The Dynamics of Trade Credit and Bank Debt in SME Finance: International Evidence

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1. Introduction

Small to medium-sized enterprises (SMEs) are of key importance for economic activity, employment and growth in many countries. The European Commission (2005) defines SMEs as firms with fewer than 250 employees, turnover of less than €50 million and total assets less than €43 million. SMEs represent 98 per cent of all firms, and account for 67 per cent of total employment and 56 per cent of total gross value added in the European Union. In 2014 there were approximately 21 million SMEs in the European Union. However, SME finance remains challenging because these firms are more opaque, riskier, more financially constrained, and more bank-dependent than large firms. They cannot access capital markets or issue stocks or bonds. Instead, they largely depend on private debt, such as bank loans or trade credit to raise external finance.

However, little is known about the dynamics of the two main sources of external finance for SMEs: bank debt and trade credit. This is surprising because trade credit represents the second most important source of credit for SMEs after bank debt (see, for example, Petersen and Rajan (1994, 1997)). The overall level of trade credit also varies significantly across countries. In Italy, the median ratio of accounts payable to total assets is 26 per cent, but in Germany it is only 9 per cent.

Research has started to examine the importance of trade credit in different contexts.[1] For example, Carbó-Valverde *et al* (forthcoming) analyse the importance of trade credit for SMEs in Spain. They find that credit-unconstrained Spanish firms fund their investments mainly with bank finance, but strongly credit-constrained firms fund their investments with trade credit and this dependency increased during the global financial crisis.

In this paper, we investigate the dynamics of trade credit and bank debt at the firm level over time. Specifically, we study whether there is a substitution relationship between firms' use of bank debt and trade credit and how this relationship varies over time and across countries. This question is relevant because a high or low availability of debt finance can amplify or weaken the business

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1 For examples of the recent literature on trade credit, see Giannetti, Burkart and Ellingsen (2011); Boissay and Gropp (2013); Ferrando and Mulier (2013); Garcia-Appendini and Montoriol-Garriga (2013); Liu (2014); Carbó-Valverde, Rodriguez-Fernandez and Udell (forthcoming).

cycle.[2] If firms offset a shock to their bank debt with trade credit they can stabilise their total credit through the cycle. However, if bank debt and trade credit are complementary (i.e. they increase or decrease at the same time) then booms and recessions are amplified, resulting in higher volatility of economic activity over time. Hence, understanding the interplay between bank debt and trade credit over time and across countries has important policy implications.

Some studies provide support for a substitution relationship between bank debt and trade credit (Biais and Gollier 1997; Petersen and Rajan 1997; Cuñat 2007). Moreover, there is evidence that financially unconstrained firms redistribute part of their bank debt to financially constrained client firms by providing trade credit (Love, Preve and Sarria-Allende 2007; Garcia-Appendini and Montoriol-Garriga 2013; Liu 2014).

However, there is also evidence that bank debt and trade credit do not exhibit a substitution relationship. First, the relationship between bank debt and trade credit is time-varying. Kestens, Van Cauwenberge and Vander Bauwhede (2012) and Bastos and Pindado (2013) show that trade credit extension declined during the recent financial crisis – in contrast to the substitution hypothesis – due to the risk of credit contagion in the supply chain. If the substitution relationship held in all states of the economy, we should see an increase in trade credit extension during recessions as firms become more constrained. Second, there are studies showing that firms accumulate trade credit even if they are unconstrained and sufficiently liquid. Petersen and Rajan (1997) report a U-shaped relationship between trade payables and profitability; this relationship should be monotonically decreasing under the substitution hypothesis. Similarly, Fisman and Love (2003) show that firm age is positively related to trade credit, but theoretically we should expect a negative relationship under the substitution hypothesis.

Based on the evidence provided by the studies above, it is not clear whether there is a substitution or complementary relationship between trade credit and bank debt and which factors drive the relationship between these two sources of credit. The goal of this study is to provide comprehensive evidence on these questions. We base our analysis on a large-scale dataset of SMEs from the five biggest European Union countries during 2006–11.

Our identification strategy relies on three elements. First, we consider SMEs that have demand for credit. This focus is important because a complementary relationship could mean two things: either firms *cannot* substitute or they do not *want* to substitute. It is therefore crucial to investigate the substitution between different sources of credit for firms that actually have demand for external finance (Becker and Ivashina 2014). We do so by following Rajan and Zingales (1998) and considering only firm-year observations where the value of a firm's investments exceeds the value of its cash flows to ensure that the firm has demand for external finance. Second, we examine what happens when these firms exhibit a decrease in their bank debt. Third, we focus on the years of the recent financial crisis when banks were forced to contract their credit supply.

We measure whether a firm substitutes between bank debt and trade credit by using a new firm-specific and time-varying binary indicator. This substitution indicator (SI_{it}^{binary}) equals zero if trade credit decreases after a negative shock to short-term bank debt (complementary relationship) and equals one if trade credit increases after a negative shock to bank debt (substitution relationship).

2 See, for example, King and Levine (1993a, 1993b); Beck, Levine and Loayza (2000); Beck and Demirgüç-Kunt (2006).

Our study contributes to the literature in several ways. First, our measurement approach based on the substitution indicator has several advantages. It allows us to study the cross-sectional and time-series variation of the interplay between trade credit and bank debt. There could be a complementary relationship in certain periods and a substitution relationship in other periods, and these dynamics might depend on firm characteristics. The substitution indicator is flexible enough to detect both types of heterogeneity and makes it possible – in combination with the two other building blocks of our empirical strategy (a shock to bank debt during the crisis and focusing on SMEs that depend on external finance) – to identify a causal effect.

Second, we focus on SMEs because these firms are missing in the studies of Garcia-Appendini and Montoriol-Garriga (2013) and Liu (2014), who investigate the trade credit provision of large firms in the United States. Because SMEs cannot access public debt markets, their financing is limited to the choice between internal finance and external finance in the form of bank debt and trade credit. Hence, SMEs are the ideal testing ground for our study.

Third, many of the related studies use single-country data, which makes it difficult to generalise the results. We base our study on cross-country data from the five biggest European Union countries. Considering cross-country heterogeneity is important because firm characteristics, the financial system and the legal environment differ significantly between these countries, which affects the supply of and demand for different types of debt (see, for example, La Porta *et al* (1997); Demirgüç-Kunt and Maksimovic (2002); Beck, Demirgüç-Kunt and Maksimovic (2004); Berger and Udell (2006); Haselmann, Pistor and Vig (2010)).

We obtain the following principal results:

- First, we find that substitution and complementary relationships are almost equally likely over the entire sample period from 2006 to 2011. However, there is substantial variation across countries and over time. We find that the probability of a firm displaying a substitution relationship decreased significantly during the crisis. Compared to pre-crisis times, the probability of a firm displaying a substitution relationship is 28.7 per cent lower during the first stage of the crisis and 59.5 per cent lower during the second stage.
- Second, higher credit quality firms are more likely to display a substitution relationship.
- Third, substitution becomes more difficult during macroeconomic downturns; the probability of a firm displaying a substitution relationship was approximately 48 per cent lower at the peak of the crisis than before the financial crisis.
- Fourth, the effect of credit quality on substitution follows an inverse U-shaped relationship in the level of financial constraints. This finding suggests that the credit quality of the firm is most important for firms with an intermediate level of financial constraints.

Overall, we conclude that trade credit has rather limited scope to step into the gap when banks cut lending to SMEs.

Our findings indicate that the substitution relationship between bank debt and trade credit is not as straightforward as assumed in the existing literature. Firms with a lower credit quality have more difficulty in offsetting a shock to their short-term bank debt with trade credit. This finding contradicts the substitution theory of trade credit because these are exactly the firms that should substitute. Moreover, the probability of substitution decreased significantly when the financial

crisis deepened. This finding indicates that the substitution relationship between bank debt and trade credit is time-varying and ultimately procyclical (less substitution when the crisis is most severe), potentially amplifying the effect of recessions.

The remainder of the paper is organised as follows. In Section 2 we summarise the related literature and present our research questions. In Section 3 we describe the data and report summary statistics. In Section 4 we present the main results. Section 5 concludes.

2. Related Literature and Research Questions

The literature has identified several supply- and demand-side rationales for why trade credit is an important component of debt finance. From the supply side, trade credit:

- helps firms acquire private information about their customers (Smith 1987; Mian and Smith 1992; Petersen and Rajan 1997; Jain 2001)
- helps to enhance strong bargaining positions over customers (Giannetti *et al* 2011)
- decreases warehouse costs (Emery 1987)
- could result in a long-term supplier-customer relationship, leading to future business opportunities (Ng, Smith and Smith 1999).

The most important demand-side rationale for trade credit is that many firms, especially SMEs, resort to trade credit because they are financially constrained and, thus, have limited or no access to other forms of external funding (Biais and Gollier 1997; Petersen and Rajan 1997). This implies that bank debt and trade credit are substitutes because these firms attract trade credit if they have insufficient access to bank debt.

The substitution theory coincides with the redistribution view on trade credit (for example, see Love *et al* (2007) and Kestens *et al* (2012)). The redistribution view implies that firms that borrow from financial intermediaries redistribute their borrowings to those who do not have access to financial intermediaries. Garcia-Appendini and Montoriol-Garriga (2013) and Liu (2014) found empirical evidence for this mechanism. However, the evidence is based on trade credit provision among large firms from the United States.

Empirical research has shown that macroeconomic conditions have a significant influence on borrower-lender relationships (Petersen and Rajan 1994; Berger and Udell 2002; Nilsen 2002; Giannetti 2003; Puri, Rocholl and Steffen 2011). Access to credit deteriorates during recessions because creditors become more risk averse and therefore restrict credit extensions (Gertler and Gilchrist 1994). Accordingly, the relationship between trade credit and bank debt varies with the state of the economy.

Ferrando and Mulier (2013) find that firms use trade credit to manage growth. Trade credit matters more for growth in countries where trade credit is more common, though its marginal impact is lower. Financially constrained firms also rely more on trade credit for growth.

Bastos and Pindado (2013) provide an explanation for how the role of trade credit may change during macroeconomic downturns. The breakout of a crisis will trigger liquidity shocks for certain firms. These shocks make firms less creditworthy and therefore their credit availability at financial institutions will decrease. This can lead to two opposite scenarios. The good scenario follows the

substitution theory. In this case, firms suffering from credit constraints due to liquidity shocks will be able to get more trade credit in lieu of bank debt. The bad scenario holds that bank debt and trade credit exhibit a complementary relationship. In this scenario, firms facing liquidity shocks will see their access to trade credit restricted at the same time as their access to bank debt declines because of the risk of credit contagion (Jorion and Zhang 2009; Jacobson and von Schedvin 2015). Bastos and Pindado (2013) find that firms with a high share of accounts payable postponed payment during the global financial crisis to prevent liquidity problems. This transferred liquidity risk to suppliers, which eventually results in suppliers extending less trade credit. Kestens *et al* (2012) show that trade credit extension in Belgium decreased progressively during the recent financial crisis and this deterioration was more pronounced for firms that were dependent on short-term debt funding in the period directly before the crisis.

In summary, the dominant view in the literature is that trade credit and bank debt are substitutes. We have several critical remarks on this view.

- Bastos and Pindado (2013) show that an economic or financial crisis might change the substitution effect into a complementary effect because of contagion.
- Petersen and Rajan (1997) find that the most profitable firms strongly use trade credit. They also find that firms located in US Metropolitan Statistical Areas with poorly developed financial institutions have more trade credit. Both findings are not consistent with the substitution hypothesis.
- Fisman and Love (2003) find that young firms have the most difficulties in obtaining trade credit. This is in contrast with the substitution hypothesis, which implies that these firms cannot borrow from banks and therefore rely on trade credit.
- Many studies on trade credit do not consider its interplay with short-term bank debt and do not address the endogeneity between trade credit and bank debt. We take this issue explicitly into account in our empirical strategy.
- Studies on trade credit often rely on single-country data.[3] Haselmann *et al* (2010) document that national laws affect the modes of debt finance, suggesting that cross-country variation should be taken into account.
- From a conceptual perspective, firms cannot use bank debt and trade credit in the same way because these modes of debt finance have different liquidity effects. Firms that receive trade credit do not experience a cash inflow, while firms that receive bank debt experience a cash inflow that can be used in a flexible way.

Based on this discussion, we investigate the following research questions:

1. Is there a substitution or complementary relationship between trade credit and bank debt at the firm level?
2. How do firm credit quality, size and financial constraints affect this relationship?
3. How does this relationship vary across countries and over time?

