 (0.066)	0.030 (0.098)	0.064 (0.100)
other_job	-0.033 (0.051)	-0.048 (0.075)	-0.028 (0.076)
exp7_13		0.052 (0.040)	0.052 (0.040)
exp13_20		0.055 (0.040)	0.041 (0.041)
exp20		0.047 (0.046)	0.035 (0.046)
idea		0.126*** (0.031)	0.115*** (0.031)
improper		0.011 (0.054)	0.034 (0.055)
escape		0.014 (0.050)	0.029 (0.051)
encourage		-0.088 (0.077)	-0.100 (0.078)
tax		-0.031 (0.128)	-0.024 (0.126)
ger		-0.045 (0.062)	-0.064 (0.062)
male		-0.003 (0.041)	-0.007 (0.040)
sit_e		0.038 (0.043)	0.051 (0.044)
sit_em		-0.057 (0.040)	-0.052 (0.041)
sit_unem		-0.079 (0.049)	-0.079 (0.051)
fage			-0.006 (0.018)
support			-0.001 (0.029)
external			0.102** (0.032)
employment			0.005 (0.003)
sh_m			-0.005 (0.006)
sh_h			0.018 (0.012)
comp_m			-0.062 (0.041)
comp_h			-0.109*** (0.032)
Industry FE	Yes	Yes	Yes
Observations	2,323	1,079	1,042
Log-likelihood	-1,316.13	-619.44	-585.09

Notes: Probit regressions. Marginal effects reported at the mean values. Robust standard errors in parentheses. *** denotes significance at 1%, ** significance at 5% and * significance at 10%.

Social scientists are less likely to release a product on the market (about 14%) but only if we do not consider other entrepreneurial and firm characteristics. Persons with vocational training in other services are more innovative (about 16-19%) but this effect is only weakly significant. The findings for competition and intrinsic motivation persist (in signs and significance) for all specifications. Again, we do not find a 'nerd effect' for apprenticeship.

Table 6.9: Market Release and Education (Apprenticeship)

	(1)	(2)	(3)
Variables	mrel	mrel	mrel
team	0.081*** (0.022)	0.023 (0.033)	-0.008 (0.033)
tech	-0.031 (0.029)	-0.038 (0.034)	-0.010 (0.034)
social	-0.145** (0.047)	-0.107 (0.056)	-0.060 (0.055)
other_serv	0.099 (0.070)	0.165* (0.083)	0.194* (0.080)
other_job	0.081 (0.060)	0.044 (0.070)	0.077 (0.069)
exp7_13		0.060 (0.037)	0.052 (0.037)
exp13_20		0.052 (0.038)	0.032 (0.037)
exp20		0.075 (0.042)	0.045 (0.041)
idea		0.148*** (0.028)	0.107*** (0.028)
improper		-0.029 (0.051)	-0.038 (0.052)
escape		-0.054 (0.051)	-0.071 (0.050)
encourage		-0.096 (0.078)	-0.113 (0.077)
tax		-0.050 (0.128)	-0.074 (0.116)
ger		-0.089 (0.058)	-0.106 (0.056)
male		0.013 (0.038)	0.026 (0.036)
sit_e		0.034 (0.041)	0.033 (0.041)
sit_em		-0.023 (0.037)	-0.023 (0.037)
sit_unem		-0.034 (0.047)	-0.031 (0.048)
fage			-0.000 (0.016)
support			0.020 (0.027)
external			-0.003 (0.032)
employment			0.008* (0.003)
sh_m			-0.005 (0.005)
sh_h			-0.002 (0.008)
comp_m			-0.065 (0.035)
comp_h			-0.212*** (0.027)
Industry FE	Yes	Yes	Yes
Observations	1,585	1,075	1,038
Log-likelihood	-845.15	-562.65	-511.54

Notes: Probit regressions. Marginal effects reported at the mean values. Robust standard errors in parentheses. *** denotes significance at 1%, ** significance at 5% and * significance at 10%.

Until now, we have provided empirical evidence for the two baseline innovation proxies: conducting R&D (*r&d*) and market release (*mrel*). In the following robustness checks, we extend this analysis to other proxies and deal with potential selection bias[72].

[72]We also conducted OLS instead of probit regressions to compare the signs, magnitudes and significance levels of the estimated coefficients but do not report the results here. We find no differences between both estimation procedures. A possible explanation is that many explanatory

6.4.2. Robustness Checks

The previous regressions support our central hypothesis for entrepreneurs who possess a university degree. We find that natural scientists are more likely to engage in R&D and have a higher probability of releasing something new on the market. Now, we want to find out whether these results rely on the definition of innovation and whether selection bias poses an endogeneity problem. We start this section with the estimation of equation (6.1) but now employ the four other proxies for innovation that were described before. In the following, we concentrate on the estimated education coefficients and do not report the complete regression table. As before, we start with the description of entrepreneurs with a university degree.

Table D.1 applies R&D expenditures per employee as proxy (*expend*). These costs can be interpreted as the importance of R&D to the firm which is based on a metric scale. We use OLS regressions because the proxy is a continuous variable. Overall, the estimates suggests that that entrepreneurs with technical orientation are not more innovative than economists. The only exception is natural science in column (2) which reports a positive and weakly significant effect. Table D.2 presents the results for the regional scope of the innovation (*new*). This variable provides information on an ordinal scale with larger values indicating a higher scope (e.g., whether the innovation is worldwide or only regional). For this reason we use ordered probit estimation. According to the estimates, natural scientists are more likely to engage in innovations with higher impact (by about 25-29%) than economists. This finding holds even if we include entrepreneurial and firm characteristics. We do not find any difference for all other fields of study. The last two proxies *prod* and *proc* are again dummy variables. Therefore, we use a probit estimator, as with the baseline regression. The first column in Table D.3 hints at a negative correlation between mathematics/informatics as well as engineering and product innovation. However, this effect does not hold after the inclusion of other controls. The findings for process innovation in Table D.4 are even weaker. Among the three specifications there is no difference at all for any field of study. Altogether, the presence of a 'nerd effect' highly depends on the definition of innovation.

Next, we report the results for apprenticeship as highest degree. Table D.5 shows that almost all coefficients are negative for *expend*. The significance vanishes as more variables are included. The previous results for possessing a university degree in natural science pointed out that these entrepreneurs are more engaged in higher-scope innovating activity. This result changes for vocational training (see Table

variables are defined as dummy variables such that almost all fitted values lie in the range between zero and one.

D.6). Table D.7, which reports the outcome for product innovation, provides even weaker results because no differences occur at all. In addition, this holds true for process innovation in Table D.8. We conclude that there is no 'nerd effect' for entrepreneurs with apprenticeship as highest qualification, independent from the definition of innovation.

In the following, we discuss two further issues: first, we examine whether the influence of education on innovating activity of single entrepreneurs differs from team entrepreneurs in more detail. Until now, we controlled for this difference by including the dummy variable *team*. However, we pointed out in the data description that the entrepreneurial characteristics are obtained just from one entrepreneur of the whole team. Therefore, a potential systematic bias could emerge[73]. Second, the choice of study could be endogenous in the sense that persons with specific personal traits choose a certain subject. If we do not control for this fact, we have a correlation between education and the error term, which leads to inconsistent β estimates. To assess the first problem, we re-estimate equation (6.1) for both university and apprenticeship as highest education using only single entrepreneurs. Then, we compare these results with the estimates from the baseline regressions. We start again with university degree, concentrate on both baseline proxies (*r&d* and *mrel*) and report only the education coefficients in the following.

Table D.9 reveals the outcome for *r&d*. The only significant impact can be found in column (1), where natural science has a positive sign but is weakly significant. Comparing this finding with our previous results suggests that R&D is more likely to be conducted in start-ups with teams where natural scientists are part of this team[74]. Next, we present the findings for *mrel* in Table D.10. Here, a different pattern emerges: natural science has a positive coefficient and becomes more significant when additional control variables are included in the regression. Accordingly, the probability of market release is higher (by about 16-18%) for single entrepreneurs with natural science degree in comparison to team entrepreneurs. Previous results suggested no (or only a weak) difference between technical and economic education[75] for market release. Overall, the presence of a 'nerd effect' not only depends on the definition of innovation but also on the leadership structure (single vs. team entrepreneurship).

[73]Note that this potential bias is only valid for the entrepreneurial characteristics. The education variable itself and all firm characteristics are complete and therefore not subject to this kind of endogeneity.

[74]In non-reported regressions with only team entrepreneurs we indeed find that the coefficient of natural science is positive and significant.

[75]In non-reported regressions with only team entrepreneurs all regressions reveal insignificant coefficients.

Now, Tables D.11 and D.12 illustrate the findings for apprenticeship. In comparison to the whole sample, there is not much difference between single and team entrepreneurs for R&D activity, as Table D.11 indicates. Again, we find a negative and significant (except for the last column) coefficient for technical education[76]. Table D.12 reveals that there are no disparities among entrepreneurs with various backgrounds in market release because all variables are insignificant. Altogether, the leadership structure is not responsible for us not finding a 'nerd effect' for entrepreneurs with vocational training as highest degree.

In addition, we discuss the second problem that was mentioned above in more detail. In an optimal setting, we would have an experiment where the choice of study is randomly distributed among individuals. However, such a situation does not exist in reality. There are potential variables (e.g., ability) which affect the career choice which leads to endogeneity. The literature offers multiple methods on how to deal with such unobserved heterogeneity: one possibility is to estimate a fixed (or random) effects estimation model where the unobserved heterogeneity is assumed to be constant over time. We are not able to employ this strategy here because we do not have a panel. Moreover, most entrepreneurs in the high-tech industry have some years of experience in their field such that there is no time variation in the field of study[77]. This would only be possible if we observe individuals who form a start-up during their studies and receive their degree later on. But even then, it is not really clear how to quantify the effect of the degree on innovating activity because knowledge grows continuously over time. Consequently, a fixed effect estimation would drop the main variable of interest in our case.

Another suggested method is to use instrumental variable estimation. One or more instruments have to be found which are correlated with the choice of study but not with the error term ϵ_i in our baseline regression. To employ this strategy, it is important to have information on households prior to the career choice. Potential instruments could be the socioeconomic background of the family (e.g., whether the father or mother work in similar occupations or are entrepreneurs themselves, household income). Again, we are not able to use this approach because the data set does not provide this information.

[76] This is also true when only team entrepreneurs are considered in the regression.

[77] ZEW provides information about the age of entrepreneurs in their data set in Mannheim. We work with an aggregated version outside Mannheim which does not provide the age variable due to data restrictions. In general, the entrepreneurs in the data set are at least in their mid-thirties. The age variable was not significant for the regressions in Mannheim and all other results remained the same, which is why we worked with the adjusted data set.

We employ a different strategy to deal with selection bias: propensity score matching[78]. Now, the outcome variable is innovation, while the 'treatment' is defined as technical education. Again, we employ nearest neighbor matching and minimize the absolute difference between the probabilities of one start-up that is treated and another that is non-treated. We identify control and treatment groups as follows: we choose economics as control group for the university degree and the treatment group consists of either natural science, mathematics/informatics or engineering[79]. We exclude all observations with more than one degree.
Table D.13 presents the findings of the nearest neighbor matching for entrepreneurs with university degree. All results have to be interpreted relative to economics. The first column reveals that start-ups with natural scientists invest more in R&D expenditures per employee than economists. A different pattern emerges for entrepreneurs with mathematics/informatics degree: they are more likely to engage in R&D in general and to perform innovation on a larger scope. This could be related to their high presence in the software industry. Column (3) shows that no 'nerd effect' is present for engineers. The last column defines technical education as either natural science, mathematics/informatics or engineering and serves as further robustness check. We find (weak) evidence for a higher probability of market release and larger-scope innovations. Finally, Table D.14 displays the nearest neighbor matching for apprenticeship. For all proxies we do not find any difference between technical and commercial education.

6.5. Summary

Entrepreneurship is one potential channel through which economic growth and employment are achievable. This chapter focuses on the transmission effect of education on innovation within start-ups. The central question is whether entrepreneurs with technical education are more innovative in high-tech industries compared to economists. To analyze this question, we examine a novel data set (KfW/ZEW Start-Up Panel) which contains a random cross-section of German start-up companies for 2007 and 2008. Two independent regressions are conducted for entrepreneurs, one for university degree and one for apprenticeship as highest qualification. Having controlled for several entrepreneurial and firm characteristics, we can conclude that there is evidence for a 'nerd effect' for entrepreneurs with univer-

[78] We explained the intuition of propensity score matching before in Chapter 4.

[79] We compare one field of study with another one while the others are not considered (e.g., economics vs. natural science, economics vs. mathematics/informatics and economics vs. engineering). In another specification we define natural science, mathematics/informatics and engineering as technical education.

sity degree. The baseline regression reveals that natural scientists are more likely to engage in R&D than economists. This effect is only present for start-ups with team leadership. Therefore, the organizational form (single vs. team entrepreneurship) seems to be an additional driver of the results. In addition, the outcome suggest (weak) evidence for a higher probability of market release. We find strong results that this market release is fostered by single entrepreneurs with natural science degree. Moreover, natural scientists engage mostly in large-scope innovations in comparison to economists. If we consider all types of technical education for the nearest neighbor matching we can conclude that the findings for market release and the scope of innovation indeed hold. In contrast, we can reject our central hypothesis for entrepreneurs with apprenticeship. If significant differences between technical and commercial vocational training emerge, they are negative (hinting at the fact that entrepreneurs with commercial apprenticeship are more innovative). This finding does not depend on the choice of the innovation proxy, the leadership structure (single vs. team) or the empirical approach. The outcome suggests that the skills which are obtained from university and vocational training are indeed different and only individuals with technical education from university foster innovating activity. Our results reveal that policy makers should foster technical studies at university. Potential future research should compare whether the innovating activity of persons with technical education is more likely within start-ups compared to middle-size and large companies. Moreover, additional information on the workforce is needed to investigate whether the education of the entrepreneur himself matters or whether innovating activity is mainly fostered by the composition of workforce (or a combination of both).

