Innovation, Credit Constraints, and Trade Credit:

Evidence from a Cross-Country Study

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Abstract

This paper studies the relationship between trade credit and innovation. While trade credit is well researched in the finance literature, its link to innovation has been neglected in prior research. We argue that innovative small and medium-sized enterprises (SMEs) are more likely to use trade credit than non-innovative SMEs because of credit constraints and that business partners may have incentives to offer trade credit especially to innovative SMEs. The relationship between innovation and trade credit is empirically examined by using a sample of SMEs from 14 European countries. The results of an econometric analysis confirm a positive relationship between innovation and trade credit. In particular, SMEs with product innovations have a higher probability of using trade credit than other SMEs. Moreover, the results suggest that the effect of product innovation is only statistically significant if SMEs report that access to financing or cost of financing are obstacles for the operation and growth of their businesses. Hence, the results point to the relevance of trade credit as a source of short-term external finance for innovative SMEs which are credit constrained.

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1   Introduction

Many firms allow their customers to delay payment for goods already delivered and by offering trade credit they enable their business partners to cope with liquidity problems. The results of empirical studies show that trade credit is a very important source of short-term external finance.[1] To date, a number of empirical and theoretical studies analyzed the demand for trade credit and the provision of trade credit: With respect to the demand for trade credit findings suggest that bank credit constrained firms are more likely to resort to trade credit (Biais & Gollier, 1997; Petersen & Rajan, 1997). Suppliers may be willing to provide trade credit to their customers if they have better information about the business and the credit risk of their customers than banks and if they have less problems to obtain external finance than their customers (Schwartz, 1974). Moreover, firms may provide trade credit in order to price discriminate since lengthening the credit period implies a reduction in the effective price (Chee K. NG, Smith, & Smith, 1999). Hence, suppliers may be more willing to offer trade credit to the most price elastic segment of the market, e.g. credit rationed firms, or they may price discriminate because they may have long-term interest in the survival of the business partner (Petersen & Rajan, 1997).

This paper contributes to the existing literature by studying the link between trade credit and innovation. We argue that especially *innovative* small and medium-sized enterprises (SMEs) have an incentive to resort to trade credit and at the same time are more likely to be offered trade credit by their business partners. SMEs are per se more likely to be credit constrained than larger firms (Beck, Demirgc-Kunt, & Maksimovic, 2005) but this may be even more severe for innovative SMEs. If an innovative SME needs short-term external finance it may be credit rationed because banks may have problems to scrutinize the value of the innovative SME and because its intangible assets cannot be used as a collateral for bank loans. Hence, innovative SMEs having problems to obtain sufficient external financing may resort to trade credit. Suppliers may be willing to offer trade credit to an innovative SME because they are better informed about the business situation of the SME than banks and because they are able to assess the future growth potential of the innovative SME. The supplier may help with trade credit, for instance, if she or he expects that a product innovation will lead to

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[1] Petersen and Rajan (1997), for instance, state that "trade credit is the single most important source of short-term external finance for firms in the United States".

an increase in SME's future sales which may in turn positively affect own future sales given that the business relation will last in the future. This would imply a positive relationship between innovation and trade credit. To the authors' best knowledge the relationship between innovation and trade credit has not been analyzed yet. However, better knowledge about this link is needed to understand how innovative SMEs cope with liquidity problems.

A related strand of literature which dates back to (Schumpeter, 1942) deals with the role of internal finance for R&D investment. The results of empirical studies suggest that the flow of internal finance is an important determinant of private R&D efforts (Hall, 2002; Himmelberg & Petersen, 1994). Our research question, however, is quite different. We focus on trade credit as a source of short-term external finance and investigate whether current use of trade credit is related to firms' product innovations in preceding years. Hence, we do not hypothesize that trade credit is a determinant of innovation activities. As pointed out by Miwa and Ramseyer (2008) firms make use of trade credit when they face short-term unexpected exigencies and consequently this type of external finance does not lend itself to financing of long-term oriented R&D investments.

Based on a sample of 3869 small and medium-sized enterprises (SMEs) from 14 European countries obtained from the World Bank Enterprise Surveys we investigate the relationship between innovation and trade credit. Our results suggest that SMEs that upgraded a product line and at the same time introduced a new product line have a higher probability of using trade credit as a source of short-term finance. The probability of using trade credit does not increase, if SMEs solely introduced a new product line. Moreover, a statistically significant relationship between product innovation and trade credit does only exist for SMEs reporting that they face credit constraints whereas this relationship is not significant for firms which do not have problems to obtain debt financing. Furthermore, separate estimations for Germany and transition economies confirm the positive relationship between innovation and trade credit but results suggest that it is stronger for German SMEs.

The paper is structured as follows. In the next section we present theories on trade credit and explain in more detail the link between innovation and trade credit. The third section describes the data set. In the fourth section estimation results are presented and the fifth section discusses the results and concludes.