3 See, for example, Biais and Gollier (1997); Petersen and Rajan (1997); Yang (2011); Kestens *et al* (2012); Boissay and Gropp (2013); Jacobson and von Schedvin (2015); and Carbó-Valverde *et al* (forthcoming).

3. Data and Summary Statistics

Our dataset comprises financial statement information from the Orbis and Sabi databases, both provided by Bureau van Dijk. It contains firm-year observations from the five largest countries in the European Union (France, Germany, Italy, Spain and the United Kingdom). Data for Spain come from the Sabi database; data for the other four countries are derived from Orbis. We restrict our analysis to firms that are not publicly listed and that have total assets less than €43 million in the last available calendar year, following the European Commission's definition of SMEs (European Commission 2005). We exclude financial firms, which is standard practice in empirical corporate finance research. Moreover, in Orbis there are many data points with values of zero. These have an ambiguous meaning – they can either mean zero, 'missing' or 'unknown'. To prevent this ambiguity in our dataset, we consider only data on firms where the value of accounts payable, accounts receivable and short-term bank debt equals at least €1 000 in all of the years in our sample period. We note that this threshold is rather low and it helps improve the quality of the final dataset.

Applying these selection criteria results in country-specific datasets with yearly observations from 2006 to 2011 (2006 to 2010 for Spain). The sample sizes differ substantially across countries. The samples from Italy (299 439 firm-year observations) and France (139 027 firm-year observations) are the largest; the sample from Germany is the smallest (8 302 firm-year observations). We therefore construct an aggregate dataset in a way that gives each country a weight that corresponds to its average GDP share among the five countries during the sample period. We do so by taking the x per cent biggest firms from the country-specific raw samples, where x is chosen to arrive at a sample composition that is in line with the country's average GDP share. The final aggregate dataset comprises 29 333 firm-year observations with 1 186 firms from Germany (28 per cent), 922 from France (22 per cent), 920 from the United Kingdom (21 per cent), 751 from Italy (17 per cent), and 501 from Spain (12 per cent). Alternatively, we construct a random aggregate sample. We stratified each of the country-specific raw samples into country-specific firm size quintiles and randomly select the same number of firms from each size quintile to arrive at a sample that is in line with the country's GDP share. The results for this random aggregate sample are similar to the ones we subsequently report.

3.1 The substitution indicator

While earlier studies have focused on the determinants of trade credit, we focus on the determinants of the substitution relationship directly. This is the key difference between this paper and related studies.

We adopt this approach because the relationship between bank debt and trade credit (or changes in both variables) is potentially endogenously determined. This endogeneity problem has not been sufficiently considered in many papers because they either regress trade credit on bank debt (or the other way around) or do not control for bank debt at all. These methodological choices make it difficult to draw conclusions about the complementarity or substitutability of trade credit for bank debt.[4]

4 See, for example, Nilsen (2002); Cuñat (2007); Love *et al* (2007); Kestens *et al* (2012); Bastos and Pindado (2013); Garcia-Appendini and Montoriol-Garriga (2013); Carbó-Valverde *et al* (forthcoming).

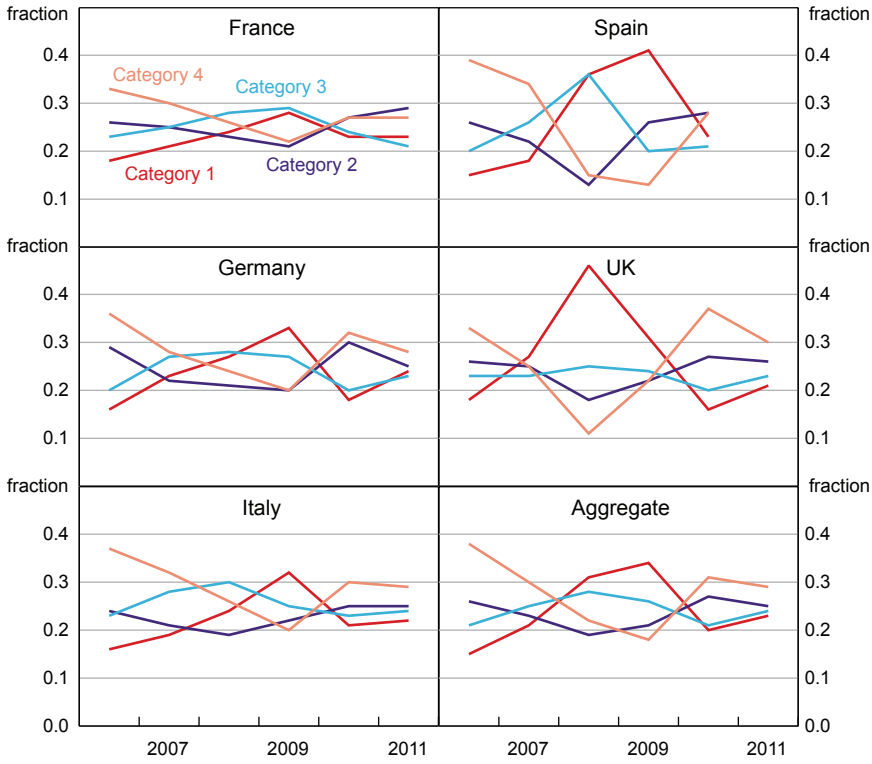
For this purpose, we introduce the substitution indicator ($SI_{ijt}^{overall}$), which indicates the nature of the relationship between bank debt (B_{ijt}) and trade credit (T_{ijt}) for firm *i* from country *j* at time *t*. It is defined as follows:

$$SI_{ijt}^{overall} = \begin{cases} 1 \text{ if } \Delta B_{ijt} \leq 0 \text{ and } \Delta T_{ijt} \leq 0 (\text{negative complementary relationship}) \\ 2 \text{ if } \Delta B_{ijt} \leq 0 \text{ and } \Delta T_{ijt} > 0 (\text{substitution}) \\ 3 \text{ if } \Delta B_{ijt} > 0 \text{ and } \Delta T_{ijt} \leq 0 (\text{substitution}) \\ 4 \text{ if } \Delta B_{ijt} > 0 \text{ and } \Delta T_{ijt} > 0 (\text{positive complementary relationship}). \end{cases} \quad (1)$$

We use a modified binary version of this index in our empirical framework. We introduce the binary substitution indicator below.

Figure 1 displays the relative frequency of the categories 1–4 of the substitution indicator by country and for the aggregate sample over time.