7. Conclusion

The goal of this dissertation was to deal with two topics which are important issues for Germany: the export economy and innovation. Although the literature discusses whether innovating activities influence exports, the focus here is to investigate certain questions within both fields. In the following, we summarize (and emphasize) the central contribution of each chapter to the literature and provide suggestions for potential future research.

The first (and larger) part of this dissertations examined the relationship between finance and international trade. All of the three chapters rely on a matched data set (MiMiK-Ustan) which contains bank-firm relationships and was provided by Deutsche Bundesbank. The main motivation to deal with this topic was the massive decline in international trade in 2008/09 (known as the 'Great Trade Collapse'), which emerged in the aftermath of the bankruptcy of Lehman Brothers. In a first step, Chapter 3 estimated the exporter premium in bank lending and described potential differences between exporters and non-exporters (independent from the financial crisis). We examined the credit relationships in Germany, covering all loans of more than 1.5 million euro over the period from 2005 to 2010. The exporting firms take on average about 15% larger loans than non-exporters, holding constant for a wide range of other firm and bank characteristics. The results are in line with previous studies which also document positive export premia in bank lending. Nevertheless, the chosen data set in this chapter has the advantage of tackling the problem of unobserved heterogeneity more effectively. The recent empirical literature employs only annual balance sheet data from firms. Besides this information, we have also access to bank-firm relationship data and can control for influences related to overall lending policies of financial institutions. Despite their overall consistency, our estimation results are still subject to limitations. For instance, a potential issue might be omitted variables bias. Trade finance could be obtained from financial markets abroad. Unfortunately, we are not able to identify these bank-firm relationships. Another obvious issue which is open for future research is to establish causality.

In a next step, Chapter 4 primarily focused on the empirical importance of external finance for exporters during (an after) the financial crisis and whether the access to bank finance had an impact on trade flows. The previous MiMiK-Ustan match was extended with balance sheet data from BAKIS to identify banks which are especially 'affected' by the financial crisis. The findings suggest that there is no correlation between exports and credit provision. In addition, we show that 'affected' financial institutions indeed lowered their credit exposures after the financial crisis. Finally,

the propensity score matching leads to the insight that German exporting firms which have a relationship with an 'affected' bank do not export significantly less than comparable firms which obtain finance from a healthy financial institution. Even if we investigate the results for each industry separately (instead of pooling all results together) the same picture emerges. The results are in line with earlier empirical contributions for European countries (e.g., Belgium and France) or Peru but not for Japan. We contribute to the literature by having more information about the bank-firm relationship in comparison to Amiti and Weinstein (2011), which is the most similar paper to this chapter. They use firm and bank balance sheet positions as main variables. In addition, they use information about linkages between banks and firms for Japan and assume that the largest bank operates the trade finance transactions. Our study is able to identify all bank-firm relationships with their credit exposure. However, our findings have to be interpreted with some caution. We do not know how the firms actually use the credit they receive from banks. Therefore, we have to assume that some part of the credit exposure actually finances foreign operations. In addition, the credit exposure can change for various reasons: there is no information about the interest rate that is paid for different credits, the number of granted loans from one bank and about the duration of credit lines. Future research could address one of these problems (the use of credits for exports) by matching detailed information about guarantees which firms receive from the German federal state (e.g., EulerHermes provides data about state guarantees for exporting firms, as shown in Felbermayr and Yalcin (2011)).

Chapter 5 extended the previous analysis by estimating the exporter premium in bank lending for service exporters. Until now, not many insights exist about the nature of trade in services. This chapter tries to understand whether service exporters face larger entry barriers in comparison to goods exporters. The MiMiK-Ustan match, which covers all bank-firm relationships with a credit exposure of more than 1.5 million euro and corporate balance sheet data over the period from 2005 to 2010, is enlarged with detailed services export data. Therefore, we are able to identify firms which primarily export services or goods and can evaluate our previous results on a more disaggregated manner. The findings reveal that goods exporters receive on average 16% larger credit exposures from financial institutions compared to non-exporters. In addition, service exporters are more dependent on external finance, with a premium of about 17% relative to goods exporters. We observe that service exporters engage more in off balance sheet instruments and less in traditional debt contracts. Future research could address the role of finance for service exports during the financial crisis in more detail.

Finally, in the last section we examined the determinants of innovation within start-ups. The literature on innovation and exports emphasizes that a start-up does not engage in foreign operations at the beginning of its life cycle and has to be innovative at the early stage. We started with the discussion of the impact of finance on trade because it fills a larger part of this dissertation. Chapter 6 dealt with the question whether entrepreneurs with technical education are more innovative than economists in high-tech industries. Entrepreneurship is one potential transmission channel through which economic growth and employment are achievable. To analyze this question, we examined a novel data set (KfW/ZEW Start-Up Panel) which contains a random cross-section of German start-up companies for 2007 and 2008. Two independent regressions were conducted for entrepreneurs, one for university degree and one for apprenticeship as highest qualification. The baseline regression revealed that natural scientists are more likely to engage in R&D than economists. In addition, the findings suggest (weak) evidence for a higher probability of market release and more engagement in large-scope innovations. Until now, the empirical literature, which examines the determinants of innovation and employs education as main determinant, does not deal with detailed information about the subject under study, as we highlighted in our literature review. Instead of aggregating different types of education into one dummy variable, we make use of five categories. However, our findings have to be interpreted as possible correlation between education and innovating behavior, which can be viewed as starting point for further research. In particular, issues related to causality might bring more insights into this field. Additional background information on the entrepreneurs prior to the subject of studies could be used as instrumental variables. Furthermore, it would be valuable to know what kind of education the workforce of start-up possesses (instead of only the highest qualification).

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A. Appendix of Chapter 3

Table A.1: Export Share

	(1)	(2)	(3)	(4)
Variables	ln(Loan)	ln(Loan)	ln(Loan)	ln(Loan)
ln(Export Share)	1.138***	0.429***	0.401***	0.106***
	(0.020)	(0.020)	(0.020)	(0.030)
ln(Sales)		0.060***	0.070***	0.046***
		(0.001)	(0.001)	(0.004)
ln(Age)		0.162***	0.141***	0.004
		(0.003)	(0.003)	(0.029)
Multi-plant		-0.481***	-0.416***	0.023**
		(0.006)	(0.006)	(0.010)
ln(Fdi)		-0.018***	-0.009***	-0.011***
		(0.002)	(0.002)	(0.002)
ln(Equity)		0.182***	0.172***	-0.015***
		(0.001)	(0.002)	(0.003)
Industry FE	Yes	Yes	Yes	Yes
Time FE	Yes	Yes	Yes	Yes
State FE	No	No	Yes	Yes
Legal FE	No	No	Yes	Yes
Bank FE	No	No	Yes	Yes
Firm FE	No	No	No	Yes
Observations	799,104	799,104	799,104	799,104
R^2	0.053	0.103	0.194	0.730

Notes: OLS estimation. Robust standard errors in parentheses. *** denotes significance at 1%, ** significance at 5% and * significance at 10%.

Table A.2: Employment as Firm Size

	(1)	(2)	(3)	(4)
Variables	ln(Loan)	ln(Loan)	ln(Loan)	ln(Loan)
Exporter	0.369***	0.190***	0.186***	0.016*
	(0.008)	(0.008)	(0.008)	(0.010)
ln(Employment)		0.106***	0.116***	0.058***
		(0.002)	(0.002)	(0.004)
ln(Age)		0.140***	0.141***	0.016
		(0.003)	(0.003)	(0.029)
Multi-plant		-0.460***	-0.389***	0.024**
		(0.006)	(0.006)	(0.010)
ln(Fdi)		-0.016***	-0.006***	-0.012***
		(0.002)	(0.002)	(0.002)
ln(Equity)		0.158***	0.155***	-0.015***
		(0.002)	(0.002)	(0.003)
Industry FE	Yes	Yes	Yes	Yes
Time FE	Yes	Yes	Yes	Yes
State FE	No	No	Yes	Yes
Legal FE	No	No	Yes	Yes
Bank FE	No	No	Yes	Yes
Firm FE	No	No	No	Yes
Observations	799,104	799,104	799,104	799,104
R^2	0.052	0.103	0.194	0.730

Notes: OLS estimation. Robust standard errors in parentheses. *** denotes significance at 1%, ** significance at 5% and * significance at 10%.

Table A.3: Adding Productivity

	(1)	(2)	(3)	(4)
Variables	ln(Loan)	ln(Loan)	ln(Loan)	ln(Loan)
Exporter	0.365***	0.165***	0.159***	0.016*
	(0.008)	(0.008)	(0.008)	(0.010)
ln(Productivity)	0.067***	0.034***	0.043***	-0.021***
	(0.003)	(0.003)	(0.003)	(0.003)
ln(Sales)		0.067***	0.078***	0.053***
		(0.002)	(0.001)	(0.004)
ln(Age)		0.178***	0.160***	0.026
		(0.003)	(0.003)	(0.030)
Multi-plant		-0.495***	-0.427***	0.015
		(0.006)	(0.006)	(0.010)
ln(Fdi)		-0.023***	-0.013***	-0.009***
		(0.002)	(0.002)	(0.002)
ln(Equity)		0.180***	0.168***	-0.009***
		(0.001)	(0.002)	(0.003)
Industry FE	Yes	Yes	Yes	Yes
Time FE	Yes	Yes	Yes	Yes
State FE	No	No	Yes	Yes
Legal FE	No	No	Yes	Yes
Bank FE	No	No	Yes	Yes
Firm FE	No	No	No	Yes
Observations	763,272	763,272	763,272	763,272
R^2	0.056	0.108	0.200	0.737

Notes: OLS estimation. Robust standard errors in parentheses. *** denotes significance at 1%, ** significance at 5% and * significance at 10%.

Table A.4: Before Q3/2008

	(1)	(2)	(3)	(4)
Variables	ln(Loan)	ln(Loan)	ln(Loan)	ln(Loan)
Exporter	0.358***	0.183***	0.184***	0.012
	(0.010)	(0.010)	(0.010)	(0.014)
ln(Sales)		0.061***	0.071***	0.039***
		(0.002)	(0.002)	(0.006)
ln(Age)		0.145***	0.127***	0.238***
		(0.004)	(0.005)	(0.049)
Multi-plant		-0.484***	-0.414***	0.060***
		(0.008)	(0.009)	(0.015)
ln(Fdi)		-0.019***	-0.012***	-0.014***
		(0.003)	(0.003)	(0.004)
ln(Equity)		0.175***	0.168***	-0.009***
		(0.002)	(0.002)	(0.004)
Industry FE	Yes	Yes	Yes	Yes
Time FE	Yes	Yes	Yes	Yes
State FE	No	No	Yes	Yes
Legal FE	No	No	Yes	Yes
Bank FE	No	No	Yes	Yes
Firm FE	No	No	No	Yes
Observations	442,660	442,660	442,660	442,660
R^2	0.052	0.096	0.190	0.757

Notes: OLS estimation. Robust standard errors in parentheses. *** denotes significance at 1%, ** significance at 5% and * significance at 10%.

Table A.5: After Q2/2008

	(1)	(2)	(3)	(4)
Variables	ln(Loan)	ln(Loan)	ln(Loan)	ln(Loan)
Exporter	0.383***	0.146***	0.123***	0.005
	(0.012)	(0.011)	(0.011)	(0.015)
ln(Sales)		0.059***	0.069***	0.035***
		(0.002)	(0.002)	(0.007)
ln(Age)		0.188***	0.163***	-0.009
		(0.005)	(0.005)	(0.065)
Multi-plant		-0.467***	-0.406***	0.045***
		(0.010)	(0.010)	(0.017)
ln(Fdi)		-0.016***	-0.006**	-0.006*
		(0.003)	(0.003)	(0.004)
ln(Equity)		0.191***	0.181***	-0.010**
		(0.002)	(0.002)	(0.004)
Industry FE	Yes	Yes	Yes	Yes
Time FE	Yes	Yes	Yes	Yes
State FE	No	No	Yes	Yes
Legal FE	No	No	Yes	Yes
Bank FE	No	No	Yes	Yes
Firm FE	No	No	No	Yes
Observations	356,444	356,444	356,444	356,444
R^2	0.055	0.112	0.215	0.820

Notes: OLS estimation. Robust standard errors in parentheses. *** denotes significance at 1%, ** significance at 5% and * significance at 10%.

