Bank Credit and Trade Credit under the COVID Crisis: A Comparison of the High-Technology and Low-Technology SMEs in Portugal[1]

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Abstract

This study mainly investigates the relationship between bank credit and trade credit separately for high-technology and low-technology small and medium-sized enterprises (SMEs) in Portugal with considering the impacts of the COVID crisis. The research results show obvious difference about the relationship between granting trade credit and obtaining bank credit between high-technology and low-technology SMEs. Regarding receiving trade credit and obtaining bank credit, the findings support an independent relationship when considering whether obtaining bank credit or not and a substitute relationship when considering the amount of bank credit. The substitute effect of receiving trade credit on obtaining bank credit reflects the existence of restrictions of bank credit for SMEs; the negative influence of the COVID crisis exacerbates the financial situations and causes strongly substitute effect on low-technology SMEs during and after the crisis. Therefore, the findings yielded enrich the research on externally financing behaviour of SMEs with different technology features from the perspective of bank credit and trade credit.

Keywords: *bank credit, trade credit, COVID crisis, high-technology, low-technology*

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Introduction and Background

Trade credit and bank credit as two important sources of external financing for firms have been studied by a number of researchers (Afrifa et al., 2023). Trade credit is the credit provided by suppliers to customers with the form of delaying the payment for a period of time in order to reduce transaction costs and evaluate product quality; payment delay usually means that suppliers charge additional fees (which are often quite expensive) from customers for compensating the delaying payment (Moro et al., 2021; Bertrand and Murro, 2022). The importance of trade credit for small and medium-sized enterprises (SMEs) is also shown in the form of occupying a considerable proportion of assets (Bertrand and Murro, 2022).

For SMEs especially the opaque ones in information, banks usually classify them as high-risk borrowers and tend to provide loans with tightening credit conditions such as the requirement of collateral and high interest rates; the COVID-19 pandemic further exacerbated the credit conditions of SMEs from banks (Arcuri and Pisani, 2024; Croce et al., 2025). According to Cuciniello (2024), the COVID-19 pandemic caused a sudden drop of economic activities, decreased business revenues, and led to the lack of operating cash flows for firms, which means that the problem of asymmetric information was more serious during the COVID crisis.

Because SMEs usually are difficult to get access to bank credit during crisis (Degryse et al., 2018), the relationship between trade credit and bank credit during crisis (especially whether being a substitute relationship) has been investigated much by scholars (Kadırgan and Özlü, 2023). From theoretical perspective, whether the relationship between trade credit and bank credit is substitute or complementary to a large extent depends on the impact of information asymmetry. According to Blanco et al. (2024), asymmetric information causes hurdles for lenders to evaluate the credit quality of borrowers. This is especially true for SMEs. As pointed out by Moro et al. (2021), banks have difficulties in assessing the creditworthiness of SMEs due to information asymmetry; by contrast, suppliers are easy to get access to the information of customers by virtue of regular interaction and long-term dealing relationship, thus showing a substitute relationship between trade credit and bank credit.

From the perspective of empirical research, a number of publications confirm a substitute effect of trade credit on bank credit especially during crisis periods for SMEs, such as Casey and O'Toole (2014), McGuinness and Hogan (2014), Carbó-Valverde et al. (2016), Palacín-Sánchez et al. (2019), and Pinto et al. (2023). However, other relationships between trade credit and bank credit are also supported by some empirical studies. For instance, the study of Love and Zaidi (2010) denies the existence of a substitute relationship between trade credit and bank credit for financially constrained SMEs in some Asian countries during the 1998 financial crisis; Del

Gaudio et al. (2022) confirm the signaling role of trade credit on obtaining bank loan for Italian SMEs that suffer the problems of information asymmetry with banks.

There are also some studies that explore the financing issues of high technology SMEs and technology-based small firms, such as Neville and Lucey (2022), North et al. (2013), and Revest and Sapio (2012); however, little research focuses on high-technology and low-technology SMEs from the viewpoint of trade credit. In order to fill in the research gap in this area, this study sheds light on bank credit and trade credit under the background of the COVID crisis. Here we choose the SMEs in Portugal where trade credit is prevalent (Moro et al., 2021). Hence, there are two main contributions of this paper. The first is that the research results enrich the related studies about SME finance in European countries during the recent COVID crisis. The second contribution is that, with considering the technology features, this paper provides valuable insights on the relationship between bank credit and trade credit as well as the influential factors on these two financing sources separately for high-technology and low technology SMEs in order to find the similarities and differences.

1. Data, Variables and Methods

To build the sample, we choose the firms from Iberian Balance sheet Analysis System (SABI) database which is developed by Bureau van Dijk. The sampled firms must report financial data in the observed three years (2019; 2020 and 2021) with turnover being no more than 50 million Euros and total balance sheet being no more than 43 million Euros in accordance with the requirements of the European Commission for defining SME. In particular, the firms with missing data and outliers are excluded from the sample. Finally, 1289 low-technology and 1896 high-technology SMEs are chosen in the manufacturing sectors of Portugal.

On the basis of NACE Rev. 2 2-digit level from European Commission, we combine both high-technology (Manufacture of basic pharmaceutical products and pharmaceutical preparations (21); Manufacture of computer, electronic and optical products (26)) and medium-high-technology (Manufacture of chemicals and chemical products (20); Manufacture of electrical equipment (27); Manufacture of machinery and equipment n.e.c. (28); Manufacture of motor vehicles, trailers and semi-trailers (29); Manufacture of other transport equipment (30)) manufacturing sectors as high-technology industry. Manufacture of food products (10) and beverages (11) are chosen as the representative of low-technology industry.

Following the research of Masiak et al. (2019), we design a dichotomous variable for measuring bank loans as the dependent variable to represent the financing source of bank credit and use logistic regression estimation to observe the impacting factors. Given that bank credit as the dependent variable is censored at zero

(indicating the firms without the support of bank credit), Tobit model is employed as the supplementary model to deal with the issue of non-linearity for the dependent variable (Brezigar-Masten et al., 2021).

In terms of trade credit, with referring to the study of Mättö and Niskanen (2019), we use both trade payable and trade receivable to measure trade credit and employ the ordinary least square (OLS) model to explore the influential factors. In addition to the above dependent variables respectively representing bank credit and trade credit, we also set a series of control variables (shown in Table 1), including size, profitability, leverage, tangibility, and intangibility.