2 Theoretical framework

In this section we analyze both the motives of innovative SMEs to use trade credit and the motives of their business partners to offer trade credit. We first present existing theories on the demand for trade credit and the provision of trade credit. In doing so, we focus on those theories which are relevant for deriving the link between innovation and trade credit.[2]

Demand for trade credit

From a theoretical perspective it is well known that asymmetric information may lead to adverse selection in financial markets (Stiglitz & Weiss, 1981). Firms may receive a smaller loan than they desire at the quoted interest rate or among borrowers, some receive loans and others do not although they are observationally identical. Emery (1984) argues that firms facing credit constraints use more trade credit than firms without credit constraints. Empirical support for this hypothesis is reported by Atanasova and Wilson (2003), Danielson and Scott (2004) and Nilsen (2002) who find that credit rationed firms increase their demand for trade credit.

Furthermore, several studies report empirical evidence for a relationship between firm growth rates and the use of trade credit (Cunat, 2007; Tsuruta, 2008). Cunat (2007) finds that firms with high growth rates tend to increase their use of trade credit relative to other sources of finance in case of liquidity shocks. This can be explained by fast growing firms' need for external finance. This is in line with the finding reported by Howorth and Reber (2003) that fast growing firms tend toward habitual late payment of trade credit. Moreover, the results reported by Tsuruta (2008) suggest that firms with a high level of intangible assets are more likely to use trade credit than firms with low levels of intangible assets.

However, as pointed out by Chee K. NG et al. (1999, p. 1110) trade credit might be a relatively expensive form of short-term finance. In their sample the most common form of trade credit is "2/10 net 30"' which is a combination of a 2 percent discount for payment within 10 days and a net period ending on day 30. This implies an annual interest rate of 43.9 percent. Hence, firms tend to use trade credit only if they need more short-term external finance than provided

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[2]Excellent surveys of trade credit theories are provided by Petersen and Rajan (1997), Chee K. NG et al. (1999). Surveys of empirical results are presented by Summers and Wilson (2003) and Cheng and Pike (2003).

by financial institutions. The most relevant explanations for using this relatively expensive kind of external financing are credit rationing by banks and high growth rates implying a need of external finance. Consequently, credit rationed firms are more likely to use trade credit even if they would prefer other sources of short-term external finance (Petersen & Rajan, 1994).

Provision of trade credit

According to the *financing advantage theory of trade credit* suppliers may have advantages as compared to financial institutions, like banks, in offering credit (Schwartz, 1974). Petersen and Rajan (1997) list three major sources for such advantages: advantage in information acquisition, advantage in controlling the buyer, and advantage in salving value from existing assets. Having closer relationship with their customers, suppliers are able to gain information about their customers in a cheaper way than banks. Moreover, suppliers use different sources of information than banks do and they are often able to seize delivered goods when customers do not pay. There is an advantage in salving if the supplier is able to restore the delivered good before the customer has assimilated it. Another advantage is that a supplier can stop delivering goods to its customer. If the customer has no alternative to get that input, the supplier has the power to threaten its buyers. Financial institutions like banks do not have that kind of power (Bastos & Pindado, 2007).

According to the *price discrimination theory of trade credit* offering trade credit to specific customers may be considered as an alternative way to practice price discrimination because trade credit offered to specific buyers is equivalent to a reduction in input price for these buyers. Empirical evidence for the price discrimination theory of trade credit is reported by Pike, Cheng, Carvens, and Lamminmaki (2005) and Chee K. NG et al. (1999). There are two major reasons for using trade credit as a measure to price discriminate (Petersen & Rajan, 1997). First, in the *short-run* suppliers may provide trade credit as a form of price reduction to customers with a more elastic demand. Second, suppliers may have a *long-run* incentive to help customers which are in financial trouble. Suppliers may have an interest in the survival of customers to profit from an increase in customers future demand.

Trade credit and innovation

Theoretical and empirical findings suggest that the demand for trade credit is positively related to credit constraints. We argue that especially *innovative SMEs* have a higher probability of using trade credit. First, innovative firms are more likely to be credit constrained than non-innovative SMEs because banks may have problems to scrutinize the firm value if firms' assets are mainly intangible. The results of several empirical studies provide empirical evidence for the hypothesis that innovative firms tend to be credit constrained (Guiso, 1998; Hyytinen & Toivanen, 2005; Ughetto, 2009). Second, small firms are more likely to be credit constrained than large firms irrespective whether they are innovative or non-innovative (Beck et al., 2005; Aghion, Fally, & Scarpetta, 2007; Jaramillo, Schiantarelli, & Weiss, 1996). Therefore we expect that innovative SMEs have a higher probability of using trade credit as a source of working capital than non-innovative firms.

Theoretical and empirical findings also suggest that the demand for trade credit is positively related to firm growth. We argue that innovative firms are more likely to use trade credit because they exhibit higher growth rates than non-innovative firms. Almus and Nerlinger (1999) find that new technology-based firms have higher growth rates as compared to non-innovative ones. Coad and Rao (2008) report that being innovative is of crucial importance for fast-growing firms. Roper (1997) finds a positive link between product innovations and output growth while Brouwer, Kleinknecht, and Reijen (1993) report a positive influence of product innovation on employment growth. Furthermore, results suggest that differences in firm performance measured as sales per employee can be explained by innovation activities. Lööf and Heshmati (2002) find that firms with a high share of sales from new products perform better. Although firm growth is measured in different ways empirical studies point to a positive link between innovation (e.g. product innovation) and firm growth. Hence, innovative SMEs tend to have a higher probability of using trade credit.

According to the financing theory of trade credit suppliers may have an advantage in offering credit to their innovative customers as compared to traditional lenders, like banks, and may therefore provide trade credit to *innovative* customers even when banks do not. Suppliers may offer trade credit to bank credit constrained customers if suppliers have better information about the business of their trading partner than banks. Suppliers may have access to other sources

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of information than banks which allows them to evaluate the situation of innovative SMEs and enables them to identify customer potentials which cannot be identified by banks. Furthermore, suppliers may use trade credit as a measure to price discriminate and provide financial support especially to *innovative* SMEs. There might be a *short-run* incentive if the demand of innovative customers are more price elastic because of the limited access to bank loans. Suppliers may also have a *long-run* interest in the survival of innovative customers to benefit from a future growth in demand.

To summarize, theory and empirical results let us expect that the demand for trade credit and provision of trade credit are positively related to innovation activities of SMEs. In our empirical analysis we focus on product innovations, i.e. new product lines or upgrades of existing product lines. We argue that especially product innovations – new products or upgraded products – tend to be related to future growth. In contrast, the relationship between process innovation and future firm growth is less clear-cut. Reduction in marginal cost may result in an increase in market shares but can also be viewed as as a more defensive measure to deal with fierce market competition. Moreover, it might be easier for suppliers to recognize product innovations and to assess their growth effects as compared to process innovations. Both theories, financing advantage theory and price discrimination theory suggest that suppliers tend to offer trade credit rather to innovative than to non-innovative SMEs .

Institutional and macroeconomic effects

Beyond innovation and firm specific characteristics trade credit provision and demand for trade credit may be influenced by institutional and macroeconomic effects. For instance, Fisman and Love (2003) point out the different role of trade credit for firms in countries with highly developed financial markets and firms in countries with less developed ones. Moreover, monetary policy and its transmission channels may differ between countries and this may affect the provision of trade credit and the demand for trade credit (Nilsen, 2002; Mateut, 2005). Atanasova and Wilson (2003) find that restrictive monetary policy leads to tighter bank credit constraints and therefore tends to increase the demand for trade credit. Empirical studies suggest that industry effects are also relevant since trade credit is more common in some industries than in others. Chee K. NG et al. (1999) suggest that there exists a lot of variation between industries in us-

ing trade credit, but less variation within. In our empirical analysis we take into account differences between countries and industries by controlling for country- and industry-specific fixed effects. One might argue, however, that controlling for fixed unobserved effects is not sufficient. For instance, a positive relationship between innovation and trade credit may exist in countries with well developed capital markets and institutions but may not exist in countries with less developed capital markets and institutions or vice versa. Our empirical analysis is based on a relatively homogeneous sample of 14 European countries which are members of the European Union. However, one might still argue that there are sizable differences between Germany on the one hand and transition economies on the other hand. Therefore, we allow for differences between countries by running separate regressions for SMEs from Germany and SMEs from transition economies.

3   Data

3.1   Sample

The data set used in this paper is based on the the World Bank Private Enterprise Surveys. World Bank Enterprise Surveys comprise firms from developing as well as developed countries. Most firms in the World Bank survey are small and medium-sized enterprises (SMEs) with less than 250 employees. Hence none of the firms in the sample should have the market power to force its suppliers to grant trade credit to them. Firms are surveyed regarding their perceptions on the major obstacles to enterprise growth, the relative importance of various constraints to increasing employment and productivity, and the effects of a country's business environment on its international competitiveness.[3]

In order to reduce the degree of heterogeneity this study analyzes firms from countries which were already members of the European Union in 2005 or were in the process of becoming members of the EU (Bulgaria and Romania). Moreover, worldwide economic effects should be similar since all companies were surveyed in 2005. Furthermore, this study focuses on firms that are more likely to be affected by financial constraints. All firms share the following characteristics: they are SMEs, the major shareholder of the company is either an individual or a family,

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[3]For detailed information about the World Bank enterprise surveys and the survey methodology see http://www.enterprisesurveys.org.

the companies are not publicly listed, no company is owned by a government or a state, the largest shareholder or owner of the firm is not a domestic company, a foreign company, a bank or an investment fund. Finally, not all questions are answered by all firms and therefore some firms had to be treated as missing. Our sample comprises 3869 firms from 14 countries.

3.2   Measurement of variables

Dependent variable

In the questionnaire, firms are asked to report their *current* sources of working capital and the corresponding shares in total working capital. Possible sources mentioned in the questionnaire are, for instance, internal funds or retained earnings, different types of banks, credit cards or trade credit. To investigate the relationship between innovation and the probability of using trade credit as a source of finance, a dummy variable is generated that takes on the value one if a firm uses trade credit and zero otherwise.