Table A.6: Loans $\leq$ 2 million euro

	(1)	(2)	(3)	(4)
Variables	ln(Loan)	ln(Loan)	ln(Loan)	ln(Loan)
Exporter	0.175***	0.218***	0.253***	0.039**
	(0.011)	(0.011)	(0.010)	(0.015)
ln(Sales)		0.001	0.013***	0.039***
		(0.002)	(0.002)	(0.007)
ln(Age)		0.167***	0.155***	0.251***
		(0.005)	(0.005)	(0.045)
Multi-plant		-0.815***	-0.669***	-0.016
		(0.009)	(0.009)	(0.016)
ln(Fdi)		-0.054***	-0.030**	-0.003
		(0.003)	(0.003)	(0.004)
ln(Equity)		-0.005**	0.003	-0.006
		(0.002)	(0.002)	(0.005)
Industry FE	Yes	Yes	Yes	Yes
Time FE	Yes	Yes	Yes	Yes
State FE	No	No	Yes	Yes
Legal FE	No	No	Yes	Yes
Bank FE	No	No	Yes	Yes
Firm FE	No	No	No	Yes
Observations	364,725	364,725	364,725	364,725
R^2	0.022	0.047	0.215	0.739

Notes: OLS estimation. Robust standard errors in parentheses. *** denotes significance at 1%, ** significance at 5% and * significance at 10%.

Table A.7: Loans > 2 million euro

	(1)	(2)	(3)	(4)
Variables	ln(Loan)	ln(Loan)	ln(Loan)	ln(Loan)
Exporter	0.098***	-0.036***	-0.064***	0.009**
	(0.004)	(0.004)	(0.003)	(0.004)
ln(Sales)		0.024***	0.028***	0.018***
		(0.001)	(0.001)	(0.001)
ln(Age)		0.007***	0.009***	-0.063***
		(0.002)	(0.002)	(0.012)
Multi-plant		0.192***	0.119***	0.003
		(0.003)	(0.003)	(0.004)
ln(Fdi)		0.016***	0.007***	-0.001
		(0.001)	(0.001)	(0.001)
ln(Equity)		0.107***	0.106***	0.001
		(0.001)	(0.001)	(0.001)
Industry FE	Yes	Yes	Yes	Yes
Time FE	Yes	Yes	Yes	Yes
State FE	No	No	Yes	Yes
Legal FE	No	No	Yes	Yes
Bank FE	No	No	Yes	Yes
Firm FE	No	No	No	Yes
Observations	434,379	434,379	434,379	434,379
R^2	0.075	0.175	0.309	0.882

Notes: OLS estimation. Robust standard errors in parentheses. *** denotes significance at 1%, ** significance at 5% and * significance at 10%.

Table A.8: On Balance Sheet

	(1)	(2)	(3)	(4)
Variables	ln(On Balance)	ln(On Balance)	ln(On Balance)	ln(On Balance)
Exporter	0.078***	-0.001	0.035***	0.047***
	(0.010)	(0.010)	(0.010)	(0.012)
ln(Sales)		0.048***	0.055***	0.034***
		(0.002)	(0.002)	(0.005)
ln(Age)		0.142***	0.145***	0.106***
		(0.004)	(0.004)	(0.033)
Multi-plant		-0.712***	-0.533***	0.020*
		(0.008)	(0.008)	(0.012)
ln(Fdi)		-0.078***	-0.055***	-0.016***
		(0.003)	(0.002)	(0.003)
ln(Equity)		0.106***	0.091***	-0.032***
		(0.002)	(0.002)	(0.003)
Industry FE	Yes	Yes	Yes	Yes
Time FE	Yes	Yes	Yes	Yes
State FE	No	No	Yes	Yes
Legal FE	No	No	Yes	Yes
Bank FE	No	No	Yes	Yes
Firm FE	No	No	No	Yes
Observations	799,104	799,104	799,104	799,104
R^2	0.104	0.120	0.251	0.783

Notes: OLS estimation. Robust standard errors in parentheses. *** denotes significance at 1%, ** significance at 5% and * significance at 10%.

Table A.9: Off Balance Sheet

	(1)	(2)	(3)	(4)
Variables	ln(Off Balance)	ln(Off Balance)	ln(Off Balance)	ln(Off Balance)
Exporter	0.536***	0.418***	0.332***	0.004
	(0.009)	(0.009)	(0.009)	(0.009)
ln(Sales)		0.017***	0.030***	0.026***
		(0.001)	(0.001)	(0.004)
ln(Age)		0.149***	0.111***	0.078***
		(0.004)	(0.004)	(0.027)
Multi-plant		0.016**	-0.117***	0.006
		(0.008)	(0.007)	(0.009)
ln(Fdi)		0.054***	0.038***	-0.009***
		(0.002)	(0.002)	(0.002)
ln(Equity)		0.062***	0.095***	0.008***
		(0.002)	(0.002)	(0.003)
Industry FE	Yes	Yes	Yes	Yes
Time FE	Yes	Yes	Yes	Yes
State FE	No	No	Yes	Yes
Legal FE	No	No	Yes	Yes
Bank FE	No	No	Yes	Yes
Firm FE	No	No	No	Yes
Observations	799,104	799,104	799,104	799,104
R^2	0.127	0.134	0.300	0.843

Notes: OLS estimation. Robust standard errors in parentheses. *** denotes significance at 1%, ** significance at 5% and * significance at 10%.

Table A.10: Loan/Total Debt

	(1)	(2)	(3)	(4)
Variables	ln(Loan/Debt)	ln(Loan/Debt)	ln(Loan/Debt)	ln(Loan/Debt)
Exporter	-0.020***	0.033***	0.005***	-0.001
	(0.001)	(0.001)	(0.001)	(0.001)
ln(Sales)		-0.006***	-0.005***	-0.001***
		(0.001)	(0.001)	(0.000)
ln(Age)		-0.006***	-0.003***	-0.011***
		(0.001)	(0.001)	(0.001)
Multi-plant		-0.055***	-0.044***	-0.001
		(0.001)	(0.001)	(0.001)
ln(Fdi)		-0.002***	-0.002***	-0.000
		(0.000)	(0.000)	(0.001)
ln(Equity)		-0.012***	-0.010***	0.001***
		(0.001)	(0.001)	(0.000)
Industry FE	Yes	Yes	Yes	Yes
Time FE	Yes	Yes	Yes	Yes
State FE	No	No	Yes	Yes
Legal FE	No	No	Yes	Yes
Bank FE	No	No	Yes	Yes
Firm FE	No	No	No	Yes
Observations	799,104	799,104	799,104	799,104
R^2	0.094	0.250	0.337	0.877

Notes: OLS estimation. Robust standard errors in parentheses. *** denotes significance at 1%, ** significance at 5% and * significance at 10%.

Table A.11: Loan/Total Assets

	(1)	(2)	(3)	(4)
Variables	ln(Loan/Assets)	ln(Loan/Assets)	ln(Loan/Assets)	ln(Loan/Assets)
Exporter	-0.017***	0.002***	0.004***	0.000
	(0.001)	(0.000)	(0.001)	(0.001)
ln(Sales)		-0.004***	-0.003***	-0.001
		(0.001)	(0.000)	(0.001)
ln(Age)		-0.002***	-0.002***	-0.011***
		(0.000)	(0.000)	(0.001)
Multi-plant		-0.038***	-0.033***	-0.001
		(0.001)	(0.001)	(0.001)
ln(Fdi)		-0.002***	-0.001***	-0.000
		(0.000)	(0.000)	(0.001)
ln(Equity)		-0.013***	-0.012***	-0.003***
		(0.001)	(0.001)	(0.001)
Industry FE	Yes	Yes	Yes	Yes
Time FE	Yes	Yes	Yes	Yes
State FE	No	No	Yes	Yes
Legal FE	No	No	Yes	Yes
Bank FE	No	No	Yes	Yes
Firm FE	No	No	No	Yes
Observations	799,104	799,104	799,104	799,104
R^2	0.107	0.290	0.373	0.890

Notes: OLS estimation. Robust standard errors in parentheses. *** denotes significance at 1%, ** significance at 5% and * significance at 10%.

Table A.12: Lagged Explanatory Variables

	(1)	(2)	(3)	(4)
Variables	ln(Loan)	ln(Loan)	ln(Loan)	ln(Loan)
Exporter	0.361***	0.162***	0.144***	0.007
	(0.008)	(0.008)	(0.008)	(0.011)
ln(Sales)		0.051***	0.061***	0.033***
		(0.001)	(0.001)	(0.004)
ln(Age)		0.142***	0.117***	-0.144***
		(0.003)	(0.004)	(0.024)
Multi-plant		-0.499***	-0.440***	0.005
		(0.007)	(0.007)	(0.011)
ln(Fdi)		-0.017***	-0.009***	-0.002
		(0.002)	(0.002)	(0.002)
ln(Equity)		0.193***	0.184***	0.009***
		(0.002)	(0.002)	(0.003)
Industry FE	Yes	Yes	Yes	Yes
Time FE	Yes	Yes	Yes	Yes
State FE	No	No	Yes	Yes
Legal FE	No	No	Yes	Yes
Bank FE	No	No	Yes	Yes
Firm FE	No	No	No	Yes
Observations	653,281	653,281	653,281	653,281
R^2	0.054	0.105	0.199	0.749

Notes: OLS estimation. Robust standard errors in parentheses. *** denotes significance at 1%, ** significance at 5% and * significance at 10%.

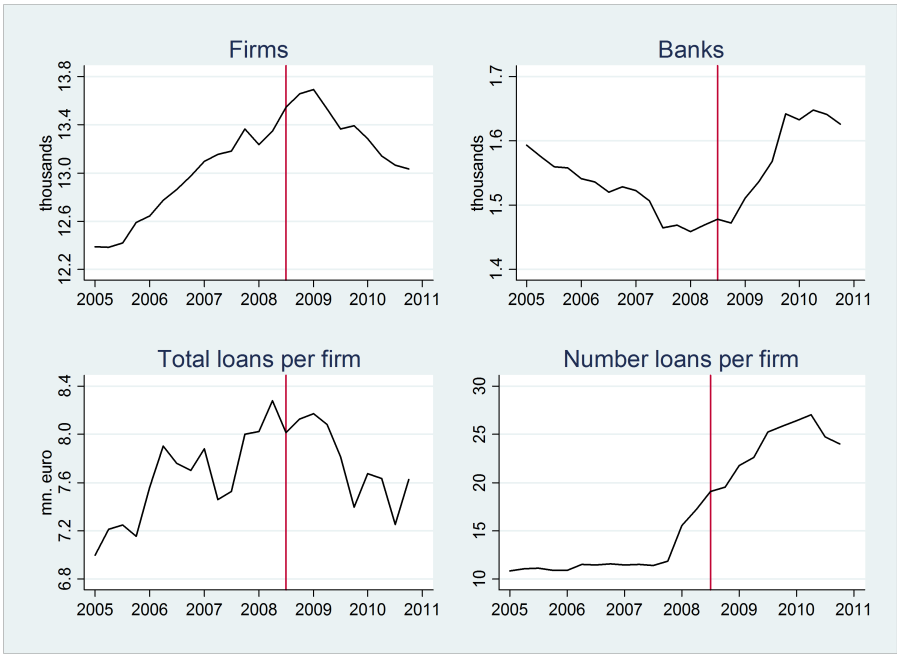
Table A.13: Industry-time and Bank-time FE

	(1)	(2)	(3)	(4)
Variables	ln(Loan)	ln(Loan)	ln(Loan)	ln(Loan)
Exporter	0.370***	0.167***	0.156***	0.028**
	(0.008)	(0.008)	(0.008)	(0.013)
ln(Sales)		0.060***	0.070***	0.041***
		(0.001)	(0.001)	(0.004)
ln(Age)		0.163***	0.142***	0.007
		(0.003)	(0.003)	(0.030)
Multi-plant		-0.497***	-0.411***	0.009
		(0.006)	(0.008)	(0.012)
ln(Fdi)		-0.019***	-0.010***	-0.011***
		(0.002)	(0.002)	(0.003)
ln(Equity)		0.184***	0.176***	-0.015***
		(0.001)	(0.002)	(0.003)
Industry-time FE	Yes	Yes	Yes	Yes
State FE	No	No	Yes	Yes
Legal FE	No	No	Yes	Yes
Bank-time FE	No	No	Yes	Yes
Firm FE	No	No	No	Yes
Observations	799,104	799,104	799,104	799,104
R^2	0.055	0.105	0.224	0.461

Notes: OLS estimation. Robust standard errors in parentheses. *** denotes significance at 1%, ** significance at 5% and * significance at 10%.

B. Appendix of Chapter 4

Figure B.1: More Details on Bank-Firm Credit Relationships in Germany, 2005-2010



Notes: The graphs are based on quarterly data from the MiMiK-Ustan matched data sources.

Table B.1: Credit Exposure and Exports

	(1)	(2)
Variables	$\Delta ln(Exports_{ijt})$	$\Delta ln(Exports_{ijt})$
$\Delta ln(Loan_{i,t-1})$	0.027	0.026
	(0.017)	(0.017)
Industry-Time FE	Yes	Yes
Bank FE	No	Yes
Observations	33,412	33,412
R^2	0.077	0.097

Notes: OLS estimation. Robust standard errors in parentheses. *** denotes significance at 1%, ** significance at 5% and * significance at 10%.