T a b l e 1

Definition of Variables

Dependent Variables	
Bank credit dummy	Dummy variable: if a firm reports short-term bank loans in the financial statements, it takes the value of 1; if not, it takes 0.
Bank credit to assets	The ratio of short-term bank loans to total assets
Trade payable	The ratio of accounts payable to total assets
Trade receivable	The ratio of accounts receivable to total assets
Independent Variables	
Size	The natural logarithm of total assets
Profitability	The ratio of profit before tax to total assets
Leverage	The ratio of total liabilities to total assets
Tangibility	The ratio of tangible fixed assets to total assets
Intangibility	Dummy variable: if a firm reports intangible assets in the financial statements, it takes the value of 1; if not, it takes 0.

Source: Authors' own definitions.

2. Results

Statistic Descriptions

The statistic descriptions of the sampled data are shown in Table 2. In comparison with high-technology SMEs, low-technology peers show lower mean values of profitability and trade receivable, but higher mean values of bank credit dummy, bank credit to assets, trade payable, size, leverage, tangibility, and intangibility dummy. A noteworthy point is that: although both the mean values of profitability of high-technology and low-technology SMEs decrease in 2020 compared to 2021 and 2019, the reduction of low-technology SMEs is more than that of high-technology SMEs. This means that the COVID crisis impacts more on the profitability of low-technology SMEs than high-technology ones. The results of the Pearson correlation for the variables are shown in Table 3 and Table 4 respectively for high-technology and low-technology SMEs; because there is no Pearson coefficient with the absolute value more than 0.7, we do not need to consider the problem of multi-collinearity.

Table 2

Results of Statistic Descriptions Year by Year

	Low-Technology SMEs				High-Technology SMEs			
Variables	**Mean**	**Minimum**	**Maximum**	**Standard deviation**	**Mean**	**Minimum**	**Maximum**	**Standard deviation**
Bank credit dummy 2021	0.569	0.000	1.000	0.495	0.539	0.000	1.000	0.499
Bank credit dummy 2020	0.552	0.000	1.000	0.497	0.511	0.000	1.000	0.500
Bank credit dummy 2019	0.545	0.000	1.000	0.498	0.520	0.000	1.000	0.500
Bank credit to assets 2021	0.078	0.000	1.885	0.148	0.062	0.000	2.545	0.136
Bank credit to assets 2020	0.075	0.000	1.637	0.144	0.055	0.000	1.395	0.109
Bank credit to assets 2019	0.078	0.000	1.566	0.133	0.059	0.000	0.750	0.104
Trade payable 2021	0.168	0.000	2.453	0.169	0.156	0.000	1.612	0.149
Trade payable 2020	0.164	0.000	2.013	0.168	0.149	0.000	1.701	0.151
Trade payable 2019	0.183	0.000	2.809	0.176	0.166	0.000	1.858	0.160
Trade receivable 2021	0.215	0.000	0.910	0.169	0.259	0.000	0.988	0.179
Trade receivable 2020	0.208	0.000	0.943	0.165	0.263	0.000	0.988	0.180
Trade receivable 2019	0.228	0.000	0.948	0.176	0.286	0.000	0.994	0.189
Size 2021	7.312	2.526	10.644	1.664	6.975	2.692	10.638	1.632
Size 2020	7.235	2.710	10.613	1.654	6.904	2.589	10.508	1.603
Size 2019	7.183	2.258	10.552	1.679	6.828	1.761	10.477	1.607
Profitability 2021	0.022	–0.814	0.628	0.115	0.042	–1.348	2.146	0.152
Profitability 2020	0.007	–1.044	2.310	0.148	0.039	–1.718	0.910	0.157
Profitability 2019	0.019	–4.110	0.586	0.160	0.051	–1.865	0.661	0.147
Leverage 2021	0.638	0.014	2.613	0.350	0.571	0.001	2.972	0.348
Leverage 2020	0.640	0.005	2.459	0.347	0.568	0.003	2.978	0.341
Leverage 2019	0.649	0.018	2.987	0.351	0.569	0.008	2.984	0.327
Tangibility 2021	0.336	0.000	0.972	0.228	0.232	0.000	0.955	0.204
Tangibility 2020	0.342	0.000	0.959	0.228	0.239	0.000	0.964	0.208
Tangibility 2019	0.343	0.000	0.947	0.231	0.242	0.000	0.958	0.209
Intangibility 2021	0.456	0.000	1.000	0.498	0.406	0.000	1.000	0.491
Intangibility 2020	0.449	0.000	1.000	0.498	0.403	0.000	1.000	0.491
Intangibility 2019	0.451	0.000	1.000	0.498	0.397	0.000	1.000	0.489
Number of observations	1289				1896			

Source: Authors' own calculation.

Table 3

Results of the Pearson Correlation Year by Year for High-Technology SMEs 2021 (Number of observations: 1896)