Product innovations

The World Bank Enterprise Surveys contains information about firm's product innovations during the last three years. In particular, firms report whether they have upgraded an existing product line or introduced a completely new one. We distinguish between firms which solely upgraded an existing product line, firms that solely implemented a new product line, and companies that did both. Based on this classification we generate three product innovation dummy variables taking the value one if a firm implemented the respective kind of product innovation during the last three years and zero otherwise.

Financial constraints

Firms are asked in the questionnaire whether access to financing (e.g., collateral required or financing not available from banks) or cost of financing (e.g., interest rates and charges) are obstacles for the operation and growth of their business. Firms assessed the respective obstacle on a five point scale ranging from no obstacle, minor, moderate, major to a very severe obstacle. We generate a dummy variable that takes on the value one if a firm reports that one of them is at least a moderate obstacle and zero otherwise.

Other control variables

To control for several firm characteristics we include the following control variables: the logarithm of the number of employees, which is a proxy for firm size, the logarithm of age, the share of high skilled employees, and purchase of raw material divided by sales. To control for international integration we include the variables share of domestic sales and share of domestic purchases. We use two other groups of binary variables, one for the owner status and one for the legal status. Within the owner status group we distinguish between individual and family owned firms. The reference group are individual owned firms. We also distinguish between four kinds of legal status, sole proprietorship, privately held limited company, partnership or cooperative and foreign owner. Here, sole proprietorship is the omitted group.

3.3 Descriptive Statistics

Table 1 reports the number of companies in each country and their shares in the total sample. Most firms are from Germany, Poland, Spain, Greece and Ireland. The rest of the SMEs are from Hungary, Romania, Czech, Bulgaria, Estonia, Latvia and Lithuania, Slovenia and Slovakia.

Table 2 reports on the distribution of sample SMEs across 20 industries. About 31 % of the SMEs are operating in manufacturing industries, especially in Metals, Machinery and Electronics, Garments, Beverages, Food and Wood, and Furniture industry. Around 69 % are non-manufaturing companies and most SMEs are operating in Retail and Wholesale trade, Construction, Hotels and Restaurants, Transport and Advertising and marketing industry.

[insert Table 1 about here]

[insert Table 2 about here]

[insert Table 3 about here]

To illustrate the importance of trade credit as a source of working capital we compare three external sources of working capital: trade credit, bank loans, and equity. As can be seen from Table 3 trade credit is used by 890 firms. 1229

companies use bank loans and 638 firms use equity. In our sample 23 percent of all SMEs use trade credit. The share of firms using trade credit exceeds the share of firms using equity and it is not much lower than the share of firms using bank loans. For those SMEs using trade credit the average share of trade credit in total working capital is 37,5 percent. This suggests that trade credit is as important as a source of short-term finance as bank loans and equity.

[insert Table 4 about here]

Table 4 presents descriptive statistics of the independent variables. As can be seen from the table, SMEs that use trade credit and SMEs that do not use trade credit differ with respect to product innovations. Among the SMEs using trade credit the share of firms that solely upgraded an existing product line is 5,6 percentage points higher and the share of firms that upgraded and at the same time introduced a new product line is 5,9 percentage points higher as compared to SMES that do not use trade credit. The difference is negative however for the share of firms that solely introduced a new product line. Furthermore, the share of firms reporting that cost of financing or access to financing are obstacles to the operation and growth of their business is about 8,8 percentage points higher for SMEs using trade credit. For the variables number of employees, main owner family, privately held, limited company and partnership or cooperative differences are positive. The differences for the variables main owner individual, sole proprietorship and share of domestic purchases are negative. Except for the variables new product line solely, share of high skilled employees, and foreign owner all differences are statistically significant at least at a five percent level.

4 Estimation results

Our data set allows us to identify SMEs using trade credit as a source of working capital but it does not contain information about the firms providing trade credit. Hence, we are not able to estimate the "demand" and the "supply" equations of trade credit separately. Instead, we test our main hypothesis of a positive relationship between product innovation and trade credit by estimating a binary probit regression model which may be interpreted as the reduced form of trade credit "demand" and "supply". The dependent variable takes on the value one

if a firm uses (receives) trade credit and zero otherwise. The right hand side variables are the product innovation variables, the dummy variable reflecting financial constraints, and various control variables such as size, age, legal form of the firm, owner status or export/import measures. Moreover, we include country and industry dummy variables to control for unobserved industry- and country-specific fixed effects.

