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RESEARCH ARTICLE

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Why do firms extend trade credit? The role of inventories

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Abstract

We are the first to explore the role of inventories as a trade credit driver in an economic/financial crisis setting. To this end, we make use of a panel of 198,024 manufacturing firms from eleven euro-area countries over the period 2006–2022. We find an inverse relationship between the stock of inventories and trade credit extended, which is magnified during the recent sovereign debt crisis. These results are robust to using different definitions of trade credit extended and of the crisis. Furthermore, we find that the association between inventories and trade credit extended is driven by financially constrained firms and firms producing differentiated products.

KEYWORDS

differentiated products, euro-area, financial constraints, inventories, sovereign debt crisis, trade credit

1 | INTRODUCTION

A vast literature shows that trade credit is one of the most important sources of short-term financing for firms (e.g., Casey & O'Toole, 2014; Giannetti et al., 2011; Giannetti et al., 2021; Petersen & Rajan, 1997). Over the period 2006–2022, euro-area companies directed a significant share of their sales to financing their customers: their average trade credit extended to sales ratio was as high as 30.0%.[1] Furthermore, Figure 1 shows a spike in trade credit extended during the 2010–2011 sovereign debt crisis.

Figure 1 also shows that the accounts receivable and stock of inventories (relative to sales) of euro-area firms move in opposite directions.[2] This pattern can be explained considering that holding inventories is costly.[3] Accordingly, it is sensible for firms to reduce their stock of inventories by enhancing sales. One way to do this is to provide credit to financially constrained buyers through accounts receivable. This is known as the inventory-management motive for offering trade credit (Bougheas et al., 2009). Bougheas et al. (2009) and Guariglia and Mateut (2016) find evidence of such a trade-off between inventories and accounts receivable respectively in the UK and China.[4] The trade-off between inventories and trade credit observed in Figure 1 could be an indication that the inventory-management motive also applies to euro-area firms. The first aim of this paper is to formally test the extent to which firms in the euro-area also tend to reduce their inventory stocks by selling on credit.

Considering that economic crises go hand in hand with increased demand uncertainty (Bloom, 2014; Bloom et al., 2018; Kozeniauskas et al., 2018), it makes less sense for firms to hold costly inventories during those periods, as these may not be sold in the next period. These considerations lead to the second and main aim of this paper, which is to investigate whether, in line with this argument, the trade-off between inventories and trade credit in the euro-area was magnified over the sovereign debt crisis period. To the best of our knowledge, our paper is

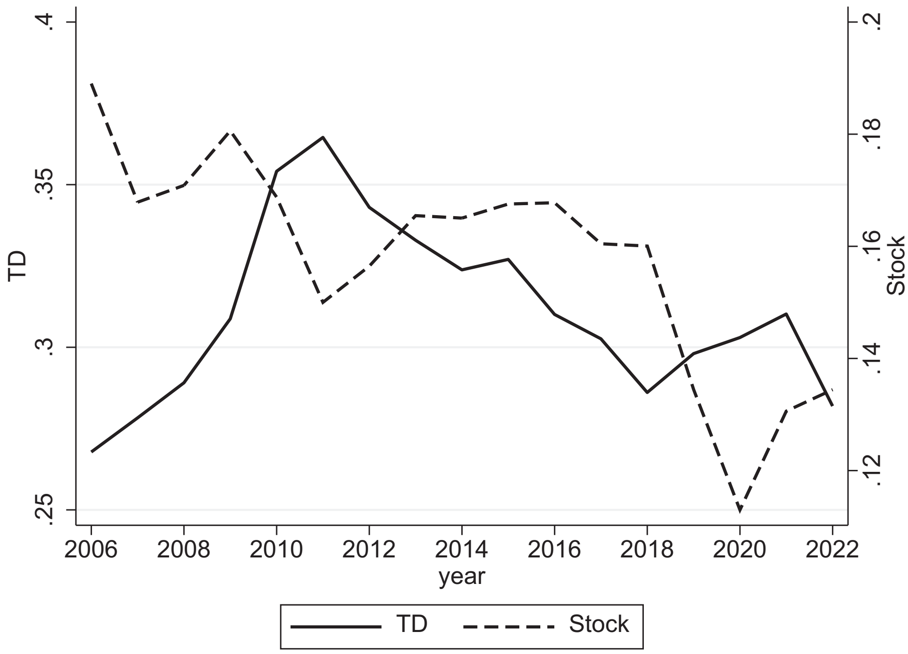


FIGURE 1 Accounts receivable relative to sales (*TD*) and stock of inventories relative to sales (*Stock*) for euro-area corporations over the period 2006–2022. Source: Authors' calculations based on the Orbis database.

the first to explore the role of inventories as a trade credit driver in an economic/financial crisis setting.

Our analysis is based on a panel of 198,024 euro-area firms, sourced from the ORBIS-Europe Database, published by Bureau Van Dijk, over the period 2006–2022. Our motivation for focusing on European firms stems from three key facts. First, European small and medium-sized enterprises (SMEs) represent approximately 99.8% of all enterprises in the region, providing 66% of employment and around 56.4% of value added (European Commission, 2020). The considerable weight of SMEs in the European economy, together with the central role played by financial constraints in general, and size in particular, in theories of trade credit (e.g., Bougheas et al., 2009; Nilsen, 2002; Petersen & Rajan, 1997) make Europe an ideal environment to better understand the determinants of trade credit provision.