Table B.2: Bank Health and Lending

	(1)	(2)	(3)	(4)	(5)	(6)
Variables			$\Delta ln(Loan_{kt})$			
SoFFin·crisis	-0.193***					
	(0.059)					
SoFFin (w/subsidiaries)·crisis		-0.281*				
		(0.153)				
EBA·crisis			-0.097**			
			(0.044)			
EBA (w/subsidiaries) ·crisis				-0.128*		
				(0.075)		
LR_{t-1}					1.00	
					(0.624)	
NPL_{t-1}						-2.15e-08
						(2.54e-08)
Time FE	Yes	Yes	Yes	Yes	Yes	Yes
Bank FE	Yes	Yes	Yes	Yes	Yes	Yes
Observations	5,688	5,688	5,688	5,688	5,688	5,688
R^2	0.310	0.310	0.310	0.310	0.310	0.310

Notes: OLS estimation. Robust standard errors in parentheses. *** denotes significance at 1%, ** significance at 5% and * significance at 10%.

Table B.3: Propensity Score Matching: Industry-Specific (Definition 1)

	(1)	(2)	(3)		
WZ	$\Delta ln(Exports)$	$\Delta ln(Domestic)$	$\Delta ln(Total)$	Treatment	Control
1	-0.513	-0.068	-0.093	15	82
	(0.623)	(0.086)	(0.076)		
14	0.086*	0.062	0.088	15	26
	(0.045)	(0.060)	(0.058)		
15	0.503	0.045	0.053	140	170
	(0.330)	(0.045)	(0.035)		
17	-0.120	-0.089	-0.053	56	56
	(0.581)	(0.073)	(0.049)		
18	0.008	-0.150	-0.156	33	30
	(1.13)	(0.518)	(0.552)		
19	1.79	-0.105	0.057	10	8
	(2.10)	(0.228)	(0.129)		
20	-0.123	0.449	0.393	22	61
	(1.06)	(0.283)	(0.278)		
21	-2.50*	-0.029	-0.136	53	64
	(1.33)	(0.129)	(0.085)		
22	-0.150	-0.051	-0.047	33	86
	(0.415)	(0.042)	(0.039)		
23	4.09*	-0.286*	-0.080	5	12
	(2.48)	(0.161)	(0.130)		
24	-2.78**	0.087	-0.009	114	84
	(1.28)	(0.107)	(0.053)		
25	0.607	-0.005	0.061	121	152
	(0.481)	(0.118)	(0.112)		
26	0.046	-0.010	-0.018	48	93
	(0.790)	(0.060)	(0.048)		
27	-0.177	-0.076	0.078	111	111
	(0.763)	(0.142)	(0.133)		
28	-0.517	0.100	0.102	190	292
	(0.407)	(0.071)	(0.064)		
29	-0.505	-0.078	-0.062	382	373
	(0.387)	(0.082)	(0.072)		
30	-1.05	0.148	0.255	11	4
	(4.15)	(0.237)	(0.225)		
31	-0.462	-0.410	-0.406	70	67
	(0.958)	(0.481)	(0.474)		
32	1.17	0.243	0.283	41	44
	(0.794)	(0.256)	(0.251)		
33	-0.446	-0.129	-0.022	67	77
	(0.475)	(0.119)	(0.068)		

Notes: Propensity score matching (nearest neighbor). Robust standard errors in parentheses. Definition 'at least one 'affected' bank'. *** denotes significance at 1%, ** significance at 5% and * significance at 10%.

Table B.4: Propensity Score Matching: Industry-Specific (Definition 1)

WZ	(1) $\Delta ln(Exports)$	(2) $\Delta ln(Domestic)$	(3) $\Delta ln(Total)$	Treatment	Control
34	0.125	0.028	0.035	97	64
	(1.00)	(0.077)	(0.060)		
35	0.407	0.059	0.049	16	17
	(1.34)	(0.334)	(0.290)		
36	-0.305	-0.072	-0.078***	33	79
	(0.673)	(0.053)	(0.029)		
37	0.561	-0.051	0.008	19	19
	(0.479)	(0.062)	(0.062)		
40	0.085	0.041	0.041	139	108
	(0.079)	(0.047)	(0.047)		
45	-0.609	-0.017	-0.071	48	207
	(0.916)	(0.155)	(0.138)		
50	-0.090	0.024	0.036	219	387
	(0.198)	(0.025)	(0.022)		
51	0.745***	0.035	0.057	560	1,172
	(0.254)	(0.047)	(0.040)		
52	-0.601	0.079	0.072	87	220
	(0.367)	(0.068)	(0.068)		
60	0.000	0.178	0.178	33	55
	(0.000)	(0.120)	(0.120)		
63	0.154	0.007	-0.057	70	93
	(0.711)	(0.131)	(0.107)		
64	1.94	0.033	0.060	12	5
	(1.32)	(0.059)	(0.055)		
65	0.270	-0.189	-0.076	18	25
	(0.308)	(0.139)	(0.086)		
70	-0.003	-0.002	-0.002	650	820
	(0.012)	(0.065)	(0.065)		
71	-0.042	-0.384	-0.390	70	86
	(0.278)	(0.387)	(0.386)		
72	1.71	-0.602	-0.482	18	32
	(1.84)	(1.54)	(1.54)		
74	-0.074	-0.188	-0.198	506	420
	(0.168)	(0.272)	(0.279)		
85	-0.093	-0.001	-0.001	37	44
	(0.093)	(0.020)	(0.020)		
90	0.272	-0.039	-0.039	25	34
	(0.346)	(0.095)	(0.096)		
92	0.703	-0.008	-0.079	13	16
	(0.863)	(0.078)	(0.076)		
93	-0.106	-0.654	-0.693	4	6
	(0.106)	(0.996)	(0.977)		

Notes: Propensity score matching (nearest neighbor). Robust standard errors in parentheses. Definition 'at least one 'affected' bank'. *** denotes significance at 1%, ** significance at 5% and * significance at 10%.

Table B.5: Propensity Score Matching: Industry-Specific (Definition 2)

	(1)	(2)	(3)		
WZ	$\Delta ln(Exports)$	$\Delta ln(Domestic)$	$\Delta ln(Total)$	Treatment	Control
1	0.366	-0.021	0.020	2	63
	(0.366)	(0.222)	(0.221)		
15	1.23	0.005	0.064	25	97
	(0.815)	(0.069)	(0.056)		
17	0.339	-0.327*	-0.062	16	30
	(1.05)	(0.169)	(0.066)		
18	0.871	0.604	0.604	4	18
	(0.712)	(0.689)	(0.634)		
19	-0.151	0.219	0.456*	4	4
	(3.60)	(0.437)	(0.260)		
20	1.72	-0.001	0.163	3	34
	(1.42)	(0.152)	(0.215)		
21	0.074	-0.009	0.022	9	41
	(0.096)	(0.067)	(0.054)		
22	7.27	0.009	0.073	1	60
	(7.21)	(1.14)	(1.15)		
24	-1.88	0.115	0.033	22	53
	(1.17)	(0.087)	(0.050)		
25	1.69*	-0.001	0.135	23	89
	(0.952)	(0.119)	(0.104)		
26	2.50	-0.086	0.203	8	51
	(3.80)	(0.193)	(0.168)		
27	-1.88	0.145	0.015	17	62
	(1.37)	(0.094)	(0.050)		
28	-0.330	0.017	-0.028	38	190
	(0.733)	(0.137)	(0.116)		
29	-1.20**	0.033	-0.080	62	219
	(0.561)	(0.214)	(0.202)		
31	-2.60	-1.42	-1.54	13	34
	(2.02)	(1.17)	(1.15)		
32	2.96	1.11	1.07	9	23
	(1.98)	(1.11)	(1.11)		
33	0.182	-0.020	0.078	15	40
	(0.146)	(0.160)	(0.057)		

Notes: Propensity score matching (nearest neighbor). Robust standard errors in parentheses. Definition 'firms with one bank-firm relationship'. *** denotes significance at 1%, ** significance at 5% and * significance at 10%.

Table B.6: Propensity Score Matching: Industry-Specific (Definition 2)

WZ	(1) $\Delta ln(Exports)$	(2) $\Delta ln(Domestic)$	(3) $\Delta ln(Total)$	Treatment	Control
34	-0.690	0.612*	0.604*	11	33
	(0.860)	(0.341)	(0.336)		
35	2.09	0.439	0.536	3	13
	(3.57)	(0.303)	(0.433)		
36	-0.173	-0.001	-0.011	11	51
	(1.01)	(0.060)	(0.053)		
40	0.000	0.117	0.117	11	58
	(0.000)	(0.333)	(0.333)		
45	0.805	-0.192	-0.136	8	143
	(0.503)	(0.131)	(0.133)		
50	-0.287	-0.042	-0.023	57	223
	(0.252)	(0.035)	(0.030)		
51	0.187	0.091	0.119*	120	690
	(0.345)	(0.083)	(0.066)		
52	-0.108*	-0.557	-0.575	15	154
	(0.602)	(0.796)	(0.794)		
60	0.000	0.123	0.123	2	30
	(0.000)	(0.097)	(0.097)		
63	1.16*	0.011	0.001	15	57
	(0.619)	(0.050)	(0.047)		
64	0.041	0.067	0.070	3	3
	(0.041)	(0.075)	(0.075)		
70	0.000	-0.113	-0.113	67	425
	(0.000)	(0.120)	(0.120)		
71	0.000	-0.386	-0.386	8	43
	(0.000)	(0.380)	(0.380)		
72	-2.56	0.231*	0.191	5	20
	(1.81)	(0.140)	(0.145)		
74	0.127	0.613*	0.619*	71	241
	(0.203)	(0.325)	(0.329)		
85	-0.521	-0.038	-0.039	9	24
	(0.433)	(0.024)	(0.024)		
90	0.000	0.138	0.138	2	17
	(0.324)	(0.109)	(0.111)		
92	-0.189	0.102	-0.048	4	7
	(0.138)	(0.113)	(0.086)		

Notes: Propensity score matching (nearest neighbor). Robust standard errors in parentheses. Definition 'firms with one bank-firm relationship'. *** denotes significance at 1%, ** significance at 5% and * significance at 10%.

Table B.7: Propensity Score Matching: Industry-Specific (Definition 3)

	(1)	(2)	(3)		
WZ	$\Delta ln(Exports)$	$\Delta ln(Domestic)$	$\Delta ln(Total)$	Treatment	Control
1	-1.41	0.023	-0.046	6	91
	(1.56)	(0.160)	(0.121)		
14	0.049	0.159*	0.141*	7	34
	(0.096)	(0.085)	(0.082)		
15	0.628	-0.037	-0.014	51	259
	(0.497)	(0.149)	(0.146)		
17	-0.311	-0.106	-0.095*	31	81
	(0.737)	(0.090)	(0.052)		
18	0.748	0.058	0.095	19	44
	(1.24)	(0.163)	(0.137)		
19	-2.33	0.370	0.258	4	14
	(2.40)	(0.303)	(0.248)		
20	1.24	0.274	0.387	5	78
	(0.905)	(0.688)	(0.670)		
21	0.699	-0.132	-0.083	23	94
	(1.03)	(0.157)	(0.111)		
22	0.721	-0.046	-0.030	12	107
	(0.623)	(0.070)	(0.069)		
24	-0.650	-0.029	-0.031	49	149
	(0.749)	(0.068)	(0.037)		
25	0.618	-0.012	0.072	49	224
	(0.587)	(0.082)	(0.051)		
26	0.944	0.082	0.046	18	123
	(1.45)	(0.148)	(0.144)		
27	-0.929	-0.251	-0.316	45	177
	(0.814)	(0.391)	(0.416)		
28	-0.306	0.006	0.052	93	389
	(0.533)	(0.076)	(0.047)		
29	-0.071	0.008	0.040	155	600
	(0.396)	(0.083)	(0.065)		
30	-0.903	-0.113	0.109	6	9
	(2.02)	(0.187)	(0.213)		
31	-1.14	-0.142	-0.216	40	97
	(0.906)	(0.400)	(0.394)		
32	1.79**	0.702	0.695	16	69
	(0.870)	(0.633)	(0.626)		
33	0.935	0.014	0.052	38	106
	(0.596)	(0.089)	(0.064)		

Notes: Propensity score matching (nearest neighbor). Robust standard errors in parentheses. Definition 'share of 'affected' banks > 50%'. *** denotes significance at 1%, ** significance at 5% and * significance at 10%.