Table 5 reports the marginal effects of the explanatory variables on the probability of using trade credit. Marginal effects instead of estimated coefficients of the probit model are reported because the former are more straightforward to interpret. Our estimation results reported in Column (1) of Table 5 suggest that upgrading an existing product line has a positive and statistically significant marginal effect on the probability of using trade credit. Upgrading an existing and at the same time implementing a new product line is associated with an increase in the probability of using trade credit by 5.75 percentage points and this marginal effect is statistically significant at the one percent level. SMEs that solely introduced a new product line are not more likely to use trade credit. Facing financing problems (limited access to or high cost of external finance) has also positive and statistically significant impact on the probability of using trade credit as a source of working capital. The second and the third columns report the results for SMEs with financing problems and SMEs without such problems. Our results show that the effect of upgrading a product line and implementing a new one is only statistically significant for firms with financing problems. Again, solely introducing a new product line does not have any statistically significant effect. Moreover, the estimated marginal effects of the product innovation variables increase if the empirical analysis is restricted to the sample of SMEs reporting financing problems. For firms without financing problems marginal effects of the innovation variables are statistically insignificant. The last two columns report marginal effects for manufacturing and non-manufacturing firms with financing problems. For manufacturing firms with financing problems solely upgrading a product line and doing both upgrading and introducing a new product have positive and statistically significant marginal effects on the probability of using trade credit, while for non-manufacturing firms with financial problems only SMEs that did both upgrading an existing product line and at the same time implementing a new one have a higher probability of using trade credit. Hence, our main hypothesis of a positive relationship between product innovation and the probability of using trade credit is confirmed by our empirical results.

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[insert Table 5 about here]

Control variables have also statistically significant effects on the probability of using trade credit. In all model specifications the number of employees has a positive and statistically significant impact on the probability of using trade credit which indicates that among SMEs larger firms are more likely to use trade credit. In contrast, the sign of the marginal effect of age is negative. Especially younger firms may be affected by financial constraints and may therefore have to resort to trade credit to overcome such restrictions. Huyghebaert (2006) finds that even business start-ups make use of trade credit and that trade credit theories are also relevant for start-ups (Huyghebaert, Gucht, & Hulle, 2007).

Furthermore, we find that family owned firms tend to have a higher probability of using trade credit than SMEs owned by individuals. This might be explained by network effects which may increase the probability of receiving trade credit. Family owned firms may have better opportunities to use social networks as compared to SMEs owned by individuals. Social network effects may also explain the finding that firms with the legal status partnership or cooperative have a higher probability of using trade credit than SMEs with the legal status sole proprietorship.

In order to check the robustness of our results we perform additional regressions. As explained in Section 2 we cannot exclude the possibility that countries differ with respect to the strength of the link between innovation and trade credit. One might expect, for instance, that the link between product innovation and the probability of using trade credit may be different for SMEs from Germany and SMEs from transition countries. We therefore run separate regressions for German SMEs and SMEs from transition economies. For each group we estimate one model using all firms and one model which is based on the subsample of firms with financing problems. The first two columns of Table 6 report the results for German SMEs and the last two columns present the results for the firms from transition economies.

[insert Table 6 about here]

For German SMEs we find a positive and statistically significant marginal effect of upgrading an existing product line and introducing a new product line

at the same time. The estimated value of the marginal effect implies that the probability of using trade credit is 14.6 percentage points higher for SMEs with upgraded products and newly introduced product lines. Column (2) reports the results for SMEs with financing problems. For these firms the marginal effect of innovation is even higher. SMEs with an upgraded product line have a 12.4 percentage points higher probability of using trade credit and for firms that did both upgrading an existing product line and implementing a new product line the probability is 38.8 percentage points higher. Estimation results based on the sample of SMEs from transition economies confirm the positive link between innovation and trade credit. SMEs that upgraded an existing product line and implemented a new product line have a higher probability of using trade credit.

[insert table 7 about here]

Table 7 reports the results of additional robustness checks. Column (1) reports the estimation results using alternative measures for credit constraints. As an alternative measures we generate dummy variables for each level of the two financing obstacles (access to finance, cost of finance). In column (1) SMEs reporting that access to financing and cost of financing are no obstacles are the reference group for the respective kind of obstacle. Compared to the model using the simple measure the marginal effects of the marginal effects of product innovation variables are hardly affected. Again SMEs upgrading an existing product line and upgrading an existing in combination with implementing a new product line are more likely to use trade credit. Column (2) reports the results of an estimation where a dummy variable is included which takes on the value one if a firm introduced a process innovation in the last three years and zero otherwise. As discussed in Section 2 we expect that product innovations are related to the probability whereas the introduction of process innovations is less likely to be related to the use of trade credit. This is confirmed by the statistically insignificant marginal effect of the process innovation variable. Column (3) reports the results of an estimation where a dummy variable is included which takes on the value one if a SME conducted R&D in the year 2004 and zero otherwise. Again the estimated marginal effect is statistically insignificant. Hence, SMEs conducting R&D are not more likely to use trade credit and/or their business partners may not be willing to provide trade credit unless the research activities lead to product innovations. The last column of table 7 provides empirical evidence for

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the relationship between product innovations and the probability of being credit constrained. Here, the dependent variable is the dummy variable reflecting financial constraints. We find positive and statistically significant marginal effects for all product innovation variables. This result is in line with the results reported by Ughetto (2009) who finds a positive link between product innovations and the probability of being credit constrained.