Second, trade credit relationships are very important in the euro-area. Cosci et al. (2020) document in fact that the entire European economy is negatively affected by late payment in commercial transactions, with numerous firms facing the prospect of bankruptcy waiting for their invoices to be paid.

Third, European companies were strongly affected by the 2010–2011 sovereign debt crisis. This crisis was unprecedented, partly because it hit in the aftermath of the global financial crisis. European Central Bank (ECB) officials highlighted on many occasions the financing constraints that SMEs faced during the sovereign debt crisis period (Draghi, 2014), with credit weakness contributing to economic weakness. Yet, despite the increased financial pressure and the uncertain climate that they faced as a result of the crisis, European SMEs continued to retain their position as the backbone of the economy. As it became increasingly difficult for these firms to obtain bank loans, they turned to alternative sources of financing such as trade credit (Carbó-Valverde et al., 2016; Casey & O'Toole, 2014).[5] In line with this argument, Figure 1 shows that accounts receivable substantially increased during the sovereign debt crisis.

Previewing our main findings, we first show that inventories are negatively associated with trade credit extended. This supports Bougheas et al.'s (2009) inventory-management motive. Second, we find that the trade-off between inventories and trade credit in the euro-area is magnified during the recent sovereign debt crisis. These results are robust to a battery of sensitivity checks. Finally, we document that the association between inventories and trade credit extended is driven by financially constrained firms and firms producing differentiated products.

We contribute to the existing literature in three ways. First, we add to the general literature on the motives for extending credit by providing the first test of the inventory-management motive for extending trade credit within a cross-country setting based on euro-area firms. This is beneficial as our sample provides richer within-country and cross-country variation relative to single-country studies.[6] Second, we advance the body of work which explores firms' access to finance during economic/financial crises. Specifically, by investigating how the recent turmoil in the euro-area affected the extension of trade credit in general and the trade-off between inventories and trade credit in particular, we extend the literature on economic crises in Europe, which, when it comes to financing effects, largely focuses on bank lending (Acharya et al., 2018; Ferrando et al., 2017). Whilst Casey and O'Toole (2014) and Carbó-Valverde et al. (2016) investigate changes in the uptake of trade credit during crises periods, our main emphasis is on trade credit extension.[7] Finally, we advance the above-mentioned literature by studying, for the first time, which firms drive the inventory-management motive for extending trade credit both in and out of the crisis.

The remainder of the paper is structured as follows. Section 2 presents an economic background. Section 3 highlights our contributions to the literature and develops our hypotheses. Section 4 presents our baseline specifications and our estimation methodology. Section 5 contains a description of our data. Section 6 illustrates the main empirical results. Section 7 investigates which firms drive the relationship between stock of inventories and trade credit extended. Section 8 concludes.

2 | ECONOMIC BACKGROUND

2.1 | Literature on the motives for extending trade credit

A vast literature investigates the motives for extending trade credit. For instance, the commercial motive suggests that trade credit can be used to guarantee product quality (Lee & Stowe, 1993; Long et al., 1993). Alternatively, according to the operational motive, firms adjust trade credit to smooth the demand for their products (Emery, 1987).[8]

From a theoretical viewpoint, financial theories of trade credit dominate this strand. These theories posit that given the frequent interactions between suppliers and customers, which reduce information asymmetries, the former have a lending advantage over banks in extending credit (Petersen & Rajan, 1997). Suppliers also have a monitoring advantage thanks to their knowledge about the products (Burkhart & Ellingsen, 2004). Yet, trade credit is typically more expensive than bank credit (Chod, 2017; Petersen & Rajan, 1997; Wilner, 2000). Theoretical models thus suggest that in the presence of ample liquidity, firms tend to finance themselves using relatively cheap bank credit, but when liquidity dries up, they make use of more expensive trade credit (Burkhart & Ellingsen, 2004; Petersen & Rajan, 1997). In line with the predictions of these models, focusing respectively on the US and the UK, Choi and Kim (2005) and Mateut et al. (2006) show that while bank lending declines in periods of tight monetary policy, trade credit issuance increases, smoothing out the impact of the policy.

2.2 | The inventory-management motive for extending trade credit

Bougheas et al. (2009) and Daripa and Nilsen (2011) advocate that extending trade credit is related to inventory management. In particular, firms produce goods for sale. If firms do not sell the goods, they retain the inventories at a cost. Bearing in mind that the demand for their products is uncertain, producers have an incentive to provide credit to financially constrained customers in order to boost sales and avoid holding costly inventories. This is known as the inventory-management motive for sales on credit. Bougheas et al. (2009) and Guariglia and Mateut (2016) find evidence of the inventory-management motive in the UK and China, respectively.

2.3 | Literature on access to finance during extreme economic events

A number of papers explore how economic/financial crises such as the global financial crisis and the European sovereign debt crisis affect the way firms finance themselves. This literature largely focuses on bank lending. For instance, Ferrando et al. (2017) document that firms in stressed euro area countries experience a disproportionately higher reduction in access to bank credit during the European sovereign debt crisis, relative to similar firms in non-stressed countries. Similarly, Acharya et al. (2018) document that European firms that had a pre-crisis lending relationship with banks that suffered from the sovereign debt crisis became financially constