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ARE TRADE CREDIT AND BANK LOANS SUBSTITUTIONAL OR COMPLEMENTARY? A CROSS-SIZE STUDY OF EU FIRMS

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Purpose: This study investigates the interaction between trade credit and short-term bank loans among European Union (EU) firms, spanning small, medium, and large sizes. The research aims to determine whether these financing sources operate as substitutional alternatives or complementary resources within varying firm scales.
Design/methodology/approach: The research is based on yearly financial data from the BACH database for three size groups of firms in the period 2000-2020. Methods include panel data models estimated for total sample and for individual size groups to capture the indirect impact of size on the relationship between short-term institutional financing and trade credit. Additionally, the study distinguishes between the supply and demand of trade credit.
Findings: The research discovered complementary relationships between net trade credit and short-term bank loans for small and medium-sized firms, which contradicted the initial expectation of substitution, while large firms did exhibit the expected complementary effect. However, the impact of trade credit supplied and demanded varied across firm sizes, with small and large firms showing no significant effects while medium-sized firms displayed substitution effects.
Research limitations/implications: The dataset employed in the study contains aggregated data rather than individual firm-level financial information. This choice represents a compromise between information richness and the need for harmonization to ensure comparability.
Practical implications: The findings could be valuable for individuals engaged in the management of short-term corporate finances. Understanding the variations in managing receivables and payables, particularly influenced by firm size, can contribute to improved comprehension of business finance and its operational dynamics. This, in turn, can aid in effectively managing the trade-off between trade credit and short-term institutional financing.
Originality/value: This research adds to the current body of knowledge primarily by employing a multi-faceted approach that encompasses three size categories and explores trade credit from both the perspectives of supply and demand. This approach provides insights into corporate short-term financing strategies, encompassing the interplay between trade credit and bank loans.

Keywords: trade credit, short-term bank loan, complementary effect, substitution effect, firm size, panel data modelling

Category of the paper: Research paper.

1. Introduction

Trade credit and bank loans are integral components of a firm's financial toolkit, providing vital resources for sustaining operational efficiency and growth. In the pursuit of optimal financing strategies, businesses must navigate the complex interplay between these two funding sources. The nature of this relationship – whether trade credit and bank loans are substitutable or complementary – holds significant implications for the financial decisions of European Union (EU) firms, particularly when accounting for variations in firm sizes.

The European business landscape is diverse, encompassing a spectrum of enterprises ranging from small start-ups to large conglomerates. Such diversity requires a detailed understanding of how firms of different sizes leverage trade credit and bank loans to meet their short-term financing needs. The interaction between these financing sources becomes a critical factor influencing working capital management, growth opportunities, and overall financial stability.

This paper embarks on a comprehensive exploration of the trade credit and bank loan within the EU context, with a distinct focus on the impact of firm size. By undertaking a cross-sectional study that encompasses small, medium, and large enterprises, this research seeks to discern whether trade credit and bank loans operate as substitutes or complements across varying firm scales. The insights from this study may enrich our understanding of the financial decision-making processes undertaken by EU firms and contribute to the broader discourse on optimizing financing strategies.

The subsequent sections of this paper present a literature review encompassing key theories and prior research, outline the data collection and employed methodology, detail the empirical analysis, and discuss the implications of the findings. Ultimately, this research aims to provide a comprehensive perspective on the complex relationship between trade credit and bank loans, shedding light on the strategic choices made by EU firms in pursuit of financial sustainability and growth.

2. Substitution vs. Complementariness of Trade Credit and Bank Loan: Literature Review and Hypotheses Development

Understanding the interaction between trade credit and bank loans is essential for devising effective financial management strategies. This section reviews existing literature, drawing insights from the main theories and empirical studies that explore the substitution and complementarity effects of these financing sources.

The substitution effect in the context of bank loans and trade credit, involves a shift from one financing method to another due to changes in relative costs or terms, while the complementary effect suggests a simultaneous utilisation of both methods for enhanced financial management. The effects are manifested in the negative relationship between the use of institutional finance and trade credit in the case of substitutability, and a positive one in the case of complementarity.

The theoretical underpinnings of this study can be traced to well-established financial theories. The pecking order theory, as proposed by Myers (1984), suggests that firms prefer internal financing over external debt and prioritize lower-cost options such as trade credit before resorting to higher-cost options like bank loans. This theory implies a potential substitution effect, where firms utilize trade credit to fulfill their short-term financing needs, thus reducing reliance on bank loans.