2021 (Number of observations: 1896)									
	Bank credit dummy	**Bank credit to assets**	**Trade payable**	**Trade receivable**	**Size**	**Profitability**	**Leverage**	**Tangibility**	**Intangibility**
Bank credit dummy	1.000	0.420	0.013	–0.120	0.469	0.027	0.063	0.181	0.341
Bank credit to assets	0.420	1.000	0.038	–0.032	0.105	–0.131	0.339	0.159	0.125
Trade payable	0.013	0.038	1.000	0.272	–0.028	–0.101	0.424	–0.163	–0.038
Trade receivable	–0.120	–0.032	0.272	1.000	–0.183	–0.009	0.068	–0.375	–0.155
Size	0.469	0.105	–0.028	–0.183	1.000	0.173	–0.153	0.223	0.501
Profitability	0.027	–0.131	–0.101	–0.009	0.173	1.000	–0.355	–0.071	0.040
Leverage	0.063	0.339	0.424	0.068	–0.153	–0.355	1.000	0.110	0.029
Tangibility	0.181	0.159	–0.163	–0.375	0.223	–0.071	0.110	1.000	0.168
Intangibility	0.341	0.125	–0.038	–0.155	0.501	0.040	0.029	0.168	1.000
2020 (Number of observations: 1896)									
	Bank credit dummy	**Bank credit to assets**	**Trade payable**	**Trade receivable**	**Size**	**Profitability**	**Leverage**	**Tangibility**	**Intangibility**
Bank credit dummy	1.000	0.489	0.025	–0.118	0.447	–0.012	0.086	0.179	0.320
Bank credit to assets	0.489	1.000	–0.007	–0.052	0.164	–0.145	0.232	0.188	0.122
Trade payable	0.025	–0.007	1.000	0.293	–0.060	–0.090	0.431	–0.166	–0.057
Trade receivable	–0.118	–0.052	0.293	1.000	–0.207	0.059	0.064	–0.399	–0.185
Size	0.447	0.164	–0.060	–0.207	1.000	0.118	–0.150	0.244	0.486
Profitability	–0.012	–0.145	–0.090	0.059	0.118	1.000	–0.362	–0.121	0.027
Leverage	0.086	0.232	0.431	0.064	–0.150	–0.362	1.000	0.125	0.027
Tangibility	0.179	0.188	–0.166	–0.399	0.244	–0.121	0.125	1.000	0.170
Intangibility	0.320	0.122	–0.057	–0.185	0.486	0.027	0.027	0.170	1.000
2019 (Number of observations: 1896)									
	Bank credit dummy	**Bank credit to assets**	**Trade payable**	**Trade receivable**	**Size**	**Profitability**	**Leverage**	**Tangibility**	**Intangibility**
Bank credit dummy	1.000	0.551	0.022	–0.115	0.471	–0.052	0.072	0.181	0.320
Bank credit to assets	0.551	1.000	0.017	–0.042	0.223	–0.167	0.210	0.148	0.192
Trade payable	0.022	0.017	1.000	0.267	–0.056	–0.075	0.468	–0.164	–0.037
Trade receivable	–0.115	–0.042	0.267	1.000	–0.203	0.090	0.029	–0.421	–0.174
Size	0.471	0.223	–0.056	–0.203	1.000	0.065	–0.142	0.255	0.491
Profitability	–0.052	–0.167	–0.075	0.090	0.065	1.000	–0.307	–0.143	–0.006
Leverage	0.072	0.210	0.468	0.029	–0.142	–0.307	1.000	0.130	0.027
Tangibility	0.181	0.148	–0.164	–0.421	0.255	–0.143	0.130	1.000	0.180
Intangibility	0.320	0.192	–0.037	–0.174	0.491	–0.006	0.027	0.180	1.000

Source: Authors' own calculation.

Table 4

Results of the Pearson Correlation Year by Year for Low-Technology SMEs 2021 (Number of observations: 1289)

2021 (Number of observations: 1289)									
	Bank credit dummy	**Bank credit to assets**	**Trade payable**	**Trade receivable**	**Size**	**Profitability**	**Leverage**	**Tangibility**	**Intangibility**
Bank credit dummy	1.000	0.462	0.038	0.021	0.534	–0.030	0.008	0.098	0.254
Bank credit to assets	0.462	1.000	0.006	0.058	0.184	–0.129	0.229	0.039	0.109
Trade payable	0.038	0.006	1.000	0.350	0.003	–0.072	0.312	–0.210	–0.054
Trade receivable	0.021	0.058	0.350	1.000	–0.061	0.099	0.044	–0.455	–0.106
Size	0.534	0.184	0.003	–0.061	1.000	0.108	–0.265	0.123	0.406
Profitability	–0.030	–0.129	–0.072	0.099	0.108	1.000	–0.421	–0.191	–0.013
Leverage	0.008	0.229	0.312	0.044	–0.265	–0.421	1.000	0.083	–0.068
Tangibility	0.098	0.039	–0.210	–0.455	0.123	–0.191	0.083	1.000	0.117
Intangibility	0.254	0.109	–0.054	–0.106	0.406	–0.013	–0.068	0.117	1.000
2020 (Number of observations: 1289)									
	Bank credit dummy	**Bank credit to assets**	**Trade payable**	**Trade receivable**	**Size**	**Profitability**	**Leverage**	**Tangibility**	**Intangibility**
Bank credit dummy	1.000	0.472	0.051	0.022	0.508	–0.011	–0.013	0.083	0.258
Bank credit to assets	0.472	1.000	0.004	0.007	0.171	–0.077	0.216	0.037	0.126
Trade payable	0.051	0.004	1.000	0.348	–0.028	0.013	0.318	–0.210	–0.031
Trade receivable	0.022	0.007	0.348	1.000	–0.066	0.143	0.020	–0.443	–0.094
Size	0.508	0.171	–0.028	–0.066	1.000	0.121	–0.275	0.123	0.393
Profitability	–0.011	–0.077	0.013	0.143	0.121	1.000	–0.332	–0.120	–0.030
Leverage	–0.013	0.216	0.318	0.020	–0.275	–0.332	1.000	0.091	–0.061
Tangibility	0.083	0.037	–0.210	–0.443	0.123	–0.120	0.091	1.000	0.081
Intangibility	0.258	0.126	–0.031	–0.094	0.393	–0.030	–0.061	0.081	1.000
2019 (Number of observations: 1289)									
	Bank credit dummy	**Bank credit to assets**	**Trade payable**	**Trade receivable**	**Size**	**Profitability**	**Leverage**	**Tangibility**	**Intangibility**
Bank credit dummy	1.000	0.537	0.056	0.036	0.516	0.035	–0.055	0.075	0.213
Bank credit to assets	0.537	1.000	0.015	0.045	0.276	–0.034	0.131	0.026	0.117
Trade payable	0.056	0.015	1.000	0.346	–0.036	–0.010	0.343	–0.231	–0.022
Trade receivable	0.036	0.045	0.346	1.000	–0.038	0.103	0.019	–0.462	–0.085
Size	0.516	0.276	–0.036	–0.038	1.000	0.103	–0.279	0.117	0.387
Profitability	0.035	–0.034	–0.010	0.103	0.103	1.000	–0.334	–0.139	–0.014
Leverage	–0.055	0.131	0.343	0.019	–0.279	–0.334	1.000	0.071	–0.035
Tangibility	0.075	0.026	–0.231	–0.462	0.117	–0.139	0.071	1.000	0.095
Intangibility	0.213	0.117	–0.022	–0.085	0.387	–0.014	–0.035	0.095	1.000

Source: Authors' own calculation.