Table B.8: Propensity Score Matching: Industry-Specific (Definition 3)

	(1)	(2)	(3)		
WZ	$\Delta ln(Exports)$	$\Delta ln(Domestic)$	$\Delta ln(Total)$	Treatment	Control
34	2.13**	0.102	0.245*	29	132
	(0.890)	(0.162)	(0.145)		
35	-2.30	0.233	0.081	11	22
	(2.18)	(0.225)	(0.188)		
36	-0.810	-0.023	-0.043	20	92
	(0.808)	(0.046)	(0.037)		
37	0.527	-0.095	-0.009	11	27
	(0.341)	(0.071)	(0.072)		
40	-0.356	0.056	0.051	41	206
	(0.241)	(0.105)	(0.105)		
45	-1.28	0.187	0.045	18	237
	(0.924)	(0.257)	(0.182)		
50	0.201	0.017	0.025	163	443
	(0.194)	(0.023)	(0.022)		
51	-0.143	0.109	0.099	248	1,484
	(0.279)	(0.069)	(0.065)		
52	-0.160	-0.028	-0.024	33	274
	(0.407)	(0.066)	(0.065)		
60	0.000	0.050	0.050	14	74
	(0.000)	(0.051)	(0.051)		
63	-0.981	0.026	-0.056	28	135
	(0.875)	(0.073)	(0.046)		
64	1.65	-0.083	-0.036	6	11
	(1.63)	(0.056)	(0.047)		
70	0.000	-0.365***	-0.365***	162	1,308
	(0.031)	(0.106)	(0.106)		
71	0.008	-0.347*	-0.347*	18	138
	(0.008)	(0.209)	(0.209)		
72	-1.79	-0.211	-0.057	9	41
	(1.86)	(0.294)	(0.199)		
74	-0.069	-0.286*	-0.299*	176	750
	(0.159)	(0.162)	(0.161)		
85	-0.191	-0.018	-0.018	18	63
	(0.191)	(0.019)	(0.019)		
90	-0.129	0.048	0.041	6	53
	(0.163)	(0.076)	(0.079)		
92	0.200	0.019	0.037	9	20
	(0.179)	(0.106)	(0.095)		
93	-0.212	0.415	0.336	2	8
	(0.212)	(0.437)	(0.358)		

Notes: Propensity score matching (nearest neighbor). Robust standard errors in parentheses. Definition 'share of 'affected' banks > 50%'. *** denotes significance at 1%, ** significance at 5% and * significance at 10%.

C. Appendix of Chapter 5

Figure C.1: Evolution of Services Exports

Source: Aggregate monthly trade statistics by Deutsche Bundesbank.

Table C.1: Goods vs. Non-Exporters: Export Share

	(1)	(2)	(3)	(4)
Variables	ln(Loan)	ln(Loan)	ln(Loan)	ln(Loan)
ln(Export Share)	1.064***	0.444***	0.433***	0.123***
	(0.022)	(0.022)	(0.022)	(0.032)
ln(Sales)		0.065***	0.076***	0.045***
		(0.001)	(0.001)	(0.004)
ln(Age)		0.144***	0.129***	0.009
		(0.003)	(0.004)	(0.030)
Multi-plant		-0.537***	-0.447***	0.027***
		(0.007)	(0.007)	(0.010)
ln(Fdi)		-0.013***	-0.004*	-0.005*
		(0.002)	(0.002)	(0.003)
ln(Equity)		0.182***	0.170***	-0.016***
		(0.002)	(0.002)	(0.003)
Industry FE	Yes	Yes	Yes	Yes
Time FE	Yes	Yes	Yes	Yes
State FE	No	No	Yes	Yes
Legal FE	No	No	Yes	Yes
Bank FE	No	No	Yes	Yes
Firm FE	No	No	No	Yes
Observations	694,351	694,351	694,351	694,351
R^2	0.062	0.111	0.197	0.742

Notes: OLS estimation. Robust standard errors in parentheses. *** denotes significance at 1%, ** significance at 5% and * significance at 10%.

Table C.2: Goods vs. Non-Exporters: Employment as Firm Size

	(1)	(2)	(3)	(4)
Variables	ln(Loan)	ln(Loan)	ln(Loan)	ln(Loan)
Goods	0.325***	0.175***	0.183***	0.030***
	(0.008)	(0.008)	(0.008)	(0.010)
ln(Employment)		0.125***	0.135***	0.057***
		(0.002)	(0.002)	(0.004)
ln(Age)		0.124***	0.108***	0.019
		(0.003)	(0.004)	(0.030)
Multi-plant		-0.520***	-0.422***	0.028***
		(0.007)	(0.007)	(0.010)
ln(Fdi)		-0.011***	-0.002	-0.005*
		(0.002)	(0.002)	(0.003)
ln(Equity)		0.156***	0.152***	-0.016***
		(0.002)	(0.002)	(0.003)
Industry FE	Yes	Yes	Yes	Yes
Time FE	Yes	Yes	Yes	Yes
State FE	No	No	Yes	Yes
Legal FE	No	No	Yes	Yes
Bank FE	No	No	Yes	Yes
Firm FE	No	No	No	Yes
Observations	694,351	694,351	694,351	694,351
R^2	0.061	0.113	0.198	0.742

Notes: OLS estimation. Robust standard errors in parentheses. *** denotes significance at 1%, ** significance at 5% and * significance at 10%.

Table C.3: Goods vs. Non-Exporters: Adding Productivity

	(1)	(2)	(3)	(4)
Variables	ln(Loan)	ln(Loan)	ln(Loan)	ln(Loan)
Goods	0.312***	0.156***	0.164***	0.027***
	(0.008)	(0.008)	(0.008)	(0.010)
ln(Productivity)	0.043***	0.034***	0.048***	-0.019***
	(0.003)	(0.003)	(0.003)	(0.003)
ln(Sales)		0.074***	0.086***	0.052***
		(0.002)	(0.002)	(0.004)
ln(Age)		0.160***	0.149***	0.044
		(0.003)	(0.004)	(0.031)
Multi-plant		-0.552***	-0.459***	0.022**
		(0.007)	(0.007)	(0.010)
ln(Fdi)		-0.019***	-0.008***	-0.003
		(0.002)	(0.002)	(0.003)
ln(Equity)		0.179***	0.167***	-0.011***
		(0.002)	(0.002)	(0.003)
Industry FE	Yes	Yes	Yes	Yes
Time FE	Yes	Yes	Yes	Yes
State FE	No	No	Yes	Yes
Legal FE	No	No	Yes	Yes
Bank FE	No	No	Yes	Yes
Firm FE	No	No	No	Yes
Observations	665,105	665,105	665,105	665,105
R^2	0.066	0.118	0.205	0.749

Notes: OLS estimation. Robust standard errors in parentheses. *** denotes significance at 1%, ** significance at 5% and * significance at 10%.

Table C.4: Goods vs. Non-Exporters: Before Q3/2008

	(1)	(2)	(3)	(4)
Variables	ln(Loan)	ln(Loan)	ln(Loan)	ln(Loan)
Goods	0.322***	0.170***	0.181***	0.027*
	(0.011)	(0.011)	(0.011)	(0.014)
ln(Sales)		0.066***	0.078***	0.036***
		(0.002)	(0.002)	(0.006)
ln(Age)		0.131***	0.121***	0.226***
		(0.004)	(0.005)	(0.050)
Multi-plant		-0.532***	-0.440***	0.065***
		(0.009)	(0.009)	(0.016)
ln(Fdi)		-0.017***	-0.010***	-0.001
		(0.003)	(0.003)	(0.004)
ln(Equity)		0.175***	0.166***	-0.014***
		(0.002)	(0.002)	(0.005)
Industry FE	Yes	Yes	Yes	Yes
Time FE	Yes	Yes	Yes	Yes
State FE	No	No	Yes	Yes
Legal FE	No	No	Yes	Yes
Bank FE	No	No	Yes	Yes
Firm FE	No	No	No	Yes
Observations	389,618	389,618	389,618	389,618
R^2	0.061	0.106	0.194	0.767

Notes: OLS estimation. Robust standard errors in parentheses. *** denotes significance at 1%, ** significance at 5% and * significance at 10%.

Table C.5: Goods vs. Non-Exporters: After Q2/2008

	(1)	(2)	(3)	(4)
Variables	ln(Loan)	ln(Loan)	ln(Loan)	ln(Loan)
Goods	0.332***	0.153***	0.147***	0.006
	(0.013)	(0.012)	(0.012)	(0.016)
ln(Sales)		0.064***	0.074***	0.035***
		(0.002)	(0.002)	(0.007)
ln(Age)		0.164***	0.142***	-0.111*
		(0.005)	(0.006)	(0.066)
Multi-plant		-0.532***	-0.442***	0.047**
		(0.010)	(0.010)	(0.019)
ln(Fdi)		-0.007**	0.003	-0.017***
		(0.003)	(0.003)	(0.005)
ln(Equity)		0.193***	0.180***	-0.0131***
		(0.002)	(0.002)	(0.005)
Industry FE	Yes	Yes	Yes	Yes
Time FE	Yes	Yes	Yes	Yes
State FE	No	No	Yes	Yes
Legal FE	No	No	Yes	Yes
Bank FE	No	No	Yes	Yes
Firm FE	No	No	No	Yes
Observations	304,733	304,733	304,733	304,733
R^2	0.064	0.120	0.217	0.831

Notes: OLS estimation. Robust standard errors in parentheses. *** denotes significance at 1%, ** significance at 5% and * significance at 10%.

Table C.6: Goods vs. Non-Exporters: Loans $\leq$ 2 million euro

	(1)	(2)	(3)	(4)
Variables	ln(Loan)	ln(Loan)	ln(Loan)	ln(Loan)
Goods	0.174***	0.203***	0.245***	0.045***
	(0.011)	(0.011)	(0.011)	(0.015)
ln(Sales)		0.012***	0.020***	0.034***
		(0.002)	(0.002)	(0.007)
ln(Age)		0.160***	0.156***	0.253***
		(0.005)	(0.005)	(0.046)
Multi-plant		-0.845***	-0.693***	-0.022
		(0.009)	(0.010)	(0.017)
ln(Fdi)		-0.055***	-0.030***	0.001
		(0.003)	(0.003)	(0.005)
ln(Equity)		-0.007***	0.006***	-0.006
		(0.002)	(0.002)	(0.005)
Industry FE	Yes	Yes	Yes	Yes
Time FE	Yes	Yes	Yes	Yes
State FE	No	No	Yes	Yes
Legal FE	No	No	Yes	Yes
Bank FE	No	No	Yes	Yes
Firm FE	No	No	No	Yes
Observations	327,609	327,609	327,609	327,609
R^2	0.023	0.051	0.140	0.739

Notes: OLS estimation. Robust standard errors in parentheses. *** denotes significance at 1%, ** significance at 5% and * significance at 10%.

Table C.7: Goods vs. Non-Exporters: Loans > 2 million euro

	(1)	(2)	(3)	(4)
Variables	ln(Loan)	ln(Loan)	ln(Loan)	ln(Loan)
Goods	0.056***	-0.048***	-0.069***	0.004
	(0.004)	(0.004)	(0.004)	(0.004)
ln(Sales)		0.018***	0.027***	0.020***
		(0.001)	(0.001)	(0.002)
ln(Age)		0.009***	0.008***	-0.041***
		(0.002)	(0.002)	(0.012)
Multi-plant		0.183***	0.120***	0.009**
		(0.003)	(0.003)	(0.004)
ln(Fdi)		0.015***	0.007***	0.003***
		(0.001)	(0.001)	(0.001)
ln(Equity)		0.106***	0.100***	-0.001
		(0.001)	(0.001)	(0.001)
Industry FE	Yes	Yes	Yes	Yes
Time FE	Yes	Yes	Yes	Yes
State FE	No	No	Yes	Yes
Legal FE	No	No	Yes	Yes
Bank FE	No	No	Yes	Yes
Firm FE	No	No	No	Yes
Observations	366,742	366,742	366,742	366,742
R^2	0.092	0.188	0.300	0.889

Notes: OLS estimation. Robust standard errors in parentheses. *** denotes significance at 1%, ** significance at 5% and * significance at 10%.

Table C.8: Goods vs. Non-Exporters: On Balance Sheet

	(1)	(2)	(3)	(4)
Variables	ln(On Balance)	ln(On Balance)	ln(On Balance)	ln(On Balance)
Goods	0.143***	0.072***	0.093***	0.048***
	(0.011)	(0.011)	(0.010)	(0.013)
ln(Sales)		0.062***	0.065***	0.035***
		(0.002)	(0.002)	(0.005)
ln(Age)		0.130***	0.140***	0.079**
		(0.004)	(0.005)	(0.034)
Multi-plant		-0.756***	-0.564***	0.022*
		(0.008)	(0.009)	(0.012)
ln(Fdi)		-0.071***	-0.043***	-0.004
		(0.003)	(0.003)	(0.004)
ln(Equity)		0.106***	0.097***	-0.031***
		(0.002)	(0.002)	(0.003)
Industry FE	Yes	Yes	Yes	Yes
Time FE	Yes	Yes	Yes	Yes
State FE	No	No	Yes	Yes
Legal FE	No	No	Yes	Yes
Bank FE	No	No	Yes	Yes
Firm FE	No	No	No	Yes
Observations	694,351	694,351	694,351	694,351
R^2	0.107	0.126	0.253	0.788

Notes: OLS estimation. Robust standard errors in parentheses. *** denotes significance at 1%, ** significance at 5% and * significance at 10%.

Table C.9: Goods vs. Non-Exporters: Off Balance Sheet

	(1)	(2)	(3)	(4)
Variables	ln(Off Balance)	ln(Off Balance)	ln(Off Balance)	ln(Off Balance)
Goods	0.440***	0.348***	0.296***	0.011
	(0.010)	(0.010)	(0.009)	(0.010)
ln(Sales)		0.007***	0.026***	0.026***
		(0.002)	(0.002)	(0.004)
ln(Age)		0.136***	0.093***	0.123***
		(0.004)	(0.004)	(0.027)
Multi-plant		-0.001	-0.119***	0.018*
		(0.007)	(0.007)	(0.003)
ln(Fdi)		0.060***	0.042***	-0.002
		(0.003)	(0.002)	(0.003)
ln(Equity)		0.070***	0.094***	0.007***
		(0.002)	(0.002)	(0.003)
Industry FE	Yes	Yes	Yes	Yes
Time FE	Yes	Yes	Yes	Yes
State FE	No	No	Yes	Yes
Legal FE	No	No	Yes	Yes
Bank FE	No	No	Yes	Yes
Firm FE	No	No	No	Yes
Observations	694,351	694,351	694,351	694,351
R^2	0.117	0.124	0.280	0.837

Notes: OLS estimation. Robust standard errors in parentheses. *** denotes significance at 1%, ** significance at 5% and * significance at 10%.