Conversely, the trade-off theory, advocated by Frank and Goyal (2003), posits that firms aim to balance the benefits of debt financing against associated costs like interest payments and potential loss of control. This theory points towards the possibility of a complementary relationship, as firms strategically combine trade credit and bank loans to achieve optimal financing while minimizing costs and risks.

The dynamics of trade credit and bank loans are further influenced by agency costs (Jensen and Meckling, 1976) and information asymmetry (Smith, 1987). Suppliers, armed with intimate knowledge of their clients' financial health, may extend trade credit based on private information, thereby lessening the need for external bank loans. On the other hand, lenders, due to information asymmetry, might necessitate collateral or impose stricter terms, making bank loans less attractive. These considerations can result in either a substitution or complementarity effect between short-term bank loans and trade credit, depending on the specific contextual conditions.

The empirical landscape presents a mixed picture regarding the substitution vs. complementarity effects of trade credit and bank loans. Some studies suggest that these financing sources are substitutes, leading to an either/or choice between them (Petersen and Rajan, 1997). This behaviour could be attributed to firms prioritising the least costly financing option or managing information asymmetry through trade credit relationships. Conversely, other studies propose a complementary relationship between trade credit and bank loans, with firms using both sources to address distinct aspects of their financing needs (Deloof, 2003). This approach leverages the flexibility of trade credit and the scalability of bank loans to optimize financing strategies. Table 1 presents a synthesis of the complementary and substitution effects derived from an extensive literature review.

In addition to the mixed evidence reported in the table, one can also encounter inconclusive research items, such as the study by Elliehausen and Wolken (1993) who found the short-term credit-to-assets ratio insignificant in determining trade credit and thus providing no evidence as to the possible substitutability or complementarity of trade credit and institutional credit.

Table 1.
Complementary versus substitution effect between institutional finance and trade credit: summary of literature review

Effect	Supporting studies chronologically
Complementary (+)	Biais and Gollier (1997); McMillan and Woodruff (1999); Demirguc-Kunt and Maksimovic (2001); Ono (2001); Fisman and Raturi (2004); Cunningham (2005) for low wealth firms (i.e. firms whose investments are more likely to be finance constrained); Maksimovic and Frank (2005); Cuñat (2007); Uesugi and Yamashiro (2008); Bougheas, Mateut and Mizen (2009) for accounts receivable; Zawadzka (2009); Cole (2010); Alarcón (2011); Vaidya (2011); Yang (2011) for accounts receivable; Cai, Chen and Xiao (2014) if the retailer's internal capital is substantially low; Carvalho and Schiozer (2015); Lin and Chou (2015) for the supply of trade credit (i.e., accounts receivable); Białek-Jaworska and Nehrebecka (2016) in medium size and large companies; Andrieu, Staglianòa and van der Zwan (2018); Afrifa et al. (2023) for private firms that have limited access to alternative financing resources, such as financial markets
Substitution (–)	Meltzer (1960); Petersen and Rajan (1997); Deloof and Jegers (1999); Kohler, Britton and Yates (2000); Nilsen (2002); Burkart and Ellingsen (2004); Cunningham (2005) for medium wealth firms (i.e. firms whose investment is less likely to be constrained by availability of external funds); Beck, Demirgüç-Kunt and Maksimovic (2008); Bougheas et. al (2009) for accounts payable; García-Teruel and Martínez-Solano (2010); Hui, Xiaojun and Shunming (2011); Kling, Salima and Eleimon (2011); Yang (2011) for accounts payable; Molina and Preve (2012) for firms in financial distress; Bastos and Pindado (2013); Ogawa, Sterken and Tokutsu (2013); Cai, Chen and Xiao (2014) if the retailer's internal capital grows; Engemann, Eck and Schnitzer (2014); Santos and Silva (2014); Lin and Chou (2015) for the demand of trade credit (i.e., accounts payable); Białek-Jaworska and Nehrebecka (2016) for small companies; Levine, Lin and Xie (2018); Palacín-Sánchez, Canto-Cuevas and Di-Pietro (2019); Duliniec and Świda (2021); Pinto et al. (2023); Afrifa et al. (2023) for public firms that have easy access to cheap external finance;

Source: own elaboration based on the listed literature items.