Figure 1: The Substitution Indicator $SI^{overall}$
Proportion of firms within category



Sources: Authors' calculations; Bureau van Dijk

For the entire sample period, the proportion of firms displaying a complementary relationship (categories 1 and 4 combined) or a substitution relationship (categories 2 and 3 combined) is almost the same; both relationships occur about half the time, in aggregate. However, there is substantial variation across countries and over time. For instance, we see a sharp increase in the proportion of firms in category 1 (i.e. negative complementary relationship) in all five countries in the years 2008–09. We also see that the peak for France, Germany, Italy and Spain is in 2009. Spain and the United Kingdom – the country that experienced the spillover of the financial crisis from the United States earliest – show a large increase of the proportion of firms in category 1 in 2008. The proportion of firms in category 4 (positive complementary relationship) follows a pattern that is inverse to that of category 1. This descriptive analysis suggests that the interplay of trade credit and bank debt shifted to a negative complementary relationship during the crisis.

The financial crisis has been characterised as a shock to credit supply from banks (Ivashina and Scharfstein 2010). Accordingly, we continue with a modified binary version of the substitution indicator that is conditional on a negative shock to firms' short-term bank debt in the *previous* year. The SI_{it}^{binary} equals zero for a complementary relationship (category 1 in Equation (1)) and one for a substitution relationship (category 2 in Equation (1)). This binary indicator is not defined for categories 3 and 4 because we want to restrict our attention to how SMEs responded to a shock to their bank debt – the main issue during the financial crisis. SI_{it}^{binary} has the main advantage that it allows us to condense information about changes in B_{it} and T_{it} into one dependent variable. This makes it possible to bypass the endogeneity problems present in earlier studies.

3.2 Empirical framework and identification strategy

Our identification strategy relies on three elements. First, we only include firms that have demand for external finance to ensure that all firms in our sample want to substitute bank debt for trade credit. Firms that have no need for external finance do not have to substitute because they have sufficient internal finance to fund their operations (Becker and Ivashina 2014). We do so by considering only firm-year observations where the value of a firm's investments exceeds the value of its cash flows to ensure that the firm has demand for external finance, following Rajan and Zingales (1998). Second, we investigate the relationship between bank debt and trade credit conditional on a negative shock to bank debt in the previous year. Third, we focus on the years of the global financial crisis.

The second and the third point are important because we expect that many SMEs in our sample were facing declines in bank debt. This is because our time frame of 2006 to 2011 includes a severe recession in which many banks were forced to contract lending due to illiquidity and insolvency problems. Therefore, it is most relevant to analyse the response of trade credit after a negative shock to bank debt.

3.3 Explanatory variables

This section provides summary statistics for the main explanatory variables, which are potential factors that could influence the dynamics of trade credit and bank debt at the firm level.

The most important explanatory variable is the credit quality of the firm, which we measure using Altman's Z-score (Z) adjusted for private firms (Altman 1968, 2000). The Z-score is a widely used

composite measure of credit quality (firm default risk) and includes several factors that are related to credit quality, such as liquidity, retained earnings, profitability, leverage, sales and size. Agarwal and Taffler (2007) show that the Z-score performs well in predicting firm defaults in different countries and periods. We compute the Z-score for private firms as shown in Equation (2). All variables are winsorised at the 1st and 99th percentile to prevent the Z-score being driven by extreme observations.

$$Z_{it} = 0.7\frac{Working\,capital_{it}}{Total\,assets_{it}} + 0.85\frac{Retained\,earnings_{it}}{Total\,assets_{it}} + 3.1\frac{Earnings\,before\,interest\,and\,tax_{it}}{Total\,assets_{it}} + 0.4\frac{Total\,assets_{it}}{Total\,liabilities_{it}} + \frac{Sales_{it}}{Total\,assets_{it}}. \quad (2)$$

The influence of the Z-score on the probability of substitution might depend on the level of financial constraints of the firm. We measure financial constraints by the Kaplan-Zingales (KZ) index (Kaplan and Zingales 1997). The KZ index is presented in Equation (3). All variables are winsorised at the 1st and 99th percentile. In order to allow for a potential non-monotonic interaction effect between firms' Z-scores and KZ index scores, we group firms' KZ index scores into quintiles (*KZ_Q*).[5]

$$KZ_{it} = -1.002\frac{Cash flow_{it}}{Total\,assets_{it-1}} + 3.139\frac{Total\,liabilities_{it}}{Total\,assets_{it-1}} + 39.368\frac{Dividends_{it}}{Total\,assets_{it-1}} - 1.315\frac{Cash_{it}}{Total\,assets_{it-1}}. \quad (3)$$

We study the effect of the financial crisis with a set of dummy variables that indicate different stages of the crisis. In continental Europe, the first (second) stage of the crisis, *D_Crisis*1 (*D_Crisis*2), is a dummy equal to one in the year 2008 (2009) and zero otherwise. We consider 2009 as the second stage of the crisis because Lehman Brothers collapsed in September 2008, which is considered as the starting point of a deep global recession (Kahle and Stulz 2013). In the United Kingdom, we consider 2007 (2008) as the first (second) stage of the crisis because the crisis started earlier and evolved faster in the United Kingdom due to its stronger linkages to the United States. The last stage in our time frame is a dummy equal to one (*D_PostCrisis*) in the years 2010–11 (2009–11 for the United Kingdom), which is the period directly after the crisis in which the world economy experienced growth again.

We consider the following control variables. The first variable is firm size (ln*TA*), measured by the natural logarithm of total assets. The second variable is collateral, which we measure in two ways. Long-term collateral is measured by fixed tangible assets (*TangFA*) and short-term collateral by inventories (*Inv*), both scaled by total assets (Cuñat 2007; Campello and Giambona 2013; Norden and van Kampen 2013). The third control variable we consider is the sum of cash and cash equivalents divided by total assets (*Cash*). The last control variable we consider is profitability, measured by return on assets (*RoA*).

In all regressions we control for industry and country fixed effects, where industry is derived from the 1-digit Standard Industry Classification industry code. The Z-scores and return on assets are both sensitive to outliers and are therefore winsorised at the 1st and 99th percentile at the country level.

5 Quintile five is the highest level of financial constraints, one the lowest.

Table 1 reports summary statistics for the main variables.