To summarize, our results suggest a positive relationship between product innovation and the probability of using trade credit. Furthermore, this positive link does only exist for credit constrained SMEs. These results are robust to changes in econometric specification, do hold for various sub-samples and are hardly affected by the inclusion of additional variables. Our results do also suggest that this relationship does only exist for product innovations whereas process innovations and R&D activities are not positively linked to the probability of using trade credit.

5 Discussion and Conclusion

This study contributes to the existing literature by studying the relationship between trade credit and innovation. We argue that innovative SMEs are more likely to use trade credit and to be offered trade credit by business partners. The demand for trade credit is related to product innovation since it is likely that innovative SMEs are credit constrained and may therefore resort to trade credit as a source of short-term external finance. Suppliers may have an incentive to offer trade credit to *innovative* SMEs because they are better informed than banks and because they can assess the growth potential of innovative SMEs.

Our main hypothesis of a positive relationship between innovation and trade credit is confirmed by the results of our empirical analysis. In particular, our results suggest that SMEs which upgraded an existing product line in the preceding years are more likely to use (receive) trade credit than other SMEs. The probability of using trade credit is not higher, however, if a SMEs solely introduced a completely new product line but did not upgrade an existing product line. Moreover, our results suggest that process innovations and R&D activities are not positively related to trade credit. One explanation for these results may be supplier expectations. While suppliers may be able to predict the demand for customers' upgraded products it is much more difficult to predict future demand

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for completely new product lines and to assess the effects of process innovations and R&D activities. Hence, trade credit does not seem to be related to innovation in general but the positive relationship seems to be restricted to incremental product innovations.

The results also suggest that the positive relationship between product innovation and trade credit does only exist for the subsample of SMEs reporting that access to financing and cost of financing are obstacles for the operation and growth of their businesses. This result can be explained by the incentives of SMEs to use trade credit. Depending on the terms of trade credit it can be an expensive source of working capital (Chee K. NG et al., 1999). Therefore, innovative SMEs which are not credit constrained simply may not have an incentive to use trade credit whereas credit constrained SMEs may use it in addition to bank loans or in the most extreme case as "financing of last resort". Finally, our results indicate that the positive relationship between product innovation and trade credit is stronger for German SMEs than for SMEs from transition economies which may point to the relevance of institutions, like legal systems or implicit institutions.

Taken together, our results suggest that trade credit is an important source of short-term external finance for innovative SMEs facing liquidity problems due to limited access to financing and cost of financing. Hence, trade credit offered by business partners may help innovative SMEs to cope with financial problems, to run their businesses, and to survive. This source of finance becomes even more important in times of financial crisis when banks reduce their credit supply and innovative SMEs are at risk to run out of bank credit.

Since this study is based on a cross-sectional data set, the results should be interpreted as prima facie evidence for a positive relationship between product innovation and trade credit. Future research should analyze the time dimension of this relationship by using panel data and it should examine the effects of product innovations on trade credit supply and demand separately. Moreover, it would be worthwhile to investigate the relationship between innovation, short-term and long-term financing within an integrated framework.

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Table 1: Sample countries: Number of observation for each country and share in total sample

Country	Frequency	Percent
Bulgaria	130	3,4%
Czech	205	5,3%
Estonia	85	2,2%
Germany	890	23,0%
Greece	384	9,9%
Hungary	303	7,8%
Ireland	332	8,6%
Latvia	81	2,1%
Lithuania	80	2,1%
Poland	547	14,1%
Romania	257	6,6%
Slovakia	73	1,9%
Slovenia	78	2,0%
Spain	424	11,0%
	3869	100,0%

Notes: Only small and medium-sized enterprises (SMEs)

Table 2: Industries: Number of observation for each industry and share in total sample

Industry	Frequency	Percent
Textiles and Leather	49	1,3%
Garments	199	5,1%
Food	105	2,7%
Beverages	120	3,1%
Metals, Machinery and Electronics	448	11,6%
Chemicals and Pharmaceutics	23	0,6%
Other Manufacturing	21	0,5%
Wood and Furniture	103	2,7%
Non-metallic and Plastic materials	62	1,6%
Paper	81	2,1%
Total manufacturing	1211	31%
IT services	60	1,6%
Construction	514	13,3%
Telecommunications	39	1,0%
Advertising and Marketing	215	5,6%
Other services	172	4,4%
Retail and Wholesale trade	954	24,7%
Hotels and Restaurants	287	7,4%
Transport	215	5,6%
Real estate and Rental services	179	4,6%
Mining and Quarrying	23	0,6%
Total non-manufacturing	2658	69%

Notes: Number of observations 3869

Table 3: External sources of working capital: trade credit, bank loans and equity

	Number of firms	Percent	Share in Working Capital
Trade credit	890	23,0%	37,50%
Bank	1229	31,0%	39,68%
Equity	658	17,0%	34,71%

Notes: Column (1): Number of SMEs using the respective kind of finance; Column (2): Share in total sample using the respective kind of finance; Column (3): Average share in working capital for SMEs that use the respective kind of finance

Table 4: Descriptive statistics of explanatory variables – SMEs without and with trade credit