The above review is certainly not exhaustive and covers only a limited portion of the extensive body of literature dedicated to trade credit management. Nevertheless, a characteristic pattern that emerges from the summary reported in Table 1 is the occurrence of a complementary effect in the context of trade credit supply, as pointed out by several studies. This manifests as a positive correlation between accounts receivable and bank loans. Conversely, for the demand of trade credit, a substitution effect is commonly identified, evidenced by a negative relationship between accounts payable and bank loans. Furthermore, certain scholars contend that the prevalence of complementarity should be anticipated in more developed economies and (or) among firms with facile access to institutional finance, as noted e.g. by Demirguc-Kunt and Maksimovic (2001). In contrast, in less mature financial markets, enterprises are compelled to explore alternate sources, including trade credit. Similarly, financially constrained companies are more inclined to resort to trade credit as a substitute of bank credit.

The absence of a unanimous consensus among scholars and the reliance on the prevalence of either complementarity or substitutability in specific circumstances renders the formulation of research hypotheses a non-trivial task. The divergent empirical outcomes encourage to delve into the underlying reasons for these conflicting findings. A plausible explanation resides in the contingent nature of the connection between trade credit and short-term bank financing, which may hinge on additional factors, such as firm size – central to the focus of this study,

wherein firm size serves as an indirect factor influencing the interplay between trade credit and bank loans. It is reasonably justifiable to anticipate that smaller enterprises, which often encounter greater challenges in securing institutional funding, will opt for trade credit as an alternative financial mechanism. Likewise, the formulation of research hypotheses is constructed in consideration of both the supply and demand facets of trade credit.

For all sizes of firms, a complementary effect between net trade credit and short-term bank loans is hypothesized (**H1a**). Specifically, a higher utilization of net trade credit is expected with an increase in short-term bank loans.

In the case of all firm sizes, the existence of a complementary effect between the trade credit supplied and short-term bank loans is proposed (**H1b**). As the utilization of short-term bank loans increases, a concurrent rise in the supply of trade credit is anticipated.

However, for all sizes of firms, a substitution effect between the trade credit demanded and short-term bank loans is expected (**H1c**). This suggests that when the reliance on short-term bank loans decreases, there will be an elevated demand for trade credit.

When considering firms categorised as small in size, a substitution effect between net trade credit and short-term bank loans is predicted (**H2a**). Consequently, a decrease in the reliance on short-term bank loans is likely as net trade credit grows. Simultaneously, a complementary effect between the trade credit supplied and short-term bank loans among small-sized firms is anticipated (**H2b**), implying that an increase in short-term bank loan utilisation will correspond to an increase in trade credit supplied. Furthermore, a substitution effect between the trade credit demanded and short-term bank loans for small-sized firms is projected (**H2c**). A decrease in the reliance on short-term bank loans will likely lead to an increase in trade credit demanded.

Turning to medium-sized firms, a substitution effect between net trade credit and short-term bank loans is hypothesized (**H3a**). Consequently, an escalation in net trade credit is likely with a decrease in the usage of short-term bank loans. For trade credit supplied, a complementary effect is proposed (**H3b**), meaning that an increase in short-term bank loans will correspond to a higher utilisation of trade credit supplied among medium-sized firms. Likewise, a substitution effect between the trade credit demanded and short-term bank loans for medium-sized firms is projected (**H3c**).

Finally, for firms classified as large in size, a complementary effect between net trade credit and short-term bank loans is anticipated (**H4a**). Hence, an increase in net trade credit is expected with an increase in short-term bank loan utilisation. Similarly, a complementary effect between the trade credit supplied and short-term bank loans among large-sized firms is predicted (**H4b**). However, a substitution effect between the trade credit demanded and short-term bank loans is expected (**H4c**), indicating that an increase in the reliance on short-term bank loans will lead to a decrease in trade credit demanded.

A synthetic summary of the hypothesised effects and the hypotheses numbering is shown in Table 2 for convenient reference.

Table 2.
The hypothesised effects concerning the relation between short-term bank loans and trade credit

Sample part		Hypotheses numbers and expected sign for trade credit measures					
		Net trade credit (NTC)		Trade credit supplied (STC)		Trade credit demanded (DTC)	
All sizes		H1a	+	H1b	+	H1c	-
Size groups	Small	H2a	-	H2b	+	H2c	-
	Medium	H3a	-	H3b	+	H3c	-
	Large	H4a	+	H4b	+	H4c	-

Note: '+' indicates a complementary effect between trade credit and short-term bank loans, whereas '-' indicates a substitution effect.

Source: author's own elaboration.

The procedure of verification of the aforementioned research hypotheses is outlined in the subsequent section of the study.

3. Data and methods

The source of data for empirial research is the BACH (2023) database, known as the Bank for the Accounts of Companies Harmonised. This comprehensive dataset contains aggregated financial information from various European companies and is updated yearly. It offers detailed insights into company balance sheets, income statements, cash flow statements, and financial indicators. The BACH data is divided into four size categories: small, medium, SMEs, and large firms. Small firms have turnovers under 10 million euros, medium-sized ones range between 10 and 50 million euros, while large companies exceed 50 million euros in turnover.

Furthermore, the BACH database provides standardized annual financial data for non-financial companies in twelve European Union countries. These countries include Austria (AT), Belgium (BE), Czech Republic (CZ), Germany (DE), Spain (ES), France (FR), Croatia (HR), Italy (IT), Luxembourg (LU), Poland (PL), Portugal (PT), and Slovakia (SK).

The database also classifies companies according to the NACE system, with the study using the first-level classification which covers sectors like Agriculture, forestry and fishing (A), Mining and quarrying (B), Manufacturing (C), Electricity, gas, steam and air conditioning supply water (D), Water supply, sewerage, waste management and remediation activities (E), Construction (F), Wholesale and retail trade, repair of motor vehicles and motorcycles (G), Transportation and storage (H), Accommodation and food service activities (I), Information and communication (J), Real estate activities (L), Professional, scientific and technical activities (M), Administrative and support service activities (N), Education (P), Human health and social work services (Q), Arts, entertainment and recreation (R), and Other service activities (S).

The research covers 12 countries, 17 industries, and 3 size categories, analysing data from 2000 to 2020 due to data availability. As for the dependent variables, three trade credit measures were used to assess different aspects of trade credit behaviour: net trade credit, trade credit supplied, and trade credit demanded. The explanatory variables were selected based on past research highlighting factors impacting trade credit. Detailed variable definitions are in Table 3.

Table 3.
Definition of dependent and explanatory variables employed in the analysis

Variable character		Symbol	Formula
Dependent		NTC	Net trade credit = (Accounts receivable – Accounts payable) / Assets
		STC	Supply of trade credit = Accounts receivable / Assets
		DTC	Demand of trade credit = Accounts payable / Assets
Explanatory	Firm-specific financial ratios	SBL	Short-term bank loan = Current amounts owed to credit institutions / Assets
		FXA	Collateral = Fixed assets / Assets
		INV	Inventory = Inventories / Assets
		LIQ	Cash at hand = Cash and available bank amounts / Assets
		CGS	Costs of goods sold = Costs of goods sold, materials and consumables / Net turnover
		LEV	Debt ratio = Debt / Equity
		ROA	Return on assets = Net operating profit / Assets
		TAT	Total asset turnover = Net turnover / Assets
	Dummy variables	SIZE	Size groups of firms (SM, ME, LA)
		CT	Countries (AT, BE, CZ, DE, ES, FR, HR, IT, LU, PL, PT, SK)
		IND	Industrial sectors by NACE (A, B, C, D, E, F, G, H, I, J, L, M, N, P, Q, R, S)
		YEAR	Years (2000, …, 2020)

Source: author's own compilation.

The research design and methods aligned with its main goals: to establish if trade credit and short-term bank loans work together or replace each other in business short-term funding, and to uncover how firm size indirectly affects such funding choices. As a result, the investigation covers both the whole dataset and distinct size categories separately.

The initial phase of the research aimed to identify the level and variation of trade credit measures and their driving factors. This was achieved by examining descriptive statistics within three size groups. After the preliminary descriptive analysis, a correlation study was carried out, and potential multicollinearity was addressed using the variance inflation factor (VIF).

The data structure, encompassing both cross-sectional and time series data, necessitates adopting a panel data approach to investigate the relationship between trade credit, bank credit, and control variables. This constitutes the core of the empirical analysis in this study. Verifying research hypotheses outlined in the preceding section is based on panel data regression analyses both for the entire dataset and separately for each size category. The version of the model for all size groups is represented by formula (1):

$$TC_{cist} = \beta_0 + \beta_1 SBL_{cist} + \beta_2 FXA_{cist} + \beta_3 INV_{cist} + \beta_4 LIQ_{cist} + \beta_5 CGS_{cist} + \beta_6 LEV_{cist} + \beta_7 ROA_{cist} + \beta_8 TAT_{cist} + \beta_9 SIZE_s + \beta_{10} CT_c + \beta_{11} \gamma_i IND_i + \beta_{12} YEAR_t + \xi_{cist}, \quad (1)$$

where TC_{cist} denotes one of the three trade credit measures (NTC_{cist} – net trade credit, STC_{cist} – supply of trade credit, DTC_{cist} – demand for trade credit) for country *c*, industry *i*, firm size *s* in year *t*. The formula includes structural parameters $\beta_{1\text{-}12}$, a random error term ξ, and variables specified in Table 3.

Since there are three separate dependent variables, the model has been segmented into three corresponding forms: (1a) addresses net trade credit as the dependent variable, (1b) focuses on trade credit supplied, and (1c) concentrates on trade credit demanded. The letter extensions applied to the model numbers correspond with the symbols employed for hypothesis numbering.

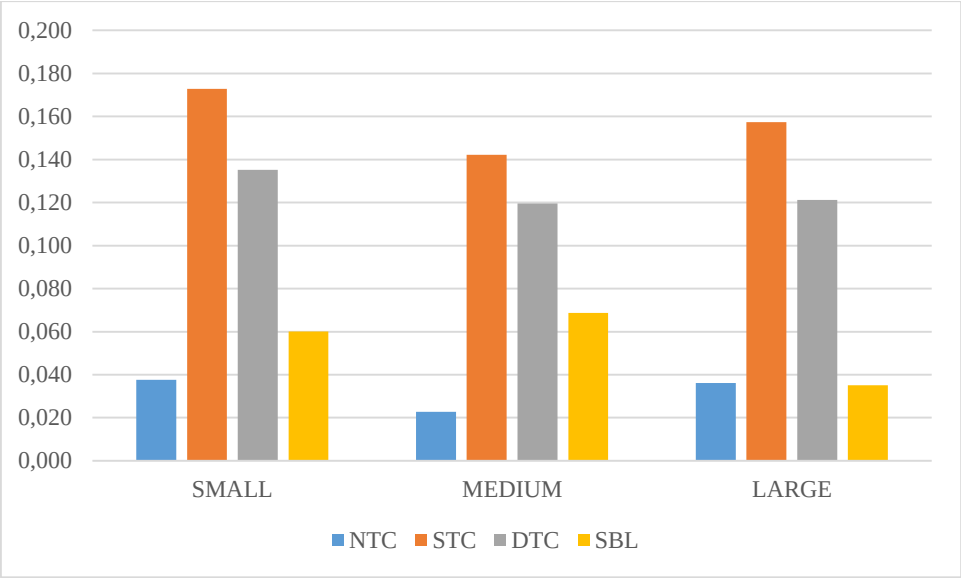
During the panel data modelling process, different approaches such as pooled OLS, fixed-effects, and random-effects models were considered. Initially, models (1a)–(1c) were estimated via pooled OLS for the complete dataset, followed by the removal of insignificant variables. Panel specification tests were employed to identify the most suitable model. Appropriateness of the pooled OLS model was assessed through joint significance testing and checks for individual effects. The Hausman test distinguished between fixed and random effects, demonstrating the suitability of the fixed-effects (FE) model for all cases. This led to a re-evaluation of models (1a)–(1c) with the inclusion of dummy variables. Subsequently, a Wald test was conducted for dummy variables related to size, country, industry, and year. The subsequent step involved adjusting model (1) for estimation within each size group, leading to equation (2), achieved by excluding size dummy variables:

$$TC_{cist} = \propto_0 + \beta_1 BKL_{cist} + \beta_2 COL_{cist} + \beta_3 INV_{cist} + \beta_4 CSH_{cist} + \beta_5 CGS_{cist} + \beta_6 DBT_{cist} + \beta_7 ROA_{cist} + \beta_8 TAT_{cist} + + \beta_9 CT_c + \beta_{10} \gamma_i IND_i + \beta_{11} YEAR_t + \xi_{cist}, \quad (2)$$

Model (2) was also estimated in variations (2a), (2b), and (2c) for different trade credit measures, akin to the extended dataset model.

4. Results and discussion

As indicated in the previous section, the first stage of the analysis was aimed at the preliminary recognition of the main trade credit patterns based on the basic statistics. Additionally, in the context of the topic of this study, it is also informative to trace the level of short-term institutional finance relative to trade credit measures across size classes of firms. That is why the ratio of short-term bank loan was the only explanatory variable included in Figure 1.



Note. NTC – net trade credit, STC – supply of trade credit, DTC – demand for trade credit, SBL – short-term bank loans ratio. Detailed formulas of ratios as in Table 3.

Figure 1. Mean values of trade credit measures and short-term bank loan ratio across size classes.

Source: own elaboration based on BACH (2023).

A glance at the mean values of the trade credit ratios across the three size groups reveals several size-related patterns concerning short-term financing strategies. Regarding net trade credit, it is evident that small firms exhibit a higher level of credit extension to customers compared to their medium and large counterparts. In contrast, medium firms appear to adopt a more conservative approach with the lowest mean net trade credit. Large firms fall in between, signifying varying credit extension strategies based on firm size.

In terms of the supply of trade credit, small firms demonstrate the highest mean value, suggesting that they are most generous with offering trade credit to their customers. Large firms also exhibit a notable mean in this respect, reflecting a substantial supply of trade credit. In contrast, medium firms display a comparatively lower mean trade credit supply, indicating a reduced relation of accounts receivable to assets.

Examining the demand for trade credit, small firms report the highest mean value, implying a greater demand for trade credit, potentially to support their operations and growth. Large companies, although lower than small firms, still exhibit a notable mean trade credit demanded. Medium firms display the lowest mean in this area, suggesting a relatively lower requirement for trade credit.

Finally, considering the short-term bank loan ratio, small firms show a moderate reliance on short-term bank loans. Medium firms, on the other hand, exhibit a slightly higher mean ratio, indicating a relatively greater dependence on short-term bank loans for financing. Large firms report the lowest mean, potentially indicating a lower reliance on such financing and, possibly, greater financial stability through alternative means.

To address the risk of multicollinearity in the empirical analysis, a correlation study was undertaken to examine the relationships between variables. The findings are summarized in Table 4, which includes correlation coefficients for the entire sample, spanning different size groups, countries, industries, and years. Furthermore, Table 5 provides values of the Variance Inflation Factor (VIF), a metric employed to detect multicollinearity in regression analysis.

Table 4.
Matrix of correlations for total sample

Ratio	NTC	STC	DTC	SBL	FXA	INV	CSH	CGS	LEV	ROA
STC	0,608*									
DTC	0,038*	0,817*								
SBL	0,005	0,233*	0,290*							
FXA	-0,408*	-0,769*	-0,670*	-0,202*						
INV	-0,103*	0,276*	0,423*	0,348*	-0,552*					
CSH	0,151*	0,172*	0,107*	-0,105*	-0,387*	-0,049*				
CGS	-0,356*	0,076*	0,354*	0,237*	-0,136*	0,571*	-0,204*			
LEV	0,083*	0,284*	0,298*	0,243*	-0,273*	0,086*	-0,081*	-0,136*		
ROA	0,029*	0,054*	0,047*	-0,021*	-0,106*	-0,030*	0,246*	-0,066*	-0,123*	
TAT	0,037*	0,454*	0,545*	0,121*	-0,468*	0,221*	0,265*	0,258*	0,094*	0,307*

Note: * – significant at $p < 0.5$.

Source: author's calculations based on BACH (2023).

Table 5.
Variance inflation factors for total sample

	Dependent variables							
	SBL	FXA	INV	CSH	CGS	LEV	ROA	TAT
VIF	1,221	2,588	2,576	1,513	1,930	1,308	1,195	1,603

Source: author's calculations based on BACH (2023).

Despite several significant correlations among variables, indications of considerable multicollinearity problems seem to be limited. The highest VIF value for the entire sample stands at 2.59, which is approximately half the threshold typically regarded as indicating low to moderate multicollinearity, a widely accepted criterion in most instances (Kutner et al., 2004). While the correlation and VIF data for size-specific subgroups are not fully presented in this study, the findings suggest that multicollinearity among predictor variables within each size category is not a major issue.

The validation of research hypotheses formulated in the previous section relies on panel regression findings, particularly focusing on the statistical significance and the nature of the connection between the short-term bank loan ratio (SBL) and trade credit measures, which serve as the dependent variables. Significantly positive relations suggest a complementary effect, indicating that both financing methods mutually reinforce each other. Conversely, significantly negative associations suggest a substitution effect, where one type of financing tends to replace the other. Table 6 displays the panel regression results for the entire dataset using equations (1a) to (1c). Based on the Hausman test results, the chosen model incorporates adjustments for endogeneity and unobserved heterogeneity through fixed effects (FE) estimation, while robust errors are employed to address heteroscedasticity and autocorrelation concerns.