Table 1: Descriptive Statistics
Median of main variables

Variable	France	Germany	Italy	Spain	UK	Aggregate GDP-weighted
SI^{binary}	0.53	0.56	0.56	0.48	0.51	0.53
Accounts payable	0.18	0.09	0.26	0.19	0.13	0.13
Net trade credit	0.07	0.05	0.09	0.13	0.08	0.05
Short-term debt	0.07	0.08	0.20	0.14	0.14	0.10
Long-term debt	0.05	0.14	0.03	0.05	0.04	0.07
Credit days	32	17	81	51	26	37
Z-score	3.18	3.15	1.94	2.58	3.33	2.59
KZ index	–0.79	–0.35	1.40	0.23	–0.91	0.22
KZ quintile score	2	2	4	3	2	3
Firm size	6.29	9.09	7.43	9.21	8.85	10.02
Cash holdings	0.09	0.03	0.01	0.03	0.06	0.03
Inventories	0.10	0.17	0.15	0.16	0.10	0.14
Fixed tangible assets	0.12	0.31	0.13	0.21	0.16	0.20
Return on assets	0.05	0.02	0.00	0.02	0.04	0.03
Number of firm-year obs	139 027	8 302	299 439	41 124	92 505	29 333

Notes: In the aggregate sample, we consider the x per cent biggest firms from the country-specific raw samples to arrive at a sample composition that is in line with the country's average GDP share during 2006–11. All variables are scaled by total assets except for 'Credit days' (which equals 360 multiplied by the ratio of accounts payable over operating revenue) and firm size (which is measured as the logarithm of total assets).

First, the mean of SI^{binary} is around 0.5 in all countries. This means that roughly 50 per cent of firms, in aggregate, displayed a substitution relationship between trade credit and bank debt in a given year. Second, trade credit (accounts payable) is relatively high in Italy (26 per cent) but much lower in the United Kingdom (13 per cent) and Germany (9 per cent). Third, long-term debt is high in Germany (14 per cent) – mainly due to long-term bank debt. It is much lower in all other countries (around 4–5 per cent). Fourth, credit days – defined as the average time a customer has to pay suppliers – are low in Germany (17 days) and the United Kingdom (26 days), but relatively high in Italy (81 days) and Spain (51 days). Fifth, the Z-score and return on assets are relatively high for France and the United Kingdom and lowest for Italy. Sixth, financial constraints – measured by the KZ index – are highest for SMEs from Italy and Spain.

4. Empirical Results

4.1 The probability of substitution

First, we investigate the factors that potentially influence the probability of substitution towards trade credit after a shock to SMEs' bank debt in the previous year. We take the binary substitution indicator (SI^{binary}) as the dependent variable and use the lagged credit quality (Z-score) and indicators for the different stages of the financial crisis as the main explanatory variables. We add lags of firm size, cash holdings, inventories, tangible assets, and return on assets as control variables.

Table 2 presents the results. We report the effects as odds ratios (i.e. values above one indicate a positive effect; values below one indicate a negative effect). In columns (1)–(5) we control for industry fixed effects and column (6) for industry and country fixed effects.

We find that firms' credit quality (Z_{it-1}) has a positive effect on the probability of substitution across the board. This result implies that low credit quality firms – the ones that are most likely to have been hit by a shock to their bank debt during the financial crisis – cannot as easily substitute towards trade credit as higher credit quality firms, contrary to what is suggested by the existing literature. The highest impact of credit quality is found for SMEs from Italy (1.307). We further find that the probability of a firm displaying a substitution relationship decreases significantly during the crisis. Compared with pre-crisis, the probability of a firm displaying a substitution relationship is 28.7 per cent lower during the first stage of the crisis and 59.5 per cent lower during the second stage. The probability of a firm displaying a substitution relationship after the crisis is not significantly different from the pre-crisis years in Germany and in the aggregate sample. In contrast, it is significantly lower in France, Italy and Spain. In unreported analysis, we confirm the findings of column (6) with variables that are demeaned at the country-level median.

This analysis provides differentiated evidence on the dynamics of trade credit and bank debt at the firm level and indicates important differences across countries and over time.

Table 2: The Determinants of the Probability of Substitution

Logit regression results, dependent variable SI_{it}^{binary}

	France	Germany	Italy	Spain	UK	Aggregate
	(1)	(2)	(3)	(4)	(5)	(6)
Z_{t-1}	1.231***	1.166***	1.307***	1.107***	1.185***	1.151***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
*D_Crisis*1	0.766***	0.805	0.752***	0.338***	0.750***	0.713***
	(0.000)	(0.203)	(0.000)	(0.000)	(0.000)	(0.000)
*D_Crisis*2	0.592***	0.423***	0.475***	0.262***	0.289***	0.405***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
D_PostCrisis	0.868***	1.027	0.875***	0.725***		0.940
	(0.000)	(0.854)	(0.000)	(0.000)		(0.425)
$\ln TA_{t-1}$	0.998	0.966	0.958***	0.860***	1.029***	0.831***
	(0.865)	(0.381)	(0.000)	(0.000)	(0.006)	(0.000)
$Cash_{t-1}$	0.506***	0.815	0.589***	0.760	0.815**	0.892
	(0.000)	(0.718)	(0.000)	(0.373)	(0.042)	(0.631)
Inv_{t-1}	0.932	1.209	1.122***	0.507***	0.986	1.073
	(0.290)	(0.579)	(0.003)	(0.000)	(0.877)	(0.601)
$TangFA_{t-1}$	1.022	1.759*	1.439***	1.256**	1.136*	1.339**
	(0.781)	(0.058)	(0.000)	(0.030)	(0.057)	(0.014)
RoA_{t-1}	0.668***	7.745**	0.552***	2.409***	0.525***	1.218
	(0.006)	(0.014)	(0.000)	(0.010)	(0.000)	(0.616)
Industry dummies	Yes	Yes	Yes	Yes	Yes	Yes
Country dummies	No	No	No	No	No	Yes
Pseudo R^2	0.015	0.033	0.019	0.057	0.050	0.034
Number of obs	31 746	1 603	81 391	12 195	20 243	7 049

Notes: These regression analyses inform how the explanatory variables increase or decrease the probability of substitution of short-term bank debt for accounts payable (conditional on short-term bank debt going down). ***, ** and * denote coefficients that are statistically significant at the 1, 5 and 10 per cent level, respectively, using robust standard errors clustered within firms. We report odds ratios with the *p*-values in parentheses for each explanatory variable. For the UK, the variable *D_PostCrisis* serves as a reference category; for the other countries the reference category is the calendar year 2006. The regressions are conducted separately for each country and for the aggregate sample. In the aggregate sample, we consider the x per cent biggest firms from the country-specific raw samples to arrive at a sample composition that is in line with the country's average GDP share during 2006–11. The sample is limited to firm-year observations where the change in total assets exceeds cash flows to ensure that firms have demand for external finance.

4.2 The effect of firm size

We now investigate whether firms' ability to replace bank debt with trade credit depends on firm size, as well as financial constraints. We follow a different strategy than Carbó-Valverde *et al* (forthcoming).

First, we consider potential interaction effects with firm size. For this purpose, we create country-specific firm size tercile dummies and interact these dummies with the Z-score. The fact that we focus on SMEs already creates a relatively homogenous sample (i.e. we leave aside large and listed companies that can access capital markets to raise external finance). Nonetheless, there might be differences between micro-, small and medium-sized enterprises. Moreover, the distribution of firm size and Z-score differs across countries.

Table 3 confirms the baseline effect from Table 2. The Z-score is significant and positive in all samples and the magnitude of the effect varies by country, as in Table 2.

We find that the sensitivity of the probability of a firm displaying a substitution relationship to firm credit quality is lower for bigger firms, as indicated by odds ratios below one for the interaction between the Z-score and the mid-tercile dummy (*D_Size2*) and upper-tercile dummy (*D_Size3*). This effect is mainly present in firms from Italy and to some extent also in firms from Spain. It is not found for firms from Germany. We see two explanations for these results. First, larger firms tend to have a higher bargaining power vis-à-vis their suppliers, which might offset negative effects from a deterioration of their credit quality. As a result, the probability of substitution becomes less sensitive to the Z-score, as found for Italy. Second, the sample of Italian firms is the largest in our dataset and heterogeneity in firm size and the Z-score is smaller than in the sample of German firms.

Table 3: The Effect of Size

Logit regression results, dependent variable SI_{it}^{binary}

	France	Germany	Italy	Spain	UK	Aggregate
	(1)	(2)	(3)	(4)	(5)	(6)
Z_{t-1}	1.261***	1.246***	1.367***	1.179***	1.188***	1.189***
	(0.000)	(0.001)	(0.000)	(0.000)	(0.000)	(0.000)
D_Size2_{t-1}	1.082	1.249	1.007	1.194	1.082***	0.871
	(0.350)	(0.489)	(0.874)	(0.176)	(0.406)	(0.301)
D_Size3_{t-1}	1.122	1.304	1.106**	1.035	1.107	0.670***
	(0.155)	(0.413)	(0.027)	(0.790)	(0.249)	(0.002)
$D\_Size2_{t-1} \times Z_{t-1}$	0.957*	0.922	0.961**	0.912**	1.008	0.931*
	(0.062)	(0.328)	(0.046)	(0.025)	(0.737)	(0.084)
$D\_Size3_{t-1} \times Z_{t-1}$	0.971	0.897	0.905***	0.933	0.970	0.934
	(0.203)	(0.197)	(0.000)	(0.114)	(0.176)	(0.165)
Controls	Yes	Yes	Yes	Yes	Yes	Yes
Industry dummies	Yes	Yes	Yes	Yes	Yes	Yes
Country dummies	No	No	No	No	No	Yes
Pseudo R^2	0.015	0.034	0.019	0.057	0.050	0.040
Number of obs	31 746	1 603	81 391	12 195	20 243	7 049

Notes: These regression analyses inform how the explanatory variables increase or decrease the probability of substitution of short-term bank debt for accounts payable (conditional on short-term bank debt going down). ***, ** and * denote coefficients that are statistically significant at the 1, 5 and 10 per cent level, respectively, using robust standard errors clustered within firms. We report odds ratios with the *p*-values in parentheses for each explanatory variable. 'Controls' is a vector of control variables (different stages of the crisis, cash holdings, tangible fixed assets, inventories and return on assets). The regressions are conducted separately for each country and for the aggregate sample. In the aggregate sample, we consider the x per cent biggest firms from the country-specific raw samples to arrive at a sample composition that is in line with the country's average GDP share during 2006–11. The sample is limited to firm-year observations where the change in total assets exceeds cash flows to ensure that firms have demand for external finance.

4.3 The effect of financial constraints

In the next step, we examine whether there are interaction effects between firm credit quality and financial constraints. As pointed out in the related literature, financial constraints and financial distress (default risk) are related but clearly not identical concepts. Financial constraints are rooted in informational asymmetries that lead to relatively high costs of external finance and a potential mismatch between growth and funding opportunities. Financial distress – or firms' credit quality – refers to the probability of default and depends on firm-specific and economy-wide factors, such as leverage, profitability and macroeconomic conditions. As noted in Section 3.3, we measure financial constraints by the KZ index, which is firm specific and time varying. It is a widely used measure of financial constraints.[6]

In the following regression, we interact the Z-score with KZ index quintile dummies to investigate whether there is an interaction between these two characteristics and the probability of a firm displaying a substitution relationship between trade credit and bank debt. Table 4 reports the results.

This analysis yields a clear result. For all five countries and in the aggregate sample we find an inverse U-shaped pattern in the sensitivity of the probability of substitution to the interaction term of credit quality and financial constraints.

First, the results suggest that the credit quality of SMEs with intermediate financial constraints matters most for the probability of substitution. For firms with low and high financial constraints, the impact of credit quality on the probability of substitution is weaker – but for different reasons. For the low-constraints group, the need for substitution is lower because they might have access to alternative sources of external finance. For the high-constraints group, it is likely that credit rationing is at work: firms are rejected across the board, irrespective of their credit quality.

Second, there are level effects across countries. Both the single-term effects and interaction-term effects are most pronounced in Italy and Spain; they are qualitatively similar but smaller in France, the United Kingdom and Germany.

6 There has been discussion in the literature about how to measure corporate financial constraints, and this has led to different indices that are based on different concepts. For a recent discussion, see Hadlock and Pierce (2010) and Farre-Mensa and Ljungqvist (2013).