Table C.10: Goods vs. Non-Exporters: Loan/Total Debt

	(1)	(2)	(3)	(4)
Variables	ln(Loan/Debt)	ln(Loan/Debt)	ln(Loan/Debt)	ln(Loan/Debt)
Goods	-0.017***	0.003***	0.005***	-0.001
	(0.001)	(0.001)	(0.001)	(0.001)
ln(Sales)		-0.007***	-0.007***	-0.001***
		(0.001)	(0.001)	(0.000)
ln(Age)		-0.005***	-0.003***	-0.012***
		(0.001)	(0.001)	(0.001)
Multi-plant		-0.056***	-0.045***	-0.001*
		(0.001)	(0.001)	(0.000)
ln(Fdi)		-0.003***	-0.002***	0.000
		(0.000)	(0.000)	(0.001)
ln(Equity)		-0.012***	-0.011***	0.001***
		(0.001)	(0.001)	(0.000)
Industry FE	Yes	Yes	Yes	Yes
Time FE	Yes	Yes	Yes	Yes
State FE	No	No	Yes	Yes
Legal FE	No	No	Yes	Yes
Bank FE	No	No	Yes	Yes
Firm FE	No	No	No	Yes
Observations	694,351	694,351	694,351	694,351
R^2	0.074	0.221	0.317	0.872

Notes: OLS estimation. Robust standard errors in parentheses. *** denotes significance at 1%, ** significance at 5% and * significance at 10%.

Table C.11: Goods vs. Non-Exporters: Loan/Total Assets

	(1)	(2)	(3)	(4)
Variables	ln(Loan/Assets)	ln(Loan/Assets)	ln(Loan/Assets)	ln(Loan/Assets)
Goods	-0.015***	0.002***	0.004***	0.000
	(0.001)	(0.000)	(0.001)	(0.001)
ln(Sales)		-0.004***	-0.004***	-0.001
		(0.001)	(0.000)	(0.001)
ln(Age)		-0.002***	-0.001***	-0.011***
		(0.000)	(0.000)	(0.001)
Multi-plant		-0.040***	-0.033***	-0.001
		(0.001)	(0.001)	(0.001)
ln(Fdi)		-0.002***	-0.001***	0.000
		(0.000)	(0.000)	(0.001)
ln(Equity)		-0.013***	-0.013***	-0.003***
		(0.001)	(0.001)	(0.001)
Industry FE	Yes	Yes	Yes	Yes
Time FE	Yes	Yes	Yes	Yes
State FE	No	No	Yes	Yes
Legal FE	No	No	Yes	Yes
Bank FE	No	No	Yes	Yes
Firm FE	No	No	No	Yes
Observations	694,351	694,351	694,351	694,351
R^2	0.089	0.268	0.357	0.887

Notes: OLS estimation. Robust standard errors in parentheses. *** denotes significance at 1%, ** significance at 5% and * significance at 10%.

Table C.12: Goods vs. Non-Exporters: Lagged Explanatory Variables

	(1)	(2)	(3)	(4)
Variables	ln(Loan)	ln(Loan)	ln(Loan)	ln(Loan)
Goods	0.296***	0.147***	0.147***	0.001
	(0.009)	(0.009)	(0.009)	(0.011)
ln(Sales)		0.056***	0.067***	0.042***
		(0.002)	(0.002)	(0.004)
ln(Age)		0.123***	0.103***	-0.155***
		(0.004)	(0.004)	(0.025)
Multi-plant		-0.560***	-0.475***	0.001
		(0.007)	(0.007)	(0.011)
ln(Fdi)		-0.015***	-0.005**	0.005
		(0.003)	(0.002)	(0.003)
ln(Equity)		0.195***	0.184***	0.008**
		(0.002)	(0.002)	(0.003)
Industry FE	Yes	Yes	Yes	Yes
Time FE	Yes	Yes	Yes	Yes
State FE	No	No	Yes	Yes
Legal FE	No	No	Yes	Yes
Bank FE	No	No	Yes	Yes
Firm FE	No	No	No	Yes
Observations	563,245	563,245	563,245	563,245
R^2	0.062	0.114	0.202	0.761

Notes: OLS estimation. Robust standard errors in parentheses. *** denotes significance at 1%, ** significance at 5% and * significance at 10%.

Table C.13: Goods vs. Non-Exporters: Industry-time and Bank-time FE

	(1)	(2)	(3)	(4)
Variables	ln(Loan)	ln(Loan)	ln(Loan)	ln(Loan)
Goods	0.326***	0.162***	0.164***	0.033**
	(0.008)	(0.008)	(0.008)	(0.013)
ln(Sales)		0.065***	0.076***	0.041***
		(0.001)	(0.001)	(0.004)
ln(Age)		0.145***	0.130***	0.013
		(0.003)	(0.003)	(0.031)
Multi-plant		-0.534***	-0.441***	0.010
		(0.007)	(0.006)	(0.013)
ln(Fdi)		-0.013***	-0.005**	-0.003
		(0.002)	(0.002)	(0.003)
ln(Equity)		0.184***	0.174***	-0.016***
		(0.002)	(0.002)	(0.004)
Industry-time FE	Yes	Yes	Yes	Yes
State FE	No	No	Yes	Yes
Legal FE	No	No	Yes	Yes
Bank-time FE	No	No	Yes	Yes
Firm FE	No	No	No	Yes
Observations	694,351	694,351	694,351	694,351
R^2	0.064	0.113	0.226	0.482

Notes: OLS estimation. Robust standard errors in parentheses. *** denotes significance at 1%, ** significance at 5% and * significance at 10%.

Table C.14: Service vs. Goods Exporters: Export Share

	(1)	(2)	(3)	(4)
Variables	ln(Loan)	ln(Loan)	ln(Loan)	ln(Loan)
ln(Export Share)	0.038***	0.002	-0.015	0.041
	(0.014)	(0.015)	(0.015)	(0.033)
ln(Sales)		0.000	0.109***	0.207***
		(0.012)	(0.013)	(0.041)
ln(Age)		0.284***	0.154***	-0.119
		(0.013)	(0.014)	(0.240)
Multi-plant		0.285***	0.040	-0.032
		(0.029)	(0.029)	(0.038)
ln(Fdi)		-0.011***	-0.012***	0.000
		(0.004)	(0.004)	(0.004)
ln(Equity)		0.132***	0.096***	-0.003
		(0.009)	(0.009)	(0.011)
Industry FE	Yes	Yes	Yes	Yes
Time FE	Yes	Yes	Yes	Yes
State FE	No	No	Yes	Yes
Legal FE	No	No	Yes	Yes
Bank FE	No	No	Yes	Yes
Firm FE	No	No	No	Yes
Observations	63,759	63,759	63,759	63,759
R^2	0.039	0.055	0.236	0.698

Notes: OLS estimation. Robust standard errors in parentheses. *** denotes significance at 1%, ** significance at 5% and * significance at 10%.

Table C.15: Service vs. Goods Exporters: Employment as Firm Size

	(1)	(2)	(3)	(4)
Variables	ln(Loan)	ln(Loan)	ln(Loan)	ln(Loan)
Service	0.539***	0.154***	0.148***	0.005
	(0.012)	(0.013)	(0.012)	(0.022)
ln(Employment)		0.077***	0.096***	0.058***
		(0.004)	(0.004)	(0.009)
ln(Age)		0.224***	0.161***	0.059
		(0.005)	(0.006)	(0.066)
Multi-plant		-0.301***	-0.338***	0.055***
		(0.010)	(0.010)	(0.016)
ln(Fdi)		-0.021***	-0.013***	-0.009***
		(0.002)	(0.002)	(0.003)
ln(Equity)		0.120***	0.126***	-0.010**
		(0.003)	(0.003)	(0.005)
Industry FE	Yes	Yes	Yes	Yes
Time FE	Yes	Yes	Yes	Yes
State FE	No	No	Yes	Yes
Legal FE	No	No	Yes	Yes
Bank FE	No	No	Yes	Yes
Firm FE	No	No	No	Yes
Observations	321,073	321,073	321,073	321,073
R^2	0.030	0.060	0.178	0.695

Notes: OLS estimation. Robust standard errors in parentheses. *** denotes significance at 1%, ** significance at 5% and * significance at 10%.

Table C.16: Service vs. Goods Exporters: Adding Productivity

	(1)	(2)	(3)	(4)
Variables	ln(Loan)	ln(Loan)	ln(Loan)	ln(Loan)
Service	0.545***	0.184***	0.179***	0.035
	(0.012)	(0.013)	(0.012)	(0.022)
ln(Productivity)	-0.024***	0.034***	-0.007	-0.032***
	(0.005)	(0.003)	(0.005)	(0.007)
ln(Sales)		0.056***	0.068***	0.086***
		(0.002)	(0.002)	(0.017)
ln(Age)		0.242***	0.186***	0.041
		(0.005)	(0.006)	(0.065)
Multi-plant		-0.327***	-0.360***	0.045***
		(0.010)	(0.010)	(0.016)
ln(Fdi)		-0.027***	-0.019***	-0.010***
		(0.002)	(0.002)	(0.003)
ln(Equity)		0.133***	0.136***	-0.014***
		(0.002)	(0.003)	(0.005)
Industry FE	Yes	Yes	Yes	Yes
Time FE	Yes	Yes	Yes	Yes
State FE	No	No	Yes	Yes
Legal FE	No	No	Yes	Yes
Bank FE	No	No	Yes	Yes
Firm FE	No	No	No	Yes
Observations	312,277	312,277	312,277	312,277
R^2	0.029	0.060	0.176	0.698

Notes: OLS estimation. Robust standard errors in parentheses. *** denotes significance at 1%, ** significance at 5% and * significance at 10%.

Table C.17: Service vs. Goods Exporters: Before Q3/2008

	(1)	(2)	(3)	(4)
Variables	ln(Loan)	ln(Loan)	ln(Loan)	ln(Loan)
Service	0.507***	0.167***	0.156***	0.029
	(0.017)	(0.018)	(0.017)	(0.029)
ln(Sales)		0.050***	0.060***	0.146***
		(0.004)	(0.004)	(0.029)
ln(Age)		0.209***	0.155***	0.461***
		(0.007)	(0.008)	(0.102)
Multi-plant		-0.345***	-0.366***	0.092***
		(0.014)	(0.014)	(0.025)
ln(Fdi)		-0.024***	-0.018***	-0.021***
		(0.003)	(0.003)	(0.004)
ln(Equity)		0.127***	0.134***	-0.002***
		(0.003)	(0.004)	(0.008)
Industry FE	Yes	Yes	Yes	Yes
Time FE	Yes	Yes	Yes	Yes
State FE	No	No	Yes	Yes
Legal FE	No	No	Yes	Yes
Bank FE	No	No	Yes	Yes
Firm FE	No	No	No	Yes
Observations	174,483	174,483	174,483	174,483
R^2	0.026	0.051	0.174	0.722

Notes: OLS estimation. Robust standard errors in parentheses. *** denotes significance at 1%, ** significance at 5% and * significance at 10%.

Table C.18: Service vs. Goods Exporters: After Q2/2008

	(1)	(2)	(3)	(4)
Variables	ln(Loan)	ln(Loan)	ln(Loan)	ln(Loan)
Service	0.574***	0.170***	0.191***	-0.036
	(0.017)	(0.018)	(0.017)	(0.033)
ln(Sales)		0.054***	0.063***	0.124***
		(0.003)	(0.003)	(0.025)
ln(Age)		0.290***	0.228***	0.095
		(0.008)	(0.009)	(0.141)
Multi-plant		-0.271***	-0.334***	0.049*
		(0.016)	(0.016)	(0.027)
ln(Fdi)		-0.027***	-0.019***	0.004
		(0.003)	(0.003)	(0.004)
ln(Equity)		0.141***	0.145***	-0.013**
		(0.003)	(0.004)	(0.007)
Industry FE	Yes	Yes	Yes	Yes
Time FE	Yes	Yes	Yes	Yes
State FE	No	No	Yes	Yes
Legal FE	No	No	Yes	Yes
Bank FE	No	No	Yes	Yes
Firm FE	No	No	No	Yes
Observations	146,590	146,590	146,590	146,590
R^2	0.037	0.074	0.207	0.795

Notes: OLS estimation. Robust standard errors in parentheses. *** denotes significance at 1%, ** significance at 5% and * significance at 10%.