Table 5

The Results of the Logistic Model for the High-Technology SMEs with Trade Payable as Independent Variable

Variables	2021			2020			2019		
	Coefficient	Wald	Significance	Coefficient	Wald	Significance	Coefficient	Wald	Significance
Trade payable	–0.301	0.569	0.451	0.030	0.006	0.938	–0.086	0.050	0.823
Size	0.665***	222.146	0.000	0.639***	211.421	0.000	0.704***	240.271	0.000
Profitability	–0.098	0.061	0.805	–0.180	0.241	0.623	–0.780**	4.137	0.042
Leverage	0.963***	25.656	0.000	1.056***	28.982	0.000	0.983***	22.962	0.000
Tangibility	0.649**	5.416	0.020	0.551**	4.099	0.043	0.360	1.691	0.194
Intangibility	0.579***	23.057	0.000	0.533***	20.516	0.000	0.469***	15.367	0.000
Constant	–5.299***	262.787	0.000	–5.280***	262.239	0.000	–5.463***	272.987	0.000
Classification accuracy	73.0%			71.8%			73.7%		
Number of observations	1896			1896			1896		

Source: Authors' own calculation.

Table 6

The Results of the Logistic Model for the Low-Technology SMEs with Trade Payable as Independent Variable

Variables	2021			2020			2019		
	Coefficient	Wald	Significance	Coefficient	Wald	Significance	Coefficient	Wald	Significance
Trade payable	–0.278	0.432	0.511	0.474	1.218	0.270	0.790*	3.281	0.070
Size	0.943***	246.175	0.000	0.836***	222.743	0.000	0.835***	231.408	0.000
Profitability	–0.920	1.748	0.186	–0.867	2.619	0.106	0.336	0.253	0.615
Leverage	1.224***	27.365	0.000	0.888***	15.249	0.000	0.636***	7.243	0.007
Tangibility	0.016	0.002	0.960	0.071	0.053	0.817	0.253	0.703	0.402
Intangibility	0.140	0.911	0.340	0.291**	4.272	0.039	0.030	0.044	0.834
Constant	–7.303***	228.999	0.000	–6.576***	212.007	0.000	–6.431***	204.842	0.000
Classification accuracy	75.4%			74.2%			74.1%		
Number of observations	1289			1289			1289		

Note: Dependent variable is the bank credit dummy variable; ***Significant at the 1% significance level; ** Significant at the 5% significance level; * Significant at the 10% significance level.

Source: Authors' own calculation.

Table 7

The Results of the Logistic Model for the High-Technology SMEs with Trade Receivable as Independent Variable

Variables	2021			2020			2019		
	Coefficient	Wald	Significance	Coefficient	Wald	Significance	Coefficient	Wald	Significance
Trade receivable	–0.245	0.579	0.447	–0.085	0.069	0.793	0.060	0.037	0.847
Size	0.660***	222.284	0.000	0.639***	213.175	0.000	0.703***	242.464	0.000
Profitability	–0.105	0.070	0.791	–0.172	0.219	0.640	–0.790**	4.241	0.039
Leverage	0.911***	28.941	0.000	1.068***	37.021	0.000	0.957***	29.140	0.000
Tangibility	0.621**	4.582	0.032	0.517*	3.299	0.069	0.399	1.896	0.169
Intangibility	0.580***	23.202	0.000	0.529***	20.156	0.000	0.473***	15.575	0.000
Constant	–5.212***	229.616	0.000	–5.250***	230.829	0.000	–5.485***	242.104	0.000
Classification accuracy	72.9%			71.5%			73.8%		
Number of observations	1896			1896			1896		

Note: Dependent variable is the bank credit dummy variable; ***Significant at the 1% significance level; ** Significant at the 5% significance level; * Significant at the 10% significance level.

Source: Authors' own calculation.

Table 8

The Results of the Logistic Model for the Low-Technology SMEs with Trade Receivable as Independent Variable

Variables	2021			2020			2019		
	Coefficient	Wald	Significance	Coefficient	Wald	Significance	Coefficient	Wald	Significance
Trade receivable	1.353***	8.616	0.003	1.404***	9.509	0.002	1.173***	7.442	0.006
Size	0.941***	248.677	0.000	0.847***	226.661	0.000	0.843***	234.784	0.000
Profitability	–1.050	2.259	0.133	–1.034*	3.542	0.060	0.328	0.245	0.621
Leverage	1.124***	26.246	0.000	0.929***	19.161	0.000	0.762***	12.701	0.000
Tangibility	0.528	2.360	0.125	0.433	1.733	0.188	0.516	2.462	0.117
Intangibility	0.172	1.350	0.245	0.314**	4.919	0.027	0.048	0.116	0.733
Constant	–7.747***	226.267	0.000	–7.033***	210.395	0.000	–6.791***	203.767	0.000
Classification accuracy	75.8%			74.2%			74.2%		
Number of observations	1289			1289			1289		

Note: Dependent variable is the bank credit dummy variable; ***Significant at the 1% significance level; ** Significant at the 5% significance level; * Significant at the 10% significance level.

Source: Authors' own calculation.

Table 9

The Results of the Tobit Model for the High-Technology SMEs with Trade Payable as Independent Variable

Variables	2021			2020			2019		
	Coefficient	t	Significance	Coefficient	t	Significance	Coefficient	t	Significance
Trade payable	–0.135***	–3.57	0.000	–0.085***	–2.61	0.009	–0.067**	–2.260	0.024
Size	0.041***	11.03	0.000	0.039***	11.87	0.000	0.041***	13.180	0.000
Profitability	–0.034	–0.97	0.333	–0.058*	–1.94	0.052	–0.125***	–4.360	0.000
Leverage	0.237***	14.06	0.000	0.151***	9.75	0.000	0.132***	8.730	0.000
Tangibility	0.074***	2.96	0.003	0.074***	3.45	0.001	0.025	1.250	0.213
Intangibility	0.030***	2.65	0.008	0.017*	1.77	0.077	0.029***	3.190	0.001
Constant	–0.454***	–15.69	0.000	–0.388***	–15.19	0.000	–0.368***	–15.350	0.000
Number of observations	1896			1896			1896		
Uncensored observations	1,021			969			985		
Left-censored observations	875			927			911		
Right-censored observations	0			0			0		
Likelihood Ratio Chi-Square	442.15			382.16			431.23		
Prob. > Chi-Square	0.000			0.000			0.000		
Log likelihood	–202.771			–106.134			–44.342		

Note: Dependent variable is the bank credit to assets with lower (left) censoring at 0; ***Significant at the 1% significance level; ** Significant at the 5% significance level; * Significant at the 10% significance level.