Table 6.
Results of panel regression models (1a–c) for total sample

Variable or specification	Model number and dependent variable symbol					
	(1a) NTC		(1b) STC		(1c) DTC	
	Estimate	Std. error	Estimate	Std. error	Estimate	Std. error
const.	0,288***	0,010	0,496***	0,014	0,203***	0,013
SBL	0,109***	0,027	0,127***	0,044		
FXA	-0,263***	0,009	-0,540***	0,015	-0,273***	0,013
INV	-0,271***	0,016	-0,403***	0,022	-0,129***	0,019
LIQ	-0,209***	0,022	-0,405***	0,027	-0,190***	0,029
CGS	-0,066***	0,005	0,023***	0,008	0,092***	0,007
LEV	-0,066***	0,008	0,018*	0,010	0,088***	0,008
ROA			-0,047***	0,007	-0,036***	0,008
TAT	-0,014***	0,003	0,020***	0,005	0,034***	0,004
SIZE	ME**		ME***, LA***		ME***, LA***	
CT	none		none		none	
IND	F*, H***, I***, J***, L*, M**, N***, P***, Q***, R***		E**, F***, G***, H***, I***, J***, L***, M***, N***, R**, Q***		E**, F***, G***, H***, I***, J***, L***, M***, P*, Q***, S***	
YEAR	2015**		2002*, 2008*, 2014*, 2020*		2002**, 2005**, 2011***, 2014**, 2017**, 2020**	
No. obs.	8797		8797		8796	
R^2	0.468		0.725		0.663	
AIC	-30905.0		-27044.9		-29295.1	
Hausman test	63.8 [0.000]		249.0 [0.000]		239.7 [0.000]	
Wald joint significance robust F test						
SIZE	6.07 [0.014]		17.1 [0.000]		24.1 [0.000]	
CT	n/a		n/a		n/a	
IND	19.28 [0.000]		12.6 [0.000]		15.3 [0.000]	
YEAR	4.43 [0.036]		3.5 [0.008]		5.8 [0.000]	

Notes: Interpretation of parameters in relation to small firms for size dummies, Austria for country dummies and agriculture for industry dummies.
* – significant at the 10% level,
** – 5%,
*** – 1%.
For dummy variables values of estimates were replaced with the list of items (symbols of size groups, countries, industries and years) for which the estimate value was significant accompanied by the significance level. Hausman test refers to the pooled OLS model before the inclusion of dummy variables.

Source: authors' calculations based on (BACH, 2023).

From the model estimation results for all-sized firms, it is evident that for both net trade credit and trade credit supplied, the observed effects align with the expected complementary effect, thus providing support for hypotheses H1a and H1b. This consistency across trade credit measures suggests a robust trend in the data. However, with reference to the trade credit demanded, the results indicate that the hypothesis H1c, which anticipated a substitution effect for this metric, did not find support in the category of all-sized firms. Instead, the observed lack of significant relationship signifies no discernible effect.

The models estimations results for specific size categories (2a-2c), i.e. small, medium and large firms, although not reported here in details, serve as grounds for the validation of hypotheses H2 through H4. Table 7 presents a concise summary of the validation of research hypotheses related to trade credit measures and their expected effects across different firm size categories.

Table 7.
Summary or research hypotheses validation

Trade credit measure	Firm size	Hypothesis symbol	Anticipated effect	Effect found	Support found
Net trade credit (NTC)	All	H1a	complementary	complementary	**supported**
	SM	H2a	substitution	complementary	rejected
	ME	H3a	substitution	complementary	rejected
	LA	H4a	complementary	complementary	**supported**
Trade credit supplied (STC)	All	H1b	complementary	complementary	**supported**
	SM	H2b	complementary	complementary	**supported**
	ME	H3b	complementary	substitution	rejected
	LA	H4b	complementary	no effect	unsupported
Trade credit demanded (DTC)	All	H1c	substitution	no effect	unsupported
	SM	H2c	substitution	no effect	unsupported
	ME	H3c	substitution	substitution	**supported**
	LA	H4c	substitution	no effect	unsupported

Source: author's calculations based on (BACH, 2023).

Several patterns emerged in the investigation of trade credit measures and their relationship with short-term institutional financing across size categories of firms. The study initially hypothesized that a substitution effect would be observed between the short-term bank loan ratio and net trade credit for small and medium firms. Surprisingly, the analysis revealed a complementary effect for both of these size classes. This finding challenges the initial hypothesis, suggesting that in these cases, both financing methods mutually reinforce each other rather than act as substitutes. Conversely, for large firms, the initial hypothesis of complementary effects between short-term bank loan and net trade credit was confirmed, indicating that these firms do indeed exhibit a complementary financing relationship.