Table C.19: Service vs. Goods Exporters: Loans $\leq$ 2 million euro

	(1)	(2)	(3)	(4)
Variables	ln(Loan)	ln(Loan)	ln(Loan)	ln(Loan)
Service	-0.393***	-0.277***	-0.204***	-0.039
	(0.019)	(0.020)	(0.020)	(0.034)
ln(Sales)		-0.043***	-0.016***	0.123***
		(0.004)	(0.004)	(0.023)
ln(Age)		0.199***	0.178***	0.267***
		(0.008)	(0.008)	(0.089)
Multi-plant		-0.660***	-0.604***	0.039
		(0.014)	(0.015)	(0.028)
ln(Fdi)		-0.043***	-0.025***	-0.002
		(0.003)	(0.003)	(0.005)
ln(Equity)		-0.005	-0.016***	-0.004
		(0.004)	(0.004)	(0.008)
Industry FE	Yes	Yes	Yes	Yes
Time FE	Yes	Yes	Yes	Yes
State FE	No	No	Yes	Yes
Legal FE	No	No	Yes	Yes
Bank FE	No	No	Yes	Yes
Firm FE	No	No	No	Yes
Observations	150,212	150,212	150,212	150,212
R^2	0.020	0.041	0.168	0.725

Notes: OLS estimation. Robust standard errors in parentheses. *** denotes significance at 1%, ** significance at 5% and * significance at 10%.

Table C.20: Service vs. Goods Exporters: Loans > 2 million euro

	(1)	(2)	(3)	(4)
Variables	ln(Loan)	ln(Loan)	ln(Loan)	ln(Loan)
Service	0.461***	0.231***	0.196***	0.003
	(0.006)	(0.006)	(0.006)	(0.008)
ln(Sales)		0.043***	0.030***	0.037***
		(0.001)	(0.001)	(0.008)
ln(Age)		0.011***	0.016***	-0.113***
		(0.003)	(0.003)	(0.028)
Multi-plant		0.144***	0.073***	-0.001
		(0.004)	(0.005)	(0.006)
ln(Fdi)		0.009***	0.003***	-0.003**
		(0.001)	(0.001)	(0.001)
ln(Equity)		0.093***	0.114***	-0.008***
		(0.001)	(0.002)	(0.002)
Industry FE	Yes	Yes	Yes	Yes
Time FE	Yes	Yes	Yes	Yes
State FE	No	No	Yes	Yes
Legal FE	No	No	Yes	Yes
Bank FE	No	No	Yes	Yes
Firm FE	No	No	No	Yes
Observations	170,861	170,861	170,861	170,861
R^2	0.115	0.194	0.381	0.854

Notes: OLS estimation. Robust standard errors in parentheses. *** denotes significance at 1%, ** significance at 5% and * significance at 10%.

Table C.21: Service vs. Goods Exporters: On Balance Sheet

	(1)	(2)	(3)	(4)
Variables	ln(On Balance)	ln(On Balance)	ln(On Balance)	ln(On Balance)
Service	-0.245***	-0.428***	-0.326***	-0.053*
	(0.017)	(0.018)	(0.017)	(0.028)
ln(Sales)		-0.019***	0.011***	0.050**
		(0.003)	(0.003)	(0.028)
ln(Age)		0.294***	0.245***	0.270***
		(0.007)	(0.008)	(0.076)
Multi-plant		-0.473***	-0.392***	0.080***
		(0.014)	(0.014)	(0.020)
ln(Fdi)		-0.072***	-0.053***	-0.016***
		(0.003)	(0.003)	(0.004)
ln(Equity)		0.085***	0.051***	-0.032***
		(0.003)	(0.003)	(0.006)
Industry FE	Yes	Yes	Yes	Yes
Time FE	Yes	Yes	Yes	Yes
State FE	No	No	Yes	Yes
Legal FE	No	No	Yes	Yes
Bank FE	No	No	Yes	Yes
Firm FE	No	No	No	Yes
Observations	321,073	321,073	321,073	321,073
R^2	0.047	0.059	0.226	0.761

Notes: OLS estimation. Robust standard errors in parentheses. *** denotes significance at 1%, ** significance at 5% and * significance at 10%.

Table C.22: Service vs. Goods Exporters: Off Balance Sheet

	(1)	(2)	(3)	(4)
Variables	ln(Off Balance)	ln(Off Balance)	ln(Off Balance)	ln(Off Balance)
Service	0.636***	0.507***	0.437***	0.096***
	(0.016)	(0.017)	(0.015)	(0.022)
ln(Sales)		0.084***	0.070***	0.086***
		(0.003)	(0.003)	(0.016)
ln(Age)		0.108***	0.087***	-0.039
		(0.007)	(0.007)	(0.059)
Multi-plant		-0.122***	-0.215***	-0.020
		(0.013)	(0.013)	(0.016)
ln(Fdi)		0.038***	0.024***	-0.011***
		(0.003)	(0.003)	(0.003)
ln(Equity)		0.013***	0.091***	0.009*
		(0.003)	(0.003)	(0.005)
Industry FE	Yes	Yes	Yes	Yes
Time FE	Yes	Yes	Yes	Yes
State FE	No	No	Yes	Yes
Legal FE	No	No	Yes	Yes
Bank FE	No	No	Yes	Yes
Firm FE	No	No	No	Yes
Observations	321,073	321,073	321,073	321,073
R^2	0.087	0.093	0.320	0.844

Notes: OLS estimation. Robust standard errors in parentheses. *** denotes significance at 1%, ** significance at 5% and * significance at 10%.

Table C.23: Service vs. Goods Exporters: Loan/Total Debt

	(1)	(2)	(3)	(4)
Variables	ln(Loan/Debt)	ln(Loan/Debt)	ln(Loan/Debt)	ln(Loan/Debt)
Service	-0.057***	-0.019***	-0.018***	0.001**
	(0.001)	(0.001)	(0.001)	(0.000)
ln(Sales)		-0.005***	-0.005***	-0.006***
		(0.001)	(0.001)	(0.001)
ln(Age)		-0.002***	-0.002***	-0.003*
		(0.000)	(0.000)	(0.002)
Multi-plant		-0.050***	-0.044***	0.001*
		(0.001)	(0.001)	(0.000)
ln(Fdi)		-0.002***	-0.002***	-0.001***
		(0.000)	(0.000)	(0.000)
ln(Equity)		-0.011***	-0.010***	0.001***
		(0.001)	(0.001)	(0.000)
Industry FE	Yes	Yes	Yes	Yes
Time FE	Yes	Yes	Yes	Yes
State FE	No	No	Yes	Yes
Legal FE	No	No	Yes	Yes
Bank FE	No	No	Yes	Yes
Firm FE	No	No	No	Yes
Observations	321,073	321,073	321,073	321,073
R^2	0.138	0.292	0.362	0.877

Notes: OLS estimation. Robust standard errors in parentheses. *** denotes significance at 1%, ** significance at 5% and * significance at 10%.

Table C.24: Service vs. Goods Exporters: Loan/Total Assets

	(1)	(2)	(3)	(4)
Variables	ln(Loan/Assets)	ln(Loan/Assets)	ln(Loan/Assets)	ln(Loan/Assets)
Service	-0.043***	-0.009***	-0.009***	0.001***
	(0.001)	(0.001)	(0.001)	(0.000)
ln(Sales)		-0.003***	-0.003***	-0.003***
		(0.001)	(0.000)	(0.000)
ln(Age)		0.001***	-0.001***	-0.04***
		(0.000)	(0.000)	(0.001)
Multi-plant		-0.036***	-0.032***	0.001
		(0.001)	(0.001)	(0.001)
ln(Fdi)		-0.002***	-0.001***	-0.001***
		(0.000)	(0.000)	(0.000)
ln(Equity)		-0.011***	-0.012***	-0.004***
		(0.001)	(0.001)	(0.001)
Industry FE	Yes	Yes	Yes	Yes
Time FE	Yes	Yes	Yes	Yes
State FE	No	No	Yes	Yes
Legal FE	No	No	Yes	Yes
Bank FE	No	No	Yes	Yes
Firm FE	No	No	No	Yes
Observations	321,073	321,073	321,073	321,073
R^2	0.137	0.322	0.391	0.887

Notes: OLS estimation. Robust standard errors in parentheses. *** denotes significance at 1%, ** significance at 5% and * significance at 10%.

Table C.25: Service vs. Goods Exporters: Lagged Explanatory Variables

	(1)	(2)	(3)	(4)
Variables	ln(Loan)	ln(Loan)	ln(Loan)	ln(Loan)
Service	0.538***	0.150***	0.154***	0.024
	(0.013)	(0.014)	(0.013)	(0.024)
ln(Sales)		0.045***	0.052***	-0.014
		(0.002)	(0.002)	(0.010)
ln(Age)		0.223***	0.165***	-0.013
		(0.006)	(0.006)	(0.055)
Multi-plant		-0.360***	-0.394***	0.009
		(0.011)	(0.011)	(0.017)
ln(Fdi)		-0.026***	-0.018***	-0.005*
		(0.003)	(0.002)	(0.003)
ln(Equity)		0.147***	0.149***	0.012**
		(0.003)	(0.003)	(0.006)
Industry FE	Yes	Yes	Yes	Yes
Time FE	Yes	Yes	Yes	Yes
State FE	No	No	Yes	Yes
Legal FE	No	No	Yes	Yes
Bank FE	No	No	Yes	Yes
Firm FE	No	No	No	Yes
Observations	267,847	267,847	267,847	267,847
R^2	0.032	0.064	0.184	0.714

Notes: OLS estimation. Robust standard errors in parentheses. *** denotes significance at 1%, ** significance at 5% and * significance at 10%.

Table C.26: Service vs. Goods Exporters: Industry-time and Bank-time FE

	(1)	(2)	(3)	(4)
Variables	ln(Loan)	ln(Loan)	ln(Loan)	ln(Loan)
Service	0.537***	0.166***	0.169***	0.011
	(0.012)	(0.013)	(0.015)	(0.027)
ln(Sales)		0.053***	0.064***	0.063***
		(0.002)	(0.003)	(0.014)
ln(Age)		0.242***	0.185***	0.121**
		(0.005)	(0.006)	(0.061)
Multi-plant		-0.321***	-0.355***	0.044**
		(0.010)	(0.012)	(0.020)
ln(Fdi)		-0.027***	-0.020***	-0.010***
		(0.002)	(0.002)	(0.004)
ln(Equity)		0.135***	0.143***	-0.004
		(0.002)	(0.003)	(0.007)
Industry-time FE	Yes	Yes	Yes	Yes
State FE	No	No	Yes	Yes
Legal FE	No	No	Yes	Yes
Bank-time FE	No	No	Yes	Yes
Firm FE	No	No	No	Yes
Observations	321,073	321,073	321,073	321,073
R^2	0.035	0.065	0.224	0.436

Notes: OLS estimation. Robust standard errors in parentheses. *** denotes significance at 1%, ** significance at 5% and * significance at 10%.

D. Appendix of Chapter 6

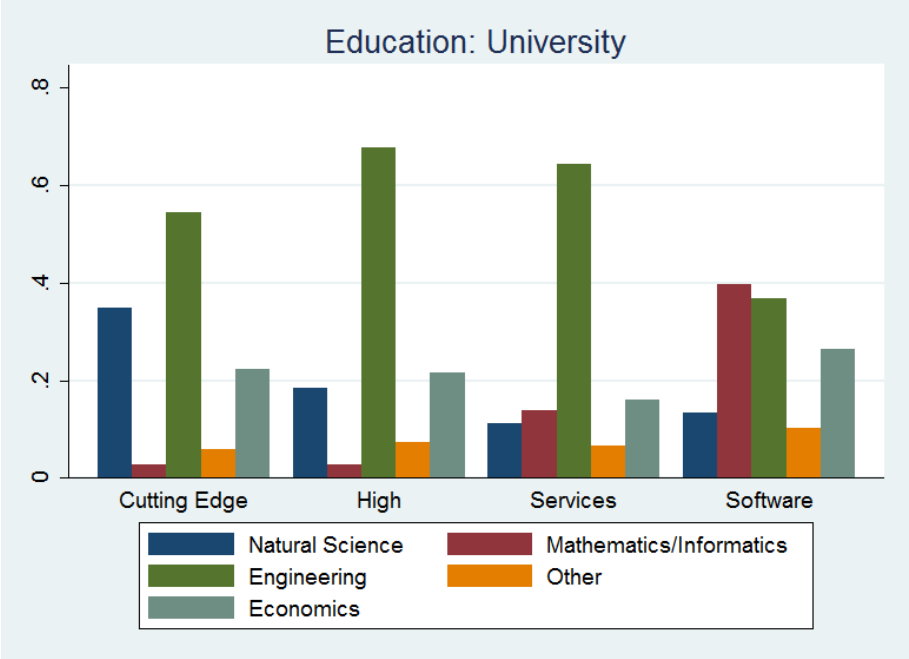


Figure D.1: Share of Education (University) in the Four Industries

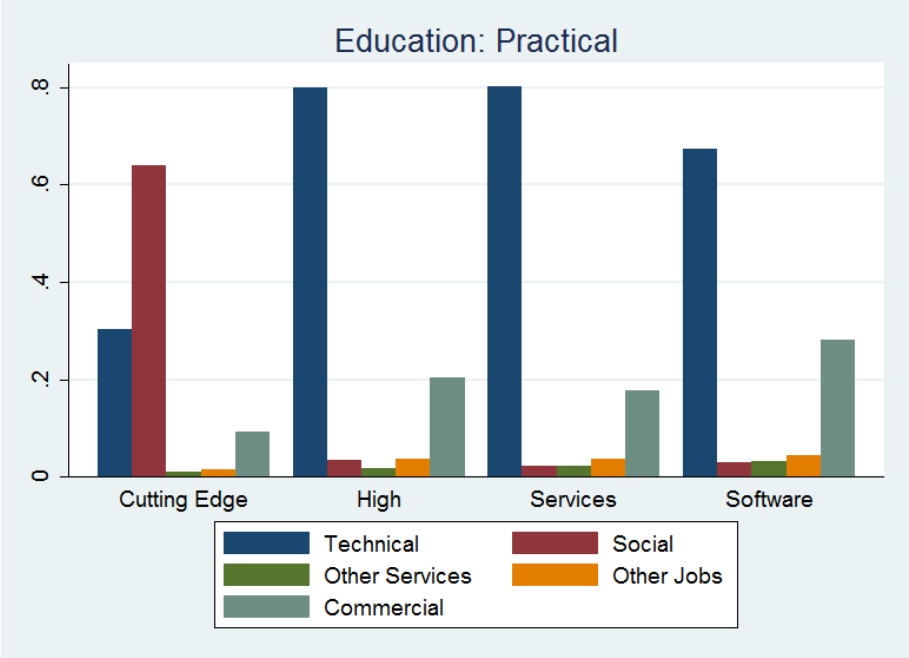


Figure D.2: Share of Education (Apprenticeship) in the Four Industries

Table D.1: R&D Expenditures and Education (University)

	(1)	(2)	(3)
Variables	expend	expend	expend
team	8,041*** (2,204)	3,373 (3,067)	3,427 (2,980)
nat	2,019 (3,198)	4,572 (2,572)	275 (2,847)
mathinf	373 (2,997)	-1,516 (1,745)	-1,157 (1,672)
eng	1,861 (3,328)	2,968 (2,092)	2,272 (2,203)
other	4,351 (4,602)	-624 (3,597)	1,463 (3,425)
Industry FE	Yes	Yes	Yes
Entrepreneur FE	No	Yes	Yes
Firm FE	No	No	Yes
Observations	2,198	965	943
R^2	0.016	0.028	0.062

Notes: OLS regressions. Robust standard errors in parentheses. *** denotes significance at 1%, ** significance at 5% and * significance at 10%.