Source: Authors' own calculation.

Table 10

The Results of the Tobit Model for the Low-Technology SMEs with Trade Payable as Independent Variable

Variables	2021			2020			2019		
	Coefficient	t	Significance	Coefficient	t	Significance	Coefficient	t	Significance
Trade payable	–0.119***	–2.89	0.004	–0.083**	–1.96	0.050	–0.039	–1.06	0.290
Size	0.070***	14.3	0.000	0.063***	12.94	0.000	0.068***	15.28	0.000
Profitability	–0.121*	–1.84	0.067	–0.053	–1.01	0.313	0.027	0.50	0.616
Leverage	0.234***	10.28	0.000	0.215***	9.52	0.000	0.156***	7.22	0.000
Tangibility	–0.033	–1.12	0.263	–0.031	–1.05	0.292	–0.018	–0.65	0.514
Intangibility	0.010	0.75	0.455	0.026*	1.89	0.060	–0.002	–0.19	0.847
Constant	–0.638***	–14.73	0.000	–0.591***	–14.01	0.000	–0.578***	–14.8	0.000
Number of observations	1289			1289			1289		
Uncensored observations	733			712			703		
Left-censored observations	556			577			586		
Right-censored observations	0			0			0		
Likelihood Ratio Chi-Square	328.93			279.72			308.11		
Prob. > Chi-Square	0.000			0.000			0.000		
Log likelihood	–158.174			–188.536			–147.450		

Note: Dependent variable is the bank credit to assets with lower (left) censoring at 0; ***Significant at the 1% significance level; ** Significant at the 5% significance level; * Significant at the 10% significance level.

Source: Authors' own calculation.

Table 11

The Results of the Tobit Model for the High-Technology SMEs with Trade Receivable as Independent Variable

Variables	2021			2020			2019		
	Coefficient	t	Significance	Coefficient	t	Significance	Coefficient	t	Significance
Trade receivable	0.003	0.09	0.931	0.019	0.70	0.482	0.037	1.50	0.134
Size	0.040***	10.69	0.000	0.039***	11.70	0.000	0.041***	13.09	0.000
Profitability	–0.038	–1.08	0.282	–0.065**	–2.15	0.032	–0.132***	–4.59	0.000
Leverage	0.211***	13.68	0.000	0.132***	9.36	0.000	0.114***	8.49	0.000
Tangibility	0.098***	3.71	0.000	0.096***	4.19	0.000	0.051**	2.35	0.019
Intangibility	0.033***	2.92	0.003	0.020**	2.08	0.038	0.031***	3.44	0.001
Constant	–0.460***	–14.73	0.000	–0.398***	–14.46	0.000	–0.384***	–14.76	0.000
Number of observations	1896			1896			1896		
Uncensored observations	1,021			969			985		
Left-censored observations	875			927			911		
Right-censored observations	0			0			0		
Likelihood Ratio Chi-Square	429.28			375.80			428.34		
Prob. > Chi-Square	0.000			0.000			0.000		
Log likelihood	–209.206			–109.315			–45.786		

Note: Dependent variable is the bank credit to assets with lower (left) censoring at 0; ***Significant at the 1% significance level; ** Significant at the 5% significance level; * Significant at the 10% significance level.

Source: Authors' own calculation.

Table 12

The Results of the Tobit Model for the Low-Technology SMEs with Trade Receivable as Independent Variable

Variables	2021			2020			2019		
	Coefficient	t	Significance	Coefficient	t	Significance	Coefficient	t	Significance
Trade receivable	0.131***	3.07	0.002	0.073*	1.66	0.097	0.094**	2.44	0.015
Size	0.068***	13.97	0.000	0.062***	12.77	0.000	0.067***	15.13	0.000
Profitability	–0.144**	–2.17	0.030	–0.076	–1.44	0.150	0.010	0.20	0.841
Leverage	0.204***	9.42	0.000	0.195***	9.14	0.000	0.141***	7.13	0.000
Tangibility	0.034	1.06	0.288	0.008	0.24	0.812	0.025	0.83	0.409
Intangibility	0.015	1.11	0.266	0.028**	2.03	0.042	–0.00004	–0.00	0.997
Constant	–0.679***	–14.93	0.000	–0.617***	–13.87	0.000	–0.607***	–14.84	0.000
Number of observations	1289			1289			1289		
Uncensored observations	733			712			703		
Left-censored observations	556			577			586		
Right-censored observations	0			0			0		
Likelihood Ratio Chi-Square	329.93			278.62			312.96		
Prob. > Chi-Square	0.000			0.000			0.000		
Log likelihood	–157.673			–189.085			–145.023		

Note: Dependent variable is the bank credit to assets with lower (left) censoring at 0; ***Significant at the 1% significance level; ** Significant at the 5% significance level; * Significant at the 10% significance level.

Source: Authors' own calculation.

Table 13

The Results of the OLS Model for the High-Technology SMEs with Trade Payable as Dependent Variable

Variables	2021				2020				2019			
	Coefficient	t	Significance	VIF	Coefficient	t	Significance	VIF	Coefficient	t	Significance	VIF
Bank credit dummy	–0.004	–0.637	0.524	1.339	0.002	0.231	0.818	1.308	–0.0004	–0.060	0.952	1.336
Size	0.013***	5.268	0.000	1.694	0.010***	4.077	0.000	1.643	0.011***	4.266	0.000	1.686
Profitability	0.035	1.640	0.101	1.169	0.050**	2.401	0.016	1.170	0.050**	2.246	0.025	1.123
Leverage	0.208***	22.069	0.000	1.204	0.220***	22.496	0.000	1.221	0.260***	25.178	0.000	1.171
Tangibility	–0.167***	–10.908	0.000	1.088	–0.169***	–11.089	0.000	1.111	–0.186***	–11.755	0.000	1.123
Intangibility	–0.024***	–3.343	0.001	1.380	–0.026***	–3.658	0.000	1.347	–0.020***	–2.657	0.008	1.350
Constant	–0.001	–0.056	0.955		0.005	0.304	0.761		–0.004	–0.244	0.807	
R-Square	0.239				0.247				0.281			
Adjusted R-Square	0.236				0.244				0.279			
F-value	98.653				103.167				123.291			
Significance	0.000				0.000				0.000			
Number of observations	1896				1896				1896			

Note: Dependent variable is the ratio of trade payable to total assets; ***Significant at the 1% significance level; ** Significant at the 5% significance level; * Significant at the 10% significance level.

Source: Authors' own calculation.

Table 14

The Results of the OLS Model for the Low-Technology SMEs with Trade Payable as Dependent Variable

Variables	2021				2020				2019			
	Coefficient	t	Significance	VIF	Coefficient	t	Significance	VIF	Coefficient	t	Significance	VIF
Bank credit dummy	–0.004	–0.391	0.696	1.452	0.013	1.291	0.197	1.388	0.021**	2.055	0.040	1.380
Size	0.017***	4.849	0.000	1.760	0.009***	2.786	0.005	1.686	0.008**	2.444	0.015	1.701
Profitability	0.033	0.779	0.436	1.256	0.118***	3.852	0.000	1.144	0.090***	3.061	0.002	1.145
Leverage	0.184***	13.050	0.000	1.325	0.193***	14.193	0.000	1.232	0.208***	14.921	0.000	1.231
Tangibility	–0.185***	–9.521	0.000	1.067	–0.181***	–9.510	0.000	1.045	–0.199***	–10.237	0.000	1.044
Intangibility	–0.021**	–2.199	0.028	1.209	–0.010	–1.058	0.290	1.197	–0.009	–0.915	0.360	1.188
Constant	0.002	0.090	0.928		0.032	1.268	0.205		0.047*	1.827	0.068	
R-Square	0.173				0.180				0.202			
Adjusted R-Square	0.169				0.176				0.198			
F-value	44.797				46.861				54.151			
Significance	0.000				0.000				0.000			
Number of observations	1289				1289				1289			

Note: Dependent variable is the ratio of trade payable to total assets; ***Significant at the 1% significance level; ** Significant at the 5% significance level; * Significant at the 10% significance level.

Source: Authors' own calculation.

Table 15

The Results of the OLS Model for the High-Technology SMEs with Trade Receivable as Dependent Variable

Variables	2021				2020				2019			
	Coefficient	t	Significance	VIF	Coefficient	t	Significance	VIF	Coefficient	t	Significance	VIF
Bank credit dummy	–0.006	–0.723	0.470	1.339	–0.002	–0.256	0.798	1.308	0.002	0.227	0.820	1.336
Size	–0.005	–1.619	0.106	1.694	–0.006**	–2.025	0.043	1.643	–0.007**	–2.136	0.033	1.686
Profitability	0.018	0.663	0.507	1.169	0.080***	3.147	0.002	1.170	0.084***	3.004	0.003	1.123
Leverage	0.057***	4.760	0.000	1.204	0.069***	5.754	0.000	1.221	0.054***	4.225	0.000	1.171
Tangibility	–0.318***	–16.467	0.000	1.088	–0.325***	–17.244	0.000	1.111	–0.360***	–18.196	0.000	1.123
Intangibility	–0.026***	–2.844	0.005	1.380	–0.036***	–4.123	0.000	1.347	–0.030***	–3.284	0.001	1.350
Constant	0.347***	16.933	0.000		0.355***	17.479	0.000		0.395***	18.492	0.000	
R-Square	0.164				0.193				0.200			
Adjusted R-Square	0.161				0.190				0.198			
F-value	61.800				75.105				78.897			
Significance	0.000				0.000				0.000			
Number of observations	1896				1896				1896			

Note: Dependent variable is the ratio of trade payable to total assets; ***Significant at the 1% significance level; ** Significant at the 5% significance level; * Significant at the 10% significance level.

Source: Authors' own calculation.

Table 16

The Results of the OLS Model for the Low-Technology SMEs with Trade Receivable as Dependent Variable

Variables	2021				2020				2019			
	Coefficient	t	Significance	VIF	Coefficient	t	Significance	VIF	Coefficient	t	Significance	VIF
Bank credit dummy	0.029***	2.841	0.005	1.452	0.029***	3.044	0.002	1.388	0.028***	2.738	0.006	1.380
Size	–0.0004	–0.110	0.913	1.760	–0.002	–0.687	0.492	1.686	0.001	0.440	0.660	1.701
Profitability	0.083**	2.050	0.041	1.256	0.137***	4.646	0.000	1.144	0.067**	2.305	0.021	1.145
Leverage	0.048***	3.504	0.000	1.325	0.043***	3.332	0.001	1.232	0.039***	2.882	0.004	1.231
Tangibility	–0.336***	–17.800	0.000	1.067	–0.316***	–17.303	0.000	1.045	–0.351***	–18.369	0.000	1.044
Intangibility	–0.022**	–2.412	0.016	1.209	–0.021**	–2.366	0.018	1.197	–0.021**	–2.236	0.026	1.188
Constant	0.291***	11.554	0.000		0.297***	12.358	0.000		0.305***	12.044	0.000	
R-Square	0.224				0.222				0.228			
Adjusted R-Square	0.221				0.218				0.224			
F-value	61.806				60.825				63.049			
Significance	0.000				0.000				0.000			
Number of observations	1289				1289				1289			

Note: Dependent variable is the ratio of trade payable to total assets; ***Significant at the 1% significance level; ** Significant at the 5% significance level; * Significant at the 10% significance level.

Source: Authors' own calculation.

Regression Results of the Logistic Mode and Tobit Model with Bank Credit as Dependent Variable

Table 5, 6, 7 and 8 show the results of logistic model in 2019, 2020, and 2021 respectively for the high-technology and low-technology SMEs for observing the impacts of trade payable and trade receivable as well as other control variables. For trade payable, we observe little effect on bank credit dummy; by contrast, trade receivable is positively related to bank credit dummy at the 1 percent significant level for low-technology SMEs.