Variable	Trade credit: No		Trade credit: Yes		
	Mean	Std. Dev.	Mean	Std. Dev.	Difference
Upgraded product line solely	0.206	0.404	0.262	0.440	0.056***
New product line solely	0.065	0.247	0.054	0.226	-0.011
Upgraded and new product line	0.189	0.391	0.247	0.432	0.059***
Access to/cost of financing an obstacle	0.541	0.498	0.629	0.483	0.088***
Age	14.545	14.533	15.902	15.966	1.357**
Number of employees	20.502	35.401	30.257	44.452	9.755***
Purchases of raw material/Sales	0.409	0.168	0.427	0.159	0.018***
Share of high skilled employees	0.173	0.267	0.163	0.229	-0.010
Main owner: Family	0.171	0.377	0.287	0.452	0.115***
Main owner: Individual	0.834	0.372	0.735	0.442	-0.099***
Foreign owner	0.046	0.209	0.048	0.215	0.003
Sole proprietorship	0.450	0.498	0.309	0.462	-0.141***
Privately held. limited company	0.300	0.458	0.343	0.475	0.043**
Partnership or cooperative	0.249	0.433	0.348	0.477	0.099***
Share of domestic sales	0.939	0.185	0.924	0.198	-0.015**
Share of domestic purchases	0.779	0.346	0.738	0.347	-0.042***

Notes: Column (1) and (2): Means and standard deviations reported for SMEs without trade credit; Column (3) and (4): Means and standard deviations reported for SMEs with trade credit; Column (5): Difference between SMEs with and without trade credit. *** $p<0.01$, ** $p<0.05$, * $p<0.1$

Table 5: Probit estimation results: relationship between the probability of using trade credit, credit constraints, and product innovation

Variable	(1)	(2)	(3)	(4)	(5)
Upgraded product line solely	0.0392**	0.0723***	-0.00117	0.141***	0.0377
	(0.0184)	(0.0264)	(0.0254)	(0.0429)	(0.0341)
New product line solely	-0.0123	-0.0160	0.00908	-0.0438	0.0167
	(0.0287)	(0.0400)	(0.0424)	(0.0460)	(0.0605)
Upgraded and new product line	0.0575***	0.0888***	0.0205	0.0833**	0.0957**
	(0.0205)	(0.0281)	(0.0294)	(0.0383)	(0.0386)
Obstacle: access to/ cost of finance	0.0911***	–	–	–	–
	(0.0137)				
Log(age)	-0.0237**	-0.0206	-0.0264*	-0.0438**	-0.00115
	(0.0103)	(0.0151)	(0.0136)	(0.0208)	(0.0202)
Log(employees)	0.0457***	0.0409***	0.0521***	0.0428***	0.0325***
	(0.00650)	(0.00911)	(0.00917)	(0.0122)	(0.0124)
Share of high skilled employed	0.0255	-0.0190	0.0606	0.113*	-0.0841
	(0.0291)	(0.0418)	(0.0401)	(0.0620)	(0.0549)
Purchase of raw material/ Sales	-0.0252	0.0323	-0.105	-0.0272	0.0626
	(0.0518)	(0.0760)	(0.0695)	(0.133)	(0.0933)
Main owner: Family	0.0765***	0.0684**	0.0881***	0.0960**	0.0617*
	(0.0193)	(0.0266)	(0.0288)	(0.0420)	(0.0343)
Foreign owner	-0.0252	-0.00570	-0.0408	-0.00345	-0.0359
	(0.0313)	(0.0503)	(0.0376)	(0.0621)	(0.0676)
Privately held, limited company	0.0281	0.0845***	-0.0302	0.164***	0.0652*
	(0.0212)	(0.0316)	(0.0276)	(0.0588)	(0.0393)
Partnership or cooperative	0.0564***	0.0860***	0.0176	0.137***	0.0720*
	(0.0203)	(0.0282)	(0.0285)	(0.0430)	(0.0376)
Share of domestic sales	-0.0637*	-0.0909*	-0.0393	-0.0882*	-0.0710
	(0.0385)	(0.0517)	(0.0589)	(0.0532)	(0.104)
Share of domestic purchases	-0.0504**	-0.0691**	-0.0226	0.0133	-0.135***
	(0.0224)	(0.0311)	(0.0318)	(0.0405)	(0.0438)
Industry Fixed Effects	YES	YES	YES	YES	YES
χ^2	63.26***	59.54***	33.46**	14.23	31.35***
Country Fixed Effects	YES	YES	YES	YES	YES
χ^2	184.62***	138.03***	61.73***	37.31***	108.95***
Pseudo R^2	0.1248	0.1568	0.1055	0.2001	0.1430
Wald χ^2	472.27***	354.96***	165.80***	120.04***	221.03***
Number of observations	3869	2173	1696	785	1383

Notes: Marginal effects after probit: Dependent variable: Trade credit yes/no. Robust standard errors in parentheses. *** $p<0.01$, ** $p<0.05$, * $p<0.1$. Column (1): all SMEs are included; Column (2): only SMEs with financing problems are included; Column (3): only SMEs without financing problems are included; Column (4): only SMEs with financing problems operating in the manufacturing sector are included; Column (5):only SMEs with financing problems operating in non-manufacturing sectors are included.