Table D.2: Newness and Education (University)

	(1)	(2)	(3)
Variables	new	new	new
team	0.201*** (0.064)	-0.037 (0.096)	-0.102 (0.101)
nat	0.250** (0.101)	0.293** (0.128)	0.264** (0.133)
mathinf	0.000 (0.102)	-0.027 (0.126)	-0.043 (0.128)
eng	0.081 (0.085)	0.108 (0.105)	0.141 (0.107)
other	0.094 (0.124)	-0.003 (0.162)	0.031 (0.170)
Industry FE	Yes	Yes	Yes
Entrepreneur FE	No	Yes	Yes
Firm FE	No	No	Yes
Observations	1,617	1,045	1,021
Log-likelihood	-1,529.01	-938.74	-865.93

Notes: Ordered probit regressions. Robust standard errors in parentheses. *** denotes significance at 1%, ** significance at 5% and * significance at 10%.

Table D.3: Product Innovation and Education (University)

	(1)	(2)	(3)
Variables	prod	prod	prod
team	-0.012 (0.024)	-0.041 (0.046)	-0.053 (0.046)
nat	-0.014 (0.040)	0.026 (0.063)	0.032 (0.063)
mathinf	-0.090** (0.040)	-0.079 (0.062)	-0.068 (0.061)
eng	-0.075** (0.033)	-0.064 (0.053)	-0.070 (0.052)
other	0.049 (0.050)	0.037 (0.077)	0.040 (0.077)
Industry FE	Yes	Yes	Yes
Entrepreneur FE	No	Yes	Yes
Firm FE	No	No	Yes
Observations	1,734	730	716
Log-likelihood	-1,153.88	-484.01	-467.47

Notes: Probit regressions. Marginal effects reported at the mean values. Robust standard errors in parentheses. *** denotes significance at 1%, ** significance at 5% and * significance at 10%.

Table D.4: Process Innovation and Education (University)

	(1)	(2)	(3)
Variables	proc	proc	proc
team	0.051** (0.022)	0.003 (0.043)	-0.024 (0.043)
nat	-0.053 (0.037)	-0.061 (0.061)	-0.081 (0.058)
mathinf	-0.009 (0.038)	-0.025 (0.060)	-0.029 (0.058)
eng	-0.039 (0.031)	-0.035 (0.050)	-0.027 (0.048)
other	-0.061 (0.046)	-0.047 (0.072)	-0.033 (0.071)
Industry FE	Yes	Yes	Yes
Entrepreneur FE	No	Yes	Yes
Firm FE	No	No	Yes
Observations	1,739	733	719
Log-likelihood	-1,044.25	-463.45	-439.09

Notes: Probit regressions. Marginal effects reported at the mean values. Robust standard errors in parentheses. *** denotes significance at 1%, ** significance at 5% and * significance at 10%.

Table D.5: R&D Expenditures and Education (Apprenticeship)

	(1)	(2)	(3)
Variables	expend	expend	expend
team	5,788*** (1,696)	2,918*** (1,131)	3,048*** (1,183)
tech	-5,370 (3,342)	-1,238 (1,062)	-1,112 (1,097)
social	-11,844* (6,683)	-4,216** (1,845)	-3,996** (1,875)
other_serv	-5,369** (2,608)	-1,023 (1,289)	-1,213 (1,376)
other_job	-4,499 (3,510)	1,465 (3,892)	1,923 (4,189)
Industry FE	Yes	Yes	Yes
Entrepreneur FE	No	Yes	Yes
Firm FE	No	No	Yes
Observations	2,205	1,033	998
R^2	0.025	0.070	0.101

Notes: OLS regressions. Robust standard errors in parentheses. *** denotes significance at 1%, ** significance at 5% and * significance at 10%.

Table D.6: Newness and Education (Apprenticeship)

	(1)	(2)	(3)
Variables	new	new	new
team	0.348*** (0.071)	0.170 (0.107)	0.078 (0.114)
tech	-0.081 (0.093)	-0.109 (0.111)	-0.021 (0.116)
social	-0.582*** (0.157)	-0.465*** (0.181)	-0.339* (0.183)
other_serv	0.287 (0.213)	0.386* (0.227)	0.487** (0.220)
other_job	0.292 (0.187)	0.134 (0.214)	0.277 (0.218)
Industry FE	Yes	Yes	Yes
Entrepreneur FE	No	Yes	Yes
Firm FE	No	No	Yes
Observations	1,585	1,075	1,038
Log-likelihood	-1,240.23	-839.44	-777.08

Notes: Ordered probit regressions. Robust standard errors in parentheses. *** denotes significance at 1%, ** significance at 5% and * significance at 10%.

Table D.7: Product Innovation and Education (Apprenticeship)

	(1)	(2)	(3)
Variables	prod	prod	prod
team	0.082*** (0.025)	0.046 (0.047)	0.020 (0.048)
tech	-0.055* (0.032)	-0.064 (0.047)	-0.047 (0.048)
social	-0.005 (0.049)	0.017 (0.074)	0.032 (0.075)
other_serv	0.079 (0.081)	0.031 (0.125)	0.038 (0.126)
other_job	-0.006 (0.067)	0.011 (0.103)	0.028 (0.103)
Industry FE	Yes	Yes	Yes
Entrepreneur FE	No	Yes	Yes
Firm FE	No	No	Yes
Observations	1,708	738	714
Log-likelihood	-1,115.05	-485.71	-452.37

Notes: Probit regressions. Marginal effects reported at the mean values. Robust standard errors in parentheses. *** denotes significance at 1%, ** significance at 5% and * significance at 10%.

Table D.8: Process Innovation and Education (Apprenticeship)

	(1)	(2)	(3)
Variables	proc	proc	proc
team	0.071*** (0.023)	0.111*** (0.043)	0.072 (0.045)
tech	-0.040 (0.030)	-0.010 (0.046)	0.023 (0.046)
social	0.067 (0.043)	0.114 (0.071)	0.140* (0.072)
other_serv	0.009 (0.076)	0.051 (0.118)	0.063 (0.126)
other_job	-0.144* (0.066)	-0.078 (0.096)	-0.058 (0.098)
Industry FE	Yes	Yes	Yes
Entrepreneur FE	No	Yes	Yes
Firm FE	No	No	Yes
Observations	1,716	744	718
Log-likelihood	-985.40	-455.29	-425.73

Notes: Probit regressions. Marginal effects reported at the mean values. Robust standard errors in parentheses. *** denotes significance at 1%, ** significance at 5% and * significance at 10%.

Table D.9: R&D and Education (University)

	(1)	(2)	(3)
Variables	r&d	r&d	r&d
nat	0.106* (0.057)	0.120 (0.086)	0.129 (0.085)
mathinf	-0.012 (0.052)	0.008 (0.075)	0.018 (0.074)
eng	-0.018 (0.044)	-0.002 (0.065)	0.031 (0.064)
other	-0.063 (0.071)	-0.067 (0.100)	-0.056 (0.097)
Industry FE	Yes	Yes	Yes
Entrepreneur FE	No	Yes	Yes
Firm FE	No	No	Yes
Observations	1,259	559	547
Log-likelihood	-788.22	-338.97	-324.26

Notes: Probit regressions. Single entrepreneurs only. Marginal effects reported at the mean values. Robust standard errors in parentheses. *** denotes significance at 1%, ** significance at 5% and * significance at 10%.

Table D.10: Market Release and Education (University)

	(1)	(2)	(3)
Variables	mrel	mrel	mrel
nat	0.074 (0.062)	0.165** (0.071)	0.180*** (0.066)
mathinf	-0.142** (0.058)	-0.081 (0.067)	-0.078 (0.061)
eng	-0.063 (0.049)	-0.003 (0.057)	0.043 (0.051)
other	-0.074 (0.079)	0.148 (0.106)	-0.074 (0.098)
Industry FE	Yes	Yes	Yes
Entrepreneur FE	No	Yes	Yes
Firm FE	No	No	Yes
Observations	849	545	533
Log-likelihood	-487.07	-289.99	-259.85

Notes: Probit regressions. Single entrepreneurs only. Marginal effects reported at the mean values. Robust standard errors in parentheses. *** denotes significance at 1%, ** significance at 5% and * significance at 10%.

Table D.11: R&D and Education (Apprenticeship)

	(1)	(2)	(3)
Variables	r&d	r&d	r&d
tech	-0.066** (0.030)	-0.090** (0.042)	-0.069 (0.044)
social	-0.212*** (0.052)	-0.131* (0.077)	-0.134* (0.078)
other_serv	0.037 (0.075)	0.114 (0.112)	0.143 (0.116)
other_job	-0.019 (0.065)	0.024 (0.092)	0.032 (0.095)
Industry FE	Yes	Yes	Yes
Entrepreneur FE	No	Yes	Yes
Firm FE	No	No	Yes
Observations	1,596	740	711
Log-likelihood	-852.21	-402.88	-379.95

Notes: Probit regressions. Single entrepreneurs only. Marginal effects reported at the mean values. Robust standard errors in parentheses. *** denotes significance at 1%, ** significance at 5% and * significance at 10%.

Table D.12: Market Release and Education (Apprenticeship)

	(1)	(2)	(3)
Variables	mrel	mrel	mrel
tech	-0.014 (0.037)	-0.037 (0.042)	-0.017 (0.041)
social	-0.078 (0.060)	-0.049 (0.069)	-0.049 (0.066)
other_serv	0.096 (0.081)	0.135 (0.101)	0.162 (0.102)
other_job	0.088 (0.075)	0.050 (0.086)	0.054 (0.081)
Industry FE	Yes	Yes	Yes
Entrepreneur FE	No	Yes	Yes
Firm FE	No	No	Yes
Observations	1,093	738	709
Log-likelihood	-552.65	-359.25	-318.13

Notes: Probit regressions. Single entrepreneurs only. Marginal effects reported at the mean values. Robust standard errors in parentheses. *** denotes significance at 1%, ** significance at 5% and * significance at 10%.

Table D.13: Propensity Score Matching (University)

	(1)	(2)	(3)	(4)
Variables	nat	mathinf	eng	all
r&d	-0.033 (0.171)	0.256** (0.121)	0.151 (0.131)	0.163 (0.111)
mrel	0.167 (0.164)	0.146 (0.112)	0.135 (0.117)	0.176* (0.098)
expend	11,507*** (4,053)	3,642 (2,671)	3,858 (3,500)	4,324 (2,945)
new	0.467 (0.386)	0.390* (0.208)	0.327 (0.274)	0.396* (0.218)
prod	0.067 (0.170)	-0.122 (0.138)	-0.107 (0.132)	-0.150 (0.114)
proc	0.050 (0.171)	-0.146 (0.133)	0.060 (0.132)	0.065 (0.112)
Untreated	60	60	60	60
Treated	60	82	318	460
Observations	120	142	378	520

Notes: Nearest neighbor matching. Robust standard errors in parentheses. *** denotes significance at 1%, ** significance at 5% and * significance at 10%.

Table D.14: Propensity Score Matching (Apprenticeship)

	(1)
Variables	tech
r&d	-0.048 (0.076)
mrel	-0.003 (0.070)
expend	805 (1,622)
new	-0.020 (0.156)
prod	-0.075 (0.079)
proc	0.040 (0.074)
Untreated	107
Treated	399
Observations	355

Notes: Nearest neighbor matching. Robust standard errors in parentheses. *** denotes significance at 1%, ** significance at 5% and * significance at 10%.

Affidavit

I hereby declare that the dissertation entitled

The Impact of Finance on Trade and Determinants of Start-Up Innovations

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