Moving on to trade credit supplied, the research initially anticipated a complementary effect across all firm sizes. The results only partially supported this hypothesis, with complementary effects observed for small firms. However, the analysis revealed a substitution effect for medium-sized firms, suggesting that in some instances, trade credit supplied may replace short-term bank loans for these firms. Interestingly, for large firms, the analysis indicated no significant effect, which contradicts the anticipated complementary relationship.

Lastly, regarding trade credit demanded, the research initially hypothesized a substitution effect, implying that short-term bank loans would replace trade credit demanded. However, the analysis yielded mixed results. For small and large firms, no significant effect was observed, indicating that the substitution hypothesis was not supported. In contrast, medium-sized firms displayed a substitution effect, where short-term bank loans did indeed replace trade credit demanded.

In conclusion, the findings reported in Table 5 reveal the complexity of the relationships between short-term institutional financing and trade credit measures, as well as the variability of these relationships across different firm sizes. While some relationships align with the initial hypotheses, others deviate from expectations, highlighting the diverse interplay between these financing methods within the context of firm size.

The prevalence of complementary effects, as opposed to substitution effects, within the context of trade credit measures and firm size can be attributed to a complex interplay of factors. One key factor contributing to this prevalence is the notion of business synergy. This synergy arises when trade credit measures and firm size mutually reinforce each other, enhancing their respective benefits. For instance, larger firms often possess greater bargaining power, enabling them to negotiate favourable trade credit terms and effectively manage their trade credit relationships.

Additionally, the diversity of firm characteristics within the category of all sizes adds another layer of complexity. This diversity can lead to varied effects across different firms. Larger firms, with their unique attributes, may naturally lend themselves to complementary relationships, whereas smaller firms may experience substitution effects due to constraints on resources and operations.

Furthermore, industry-specific factors also play a vital role. Different industries exhibit distinct operational dynamics, which can influence the strength and nature of the relationships between trade credit measures and firm size. Some industries may inherently foster complementary relationships, while others may emphasize substitution effects more prominently.

In summary, the prevalence of complementary effects highlights a harmonious relationship between trade credit measures and short-term institutional financing for all-sized firms as total. However, the variability in results, particularly for trade credit demanded, underscores the intricate and multifaceted nature of these relationships. It becomes evident that various factors, including business synergies, firm characteristics, methodological choices, and industry-specific dynamics, collectively shape these outcomes.

5. Conclusions

The research conducted in this study investigated the relationship between trade credit patterns and short-term institutional financing across different firm sizes. The key findings can be summarized as follows. The analysis of mean values of trade credit metrics and the short-term bank loan ratio reveals diverse financial strategies and risk profiles across firms of different sizes. Small firms emphasize credit extension and trade credit reliance, medium firms exhibit a middle-ground approach, whereas large firms prioritise financial stability with potentially diversified financing strategies. The analysis of basic statistics provides initial indication that firm size influences trade credit behaviours and financing decisions in the business landscape.

Contrary to the initial hypothesis of a substitution effect, the analysis revealed complementary relationships between net trade credit and short-term bank loans for both small and medium-sized firms. In these cases, it was found that these financing methods mutually reinforce each other rather than acting as substitutes. Large firms did exhibit a complementary financing relationship, as initially hypothesised.

While the research initially anticipated a complementary effect across all firm sizes in trade credit supplied, the results only partially supported this hypothesis. Complementary effects were observed for small firms, but medium-sized firms displayed a substitution effect, suggesting that trade credit supplied may replace short-term bank loans for these firms. Interestingly, for large firms, no significant effect was observed, which contradicts the anticipated complementary relationship.

The study initially hypothesized a substitution effect in trade credit demanded, implying that short-term bank loans would replace trade credit demanded. However, the analysis yielded mixed results. Small and large firms showed no significant effect, indicating that the substitution hypothesis was not supported. In contrast, medium-sized firms displayed a substitution effect, where short-term bank loans did replace trade credit demanded.

These findings highlight the complexity and variability of the relationships between short-term institutional financing and trade credit measures across different firm sizes. The prevalence of complementary effects can be attributed to factors such as business synergies, firm characteristics, and industry-specific dynamics, which collectively shape the outcomes of these relationships. Overall, the study reveals the unobvious interplay between these financing methods within the context of firm size.

Future research paths could include examining industry-specific variations in trade credit and short-term financing, as well as international comparisons of firms' decision-making processes within this area.

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