For both the high-technology and low-technology SMEs, size and leverage are statistically significant at the 1 percent level and positively related to bank credit dummy in all the observed years. In addition, we also find that there is a trend of increasing in the absolute value of the coefficient of leverage (representing an increase of the positive effect) from 2019 to 2021 for low-technology SMEs. For high-technology SMEs profitability shows relatively strong and negative effects on bank credit dummy in 2019, while tangibility shows strongly positive effects on bank credit dummy in 2020 and 2021. Intangibility shows significantly positive effects on bank credit dummy for high-technology SMEs in all the observed years as well as low-technology SMEs in 2020.

Table 9, 10, 11 and 12 show the results of Tobit model in 2019, 2020, and 2021 respectively for the high-technology and low-technology SMEs. Compared to the results of logistic model, an obvious difference is observed on the effect of trade payable; that is, trade payable shows statistically significant and negative effects on the proportion of bank credit to assets in most regressions. For the other variables, the results of the Tobit model and the logistic model are generally similar.

Regression Results of the OLS with Trade Credit as Dependent Variable

Table 13, 14, 15 and 16 represent the results of linear model in 2019, 2020, and 2021 respectively for the high-technology and low-technology SMEs for observing the impacts of obtaining bank loans on trade payable and trade receivable. The values of variance inflation factor (VIF) observed here are less than 10; so, according to Neville and Lucey (2022), multi-collinearity is not a problem in the OLS regressions. With regard to the bank credit dummy, non-significant effect on both trade payable and trade receivable is observed for high-technology SMEs; for low-technology SMEs, it shows a positive effect mainly on trade receivable.

Size shows a significant and positive effect on trade payable for both the high-technology and low-technology SMEs, while it is statistically significant and negatively related to trade receivable in 2019 and 2020 only for high-technology SMEs. Profitability is positively related to trade payable and trade receivable for both the high-technology and low-technology SMEs especially in 2019 and 2020.

Additionally, the magnitude of profitability to trade receivable is higher in 2020 than in 2019 and 2021 for low-technology SMEs.

For both the high-technology and low-technology SMEs, leverage and tangibility separately show positive effect and negative effect on both trade payable and trade receivable in all the observed years. Intangibility shows a significantly negative effect on both trade payable and trade receivable for the high-technology SMEs in all the observed years at the significant level of 1 percent, whereas for the low-technology SMEs this negative effect is mainly shown on trade receivable at the significant level of 5 percent.

3. Discussion

In the logistic regressions for testing the impacts of trade credit on bank credit dummy, the effects of both trade payable and trade receivable are non-significant for high-technology SMEs; for low-technology SMEs, trade receivable shows a significant and positive effect on bank credit dummy, while the positive effect of trade payable is significant only in 2019. In the OLS regressions for observing the impacts of bank credit dummy on trade credit, non-significant effect is shown for high-technology SMEs; for low-technology SMEs, bank credit dummy shows a positive effect on trade payable in 2019 as well as on trade receivable in 2019, 2020, and 2021.

Here, in terms of the relationship between trade credit and bank credit, our findings confirm the existence of the difference between high-technology and low-technology SMEs on whether obtaining bank loan (that is represented by bank credit dummy). For high-technology SMEs, due to the findings of non-significant effect, we believe that trade credit and bank credit are independent with each other from the perspective of obtaining or not. On the other hand, for low-technology SMEs a complementary relationship between trade payable (receiving trade credit) and bank credit is supported by our findings in the pre-crisis year; the relationship between trade receivable (granting trade credit) and bank credit is also complementary on the basis of the findings of the significantly positive effects in the pre-crisis, crisis and post-crisis years.

In the Tobit model with the dependent variable being left censored at zero, trade payable is significantly and negatively related to the proportion of bank credit to assets in most regressions, which clearly indicates a substitute effect of trade credit on bank credit when considering the amount of bank loans obtained. According to Martínez-Sola et al. (2014), the substitute effect of trade credit on bank credit means information advantages for vendor firms over financial institutions, which indicates the existence of financial market imperfection. The increase

in the magnitude of the negative effect of trade payable is manifest for the low-technology SMEs compared to the high-technology ones from 2019 to 2021. As pointed out by London and Silvestrini (2025), the role of trade credit as an alternative financing source is of importance especially under the tightening financial circumstance.

Thereby, the increase in the alternative (negative) effect of trade payable here for low-technology SMEs shows that low-technology SMEs are more impacted by the COVID crisis than high-technology ones. As for trade receivable, similar to the results of logistic model, it shows significant and positive effects for low-technology SMEs and non-significant effect for high-technology ones.

The positive relationship between granting trade credit (trade receivable) and bank credit can be interpreted as the signaling effect of good sales, as extending trade credit to customers usually can help firms decrease the costs of inventory as well as drive sales and then profitability particularly during economic recession periods with the reduction on the demand for products and services (Kubíčková and Souček, 2013; Afrifa and Gyapong, 2017; Martínez-Victoria and Maté-Sanchez-Val, 2022; Silva, 2025). As pointed out by Bussoli and Marino (2018), when lacking of financing sources, firms tend to reduce the supply of trade receivable. On the other hand, receiving the support of bank credit can help to increase the provision of trade credit, for the reason that the cost of trade credit is higher than that of bank credit (Afrifa et al., 2023).

For high-technology SMEs, we find that the relationship between bank credit and trade credit is statistically insignificant. To explain this phenome-non, it is necessary to consider the difference of the features between high-technology and low-technology SMEs. Compared to low-technology SMEs, high-technology peers tend to reflect more characteristics of innovation. Because innovation usually goes hand in hand with risk, high-technology firms should bear higher risk compared to the low-technology firms; thus, resulting in difficulties for high-technology firms in obtaining external finance (including both trade finance and bank finance). This means that whether a high-technology firm can obtain external finance depends mainly on the independent risk assessment based on innovation rather than credit worthiness.