Table 4: The Effect of Financial Constraints

Logit regression results, dependent variable SI_{it}^{binary}

	France	Germany	Italy	Spain	UK	Aggregate
	(1)	(2)	(3)	(4)	(5)	(6)
Z_{t-1}	1.327***	1.317***	1.611***	1.199***	1.185***	1.288***
	(0.002)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
$KZ\_Q2 \times Z_{t-1}$	1.116***	0.973	2.167***	1.328***	1.145***	1.056
	(0.000)	(0.840)	(0.000)	(0.000)	(0.000)	(0.366)
$KZ\_Q3 \times Z_{t-1}$	1.497***	1.465**	2.966***	1.868***	1.314***	1.245***
	(0.000)	(0.021)	(0.000)	(0.000)	(0.000)	(0.001)
$KZ\_Q4 \times Z_{t-1}$	1.720***	1.456**	2.622***	2.063***	1.485***	1.284***
	(0.000)	(0.049)	(0.000)	(0.000)	(0.000)	(0.001)
$KZ\_Q5 \times Z_{t-1}$	1.407***	1.134	1.089***	1.178**	1.116***	1.041
	(0.000)	(0.363)	(0.007)	(0.026)	(0.003)	(0.560)
KZ_Q dummies	Yes	Yes	Yes	Yes	Yes	Yes
Controls	Yes	Yes	Yes	Yes	Yes	Yes
Industry dummies	Yes	Yes	Yes	Yes	Yes	Yes
Country dummies	No	No	No	No	No	Yes
Pseudo R^2	0.048	0.062	0.087	0.087	0.073	0.052
Number of obs	30 997	1 527	81 208	12 195	18 882	6 831

Notes: See notes for Table 3. 'Controls' is a vector of control variables (different stages of the crisis, cash holdings, tangible fixed assets, inventories, firm size and return on assets).

4.4 Stages of the financial crisis

We continue the analysis by investigating how the sensitivity of the probability of substitution to credit quality varies in the different stages of the financial crisis. We split the sample period into a pre-crisis period (2006–07), first stage of the crisis (2008), second stage of the crisis (2009) and post-crisis period (2010–11).[7] We then interact the indicator variables for these stages with the Z-score. Table 5 presents the results.

We find that the probability of a firm displaying a substitution relationship decreased significantly in the first stage of the crisis in Spain and the United Kingdom and decreased strongly in all countries in the second stage of the crisis. This effect is most pronounced for firms from Spain.

The interaction terms of the Z-score and the stages of the crises are mostly statistically significant and are below one. This finding together with the single-term effects suggests that the proportion of firms able to substitute went down during the crisis. Moreover, the likelihood of a firm substituting trade credit for bank debt became increasingly disconnected from credit quality. Overall, the evidence shows that trade credit has only limited scope to replace the gap when banks cut their lending to SMEs.

7 For the United Kingdom, we use 2007 for the first stage of the crisis and do not have data for a pre-crisis stage because we use one-year lags of the explanatory variables in our regression models.

Table 5: The Stages of the Financial Crisis

Logit regression results, dependent variable SI_{it}^{binary}

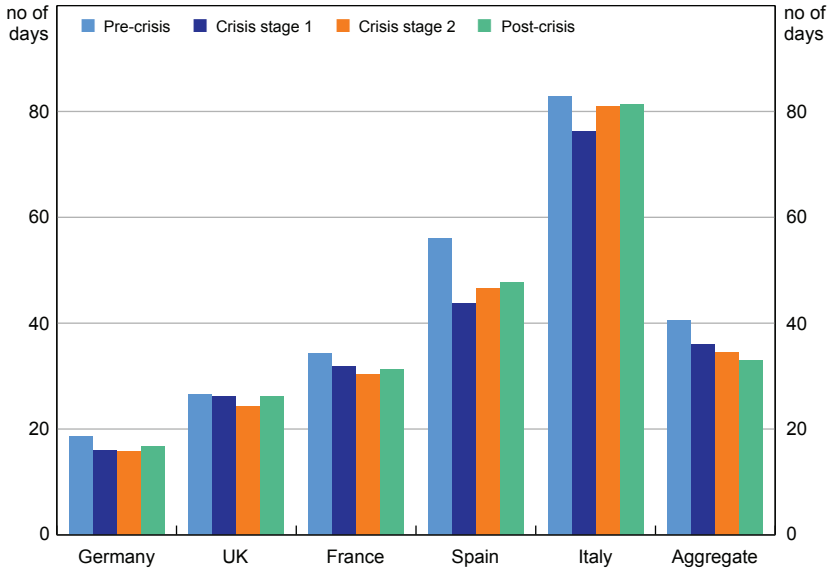
	France	Germany	Italy	Spain	UK	Aggregate
	(1)	(2)	(3)	(4)	(5)	(6)
Z_{t-1}	1.288***	1.222**	1.367***	1.147***	1.203***	1.239***
	(0.000)	(0.037)	(0.000)	(0.001)	(0.000)	(0.000)
*D_Crisis*1	0.976	1.489	1.024	0.545***	0.798**	1.185
	(0.834)	(0.368)	(0.709)	(0.000)	(0.026)	(0.398)
*D_Crisis*2	0.802**	0.437*	0.681***	0.256***	0.371***	0.557***
	(0.048)	(0.056)	(0.000)	(0.000)	(0.000)	(0.003)
D_PostCrisis	0.952	1.070	0.847***	0.740**		1.005
	(0.610)	(0.854)	(0.002)	(0.037)		(0.977)
*D_Crisis*1 × Z_{t-1}	0.929**	0.832	0.866***	0.852***	0.982	0.830***
	(0.024)	(0.127)	(0.000)	(0.003)	(0.503)	(0.005)
*D_Crisis*2 × Z_{t-1}	0.913***	0.988	0.885***	1.010	0.933***	0.890*
	(0.004)	(0.914)	(0.000)	(0.854)	(0.006)	(0.070)
D_PostCrisis × Z_{t-1}	0.972	0.988	1.021	0.998		0.975
	(0.305)	(0.907)	(0.362)	(0.960)		(0.667)
Controls	Yes	Yes	Yes	Yes	Yes	Yes
Industry dummies	Yes	Yes	Yes	Yes	Yes	Yes
Country dummies	No	No	No	No	No	Yes
Pseudo R^2	0.015	0.035	0.020	0.058	0.050	0.035
Number of obs	31 746	1 603	81 391	12 195	20 243	7 049

Notes: See notes for Table 3. 'Controls' is a set of control variables (cash holdings, tangible fixed assets, inventories, firm size and return on assets).

4.5 Variation in credit days

Finally, we consider the yearly change in the logarithm of the credit days, as reported in the Orbis database, as the dependent variable (i.e. the time for which trade credit is granted). SMEs can obtain more trade credit by stretching out the payment for goods to their suppliers. As reported in Table 1, there is substantial cross-country variation in median credit days. Figure 2 displays this level of variation by country and stages of the crisis.