Table 6: Probit estimation results: relationship between the probability of using trade credit and product innovation - differences between German SMEs and SMEs from transition countries

Variable	(1)	(2)	(3)	(4)
Upgraded product line solely	0.0364	0.124**	0.0506**	0.0824**
	(0.0410)	(0.0592)	(0.0245)	(0.0321)
New product line solely	-0.0740	0.105	0.0183	0.00597
	(0.112)	(0.164)	(0.0340)	(0.0421)
Upgraded and new product line	0.146**	0.388***	0.0564**	0.0449
	(0.0600)	(0.0647)	(0.0246)	(0.0292)
Obstacle: access to/ cost of to finance	0.220***	–	0.0500***	–
	(0.0337)		(0.0170)	
Log(age)	-0.0287	-0.00112	-0.0301**	-0.0299*
	(0.0267)	(0.0423)	(0.0147)	(0.0180)
Log(employees)	0.0662***	0.0173	0.0322***	0.0341***
	(0.0210)	(0.0326)	(0.00743)	(0.00929)
Share of high skill employed	-0.0486	-0.0759	0.0271	0.00930
	(0.0963)	(0.175)	(0.0336)	(0.0410)
Purchase of raw material/ Sales	-0.280**	-0.136	0.0854	0.138
	(0.117)	(0.183)	(0.0734)	(0.0934)
Main owner: Family	0.165***	0.0889	0.0514*	0.0456
	(0.0465)	(0.0670)	(0.0279)	(0.0332)
Foreign owner	0.0625	-0.00685	-0.0245	-0.00824
	(0.101)	(0.139)	(0.0350)	(0.0514)
Privately held, limited company	0.0959	0.178**	0.0704**	0.0966**
	(0.0604)	(0.0811)	(0.0330)	(0.0440)
Partnership or cooperative	0.0542	0.154**	0.0645***	0.0816***
	(0.0453)	(0.0672)	(0.0249)	(0.0314)
Share of domestic sales	0.328	0.151	-0.0525	-0.0733*
	(0.217)	(0.317)	(0.0360)	(0.0444)
Share of domestic purchases	-0.110	-0.128	-0.0378	-0.0388
	(0.0932)	(0.135)	(0.0238)	(0.0299)
Industry Fixed Effects	YES	YES	YES	YES
χ^2	37.67***	43.74***	28.01*	26.84*
Country Fixed Effects	NO	NO	YES	YES
χ^2			42.63***	15.54**
Pseudo R^2	0.1524	0.1581	0.1245	0.1174
Wald χ^2	155.62***	102.54***	188.60***	129.57***
Number of observations	888	456	1839	1228

Notes: Marginal effects are reported; Dependent variable: trade credit yes/no; Robust standard errors in parentheses *** $p<0.01$, ** $p<0.05$, * $p<0.1$; Column (1): only German SMEs are included; Column (2): only German SMES with financing are included; Column (3): only SMEs from transition countries are included; Column (4): only SMEs with financing problems from transition countries are included .

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Table 7: Additional estimation results

Variable	(1) Trade credit	(2) Trade credit	(3) Trade credit	(4) Access to/ cost of finance
Upgraded product line solely	0.0367**			0.126***
	(0.0184)			(0.0211)
New product line solely	-0.0136			0.0614*
	(0.0284)			(0.0354)
Upgraded and new product line	0.0568***			0.160***
	(0.0205)			(0.0217)
Process innovation		0.0141		
		(0.0160)		
Invested in R&D			0.0254	
			(0.0265)	
Obstacle: access to/ cost of finance		0.0965***	0.100***	
		(0.0136)	(0.0142)	
Access minor obstacle	0.0601***			
	(0.0231)			
Access moderate obstacle	0.109***			
	(0.0250)			
Access major obstacle	0.0847***			
	(0.0293)			
Cost minor obstacle	0.0981***			
	(0.0247)			
Cost moderate obstacle	0.0862***			
	(0.0250)			
Cost major obstacle	0.0291			
	(0.0274)			
Controlled for firm characteristics	YES	YES	YES	YES
Industry Fixed Effects	YES	YES	YES	YES
χ^2	68.21***	58.19***	61.33***	31.11**
Country Fixed Effects	YES	YES	YES	YES
χ^2	178.28***	191.65***	186.31***	242.79***
Pseudo R^2	0.1366	0.1215	0.1277	0.0966
Wald χ^2	507.18***	458.63***	443.56***	459.34***
Number of observations	3869	3851	3574	3869

Notes: Marginal effects are reported; Robust standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1. Column (1): Dummies for the degree of credit rationing are included; Column (2): Dummy included which takes on the value one if a SME introduced a process innovation and zero otherwise; Column (3): Dummy included which takes on the value one if a SME invested in R&D and zero otherwise; Column (4): Dependent variable is the dummy variable for credit constraints.