With regard to firm size and leverage as the control variables representing the general financial characteristics of firms, both exert positive effects on obtaining bank loans and trade payable, which correspond to the research results of Agostino and Trivieri (2017), Bussoli and Giannotti (2016), and Canto-Cuevas et al. (2019). This means that for SMEs firm size and leverage are positively associated with external debt. Besides, leverage also shows a positive effect on trade receivable.

Firm size reflects financial constraints, while leverage not only represents financial risk but also plays a signaling role on credit worthiness. Therefore, the findings here support the usefulness of firm size in measuring financial constraint (Afrifa et al., 2023), that is, larger firms are less likely to be financially constrained. In addition, the findings confirm the effect of larger firm size on reducing financial constraints and the signaling role of higher leverage on obtaining debts for SMEs.

Compared to firm size and leverage, tangibility and intangibility can reflect the financial characteristics one step further. Their effects on bank credit and trade credit are different. Our findings indicate that both tangibility and in-tangibility show positive effects on bank credit for high-technology SMEs but negative effects on trade credit. The positive effect of intangibility on obtaining bank credit for high-technology SMEs confirms the crucial role of innovation and research and development (R&D) outcomes on the future development of high-technology firms. This is because for high-technology firms intangibles are mainly attributed to innovation and R&D outcomes.

Regarding tangibility, as pointed out by Pinto et al. (2023), the tangibility of assets represents collateral that can help firms obtain debt. From the perspective of credit supply, the collateral effect of the tangibility of assets reflects the riskiness of granting credit. This means that granting credit to the firms with less tangible fixed assets should be riskier than those with more tangible fixed assets. Thus, the significant and positive effect for high-technology SMEs in obtaining bank credit shows the riskiness of high-technology SMEs compared to low-technology SMEs especially during the crisis and post-crisis years from the perspective of banks.

The negative effects of tangibility and intangibility on trade credit (including both trade payable and trade receivable) reflect the close relationship between liquidity and trade credit. Tangibles and intangibles belong to fixed assets, and increasing the proportion of fixed assets usually means decreasing current assets and then liquidity. Trade payable and trade receivable separately work as important parts of current liabilities and current assets, which directly influence firm's liquidity. Therefore, for SMEs, good liquidity is helpful to the use of trade credit.

In terms of profitability, as pointed out by Psillaki and Eleftheriou (2015) and Pinto et al. (2023), better profitability can help to accumulate internal funds which should be more welcomed than external debt according to the pecking order theory of Myers and Majluf (1984) and Myers (1984), thus leading to a negative relationship between profitability and debt. Here the pecking order theory is partially supported, as profitability shows significantly negative effect on bank credit but significantly positive effect on trade credit.

Conclusions

This study aims to explore the relationship of the two external financing sources (bank credit and trade credit) for SMEs as well as their influential factors under the circumstance of the COVID crisis. Although the relationship between bank credit and trade credit as a hot research topic has been investigated much, the related research on European SMEs with considering the difference of technology type is limited. Hence, the relationship between bank credit and trade credit is tested here respectively for high-technology and low-technology SMEs in Portugal with considering the impacts of the COVID crisis.

The research results here show the existence of differences between high-technology and low-technology SMEs especially regarding the relationship between obtaining bank credit and granting trade credit. In particular, for high-technology SMEs obtaining bank credit is independent of granting trade credit, while for low-technology SMEs a complementary relationship is supported here thanks to the findings of the positive effects of obtaining bank credit on increasing trade receivable. With regard to the relationship between obtaining bank credit and receiving trade credit, it is non-significant when considering whether obtaining bank credit or not but is negative when considering the amount and proportion of bank credit in all the regressions for high-technology SMEs and the regressions during and after the crisis for low-technology SMEs.

Compared to low-technology firms, high-technology firms particularly SMEs are often believed to be risky by financial institutions because of the uncertainty about highly investing in R&D and innovation projects as an important feature of high-technology industry sectors; thus, showing more informational asymmetry. For high-technology SMEs it is reasonable that credit providers (including both banks and suppliers) evaluate credit worthiness on the basis of their own judgement systems with the focus mainly on the internal characteristics of the firms per se, when deciding whether to provide credit to a firm initially. This should be also true for low-technology SMEs during and after crisis that increases the risk and informational asymmetry.

Theoretically, trade credit is an expensive financing source compared to bank credit; thus, firms should prefer bank credit to trade credit when bank credit is accessible (Osinubi, 2020; Dottori et al., 2024). The findings here about the substitute effect of receiving trade credit on bank credit (the pro-portion of bank credit to assets) reflects the restrictions on obtaining bank credit for SMEs as well as poorly developed bank system (Cassia and Vismara, 2009). In addition, high-technology SMEs show this substitute effect strongly no matter in the pre-crisis and post-crisis years, whereas low-technology SMEs do not show significance of this substitute effect in the pre-crisis year. Hence, the COVID crisis impacts more on

low-technology SMEs about obtaining bank credit than on high-technology ones, which should be attributed to the feature of opaque information for high-technology firms and the in-crease in the riskiness caused by crisis for low-technology firms. The findings also confirm that the signaling (positive) effect of granting trade credit on obtaining bank credit is especially obvious for low-technology SMEs instead of high-technology ones, which reflects the relative easiness for low-technology firms to release information through granting trade credit.

For the control variables, leverage shows a significant and positive effect in all the regressions for bank credit and trade credit (including both trade payable and trade receivable), which is followed by size positively impacting on obtaining bank finance and trade finance. Differently enough, when being significant, both tangibility and intangibility show positive effects on bank credit but negative effects on trade credit; by contrast, profitability shows negative effects on bank credit but positive effects on trade credit. Given that tangibility and intangibility can demonstrate the liquidity of a firm from the opposite angle, the control variables chosen here reflect the impacts on ex-ternal finance of SMEs from the perspectives of financial risk, financial constraint, profitability and liquidity, which include the main financial areas of a firm.

In a nutshell, this study supports the existence of an independent relationship as well as a substitute relationship between obtaining bank credit and obtaining trade credit with the influence of the COVID crisis on low-technology SMEs. And, compared to high-technology SMEs, low-technology ones rely more on granting trade credit for signaling. This study is limited by the availability of the data; we only investigate Portuguese SMEs under the COVID crisis. Future research could extend to explore SMEs in more countries.

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