Figure 2: Credit Days by Country and Stages of the Crisis



Sources: Authors' calculations; Bureau van Dijk

The median duration of trade credit is relatively low in Germany, the United Kingdom and France and relatively high in Spain and especially Italy. Looking at the changes, we see that credit days decrease in all five countries in the first stage of the crisis. This finding suggests that SMEs did not increase trade credit during the crisis, and is fully consistent with our previous analysis based on the substitution indicator. The decrease in credit days is particularly strong in Spain and Italy. This finding is consistent with the result of Ferrando and Mulier (2013) and Carbó-Valverde *et al* (forthcoming). The level remains slightly below the pre-crisis level in all countries, especially in Spain. In the aggregate sample, the number of credit days continuously decrease the further we move forward in time. Overall, the patterns in Figure 2 confirm the findings from Table 2 and Table 5, suggesting that SMEs could not sufficiently offset the decrease of their bank debt with an increase of trade credit.

Furthermore, we examine the determinants of credit days by country and for the aggregate sample. We add the same control variables as in previous analyses. We also include firm fixed effects in all regressions. This analysis is related to that reported in Table 2. It is similar because we consider a measure for firms' use of trade credit as the dependent variable; it is different because

instead of examining the trade-off between bank debt and trade credit we here examine the change in the duration of trade credit (and we ignore what happens to firms' bank debt). Table 6 reports the results.

We obtain several findings that are in line with previous analyses. The coefficients of the Z-score are significantly positive in all samples. Hence, the better the credit quality of a firm, the longer the firm's credit days. The findings on the stages of the crisis and the interaction with credit quality are quite different across countries – as expected given the patterns presented in Figure 2. For instance, in the first stage of the crisis we see an increase of credit days in Italy, while credit days decreased in Spain. Moreover, credit days develop similarly in France, Germany and the United Kingdom. For these three countries, the coefficients for the different stages of the crisis and the post-crisis indicator variable are all negative (and most of them are statistically significant). Finally, the interaction term of *D_Crisis*2 and the Z-score is positive and statistically significant in France, Germany and Spain. The interaction term of *D_PostCrisis* and the Z-score is positive and statistically significant in France, Italy and the United Kingdom. These findings indicate that higher credit quality firms could use more trade credit during and after the crisis.

Table 6: Determinants of Credit Days

Panel regression results, dependent variable is the change in natural logarithm of credit days

	France	Germany	Italy	Spain	UK	Aggregate
	(1)	(2)	(3)	(4)	(5)	(6)
Z_{t-1}	0.235***	0.167***	0.338***	0.220***	0.185***	0.207***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
*D_Crisis*1	–0.049***	–0.112	0.035***	–0.237***	–0.039	0.005
	(0.000)	(0.209)	(0.002)	(0.000)	(0.268)	(0.892)
*D_Crisis*2	–0.096***	–0.292***	0.106***	0.018	–0.101***	0.010
	(0.006)	(0.000)	(0.000)	(0.524)	(0.001)	(0.765)
D_PostCrisis	–0.023*	–0.020	0.090***	0.042	–0.049*	0.023
	(0.083)	(0.744)	(0.000)	(0.107)	(0.064)	(0.352)
*D_Crisis*1 × Z_{t-1}	0.006	0.009	–0.013***	0.003	0.016	–0.013
	(0.277)	(0.702)	(0.008)	(0.781)	(0.111)	(0.236)
*D_Crisis*2 × Z_{t-1}	0.023***	0.073***	0.005	0.036***	0.010	0.004
	(0.000)	(0.000)	(0.254)	(0.000)	(0.239)	(0.677)
D_PostCrisis × Z_{t-1}	0.020***	0.022	0.015***	0.013	0.015**	0.008
	(0.000)	(0.193)	(0.000)	(0.173)	(0.042)	(0.316)
Controls	Yes	Yes	Yes	Yes	Yes	Yes
Firm fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Within R^2	0.105	0.056	0.080	0.079	0.057	0.050
Number of obs	81 679	4 175	218 752	31 624	45 739	18 096

Notes: ***, ** and * denote coefficients that are statistically significant at the 1, 5 and 10 per cent level, respectively, using robust standard errors clustered within firms. We report odds ratios with the *p*-values in parentheses for each explanatory variable. 'Controls' is a set of control variables (the change in the natural logarithm of the collection days, cash holdings, tangible fixed assets, inventories, firm size and return on assets). The grouping variable in the panel regression is the firm identifier, making industry and country fixed effects redundant. The regressions are conducted for the aggregate sample. In the aggregate sample, we consider the x per cent biggest firms from the country-specific raw samples to arrive at a sample composition that is in line with the country's average GDP share during 2006–11.

5. Conclusion

We investigate the dynamics of trade credit and bank debt at the firm level and the variation in these dynamics over time and across countries. We focus on SMEs because they are more opaque, riskier, more credit constrained and more bank dependent than large firms. We base our analysis on a new multinomial measure, the substitution indicator, which we apply to a large dataset comprising SMEs from the five largest European Union countries during 2006–11. This measure makes it possible to examine the relative importance of trade credit and bank debt at the firm level over time.

We find that firms are almost equally likely to display substitution and complementary relationships between bank debt and trade credit, but there is substantial cross-country and time variation. The probability of a firm substituting toward trade credit after a negative shock to their bank debt is significantly higher if the firm has higher credit quality. The probability of a firm substituting into trade credit decreased in the first stage of the financial crisis and further decreased in the second stage of the crisis compared with the pre-crisis period. Interestingly, the effect of credit quality on the probability of substitution shows an inverse U-shaped pattern in the level of financial constraints in all countries. Credit quality matters most for firms with intermediate financial constraints, while it is less important for the least- and most-constrained firms.

The interplay of bank debt and trade credit is much more complex than suggested in earlier studies. We conclude that trade credit has limited scope to replace the funding gap when banks cut lending to SMEs. High credit quality firms are more likely to attract trade credit, regardless of the nature of the shock to bank debt. The dynamics of trade credit and bank debt change from a substitution relationship in the pre-crisis period to a negative complementary relationship during the financial crisis. Finally, there are significant cross-country differences in the importance of firm risk characteristics on SMEs' ability to substitute between bank debt and trade credit. Our study provides differentiated evidence on the dynamics of trade credit and bank debt in SME finance and has implications for the institutional and legal design of the lending environment and economic policy.

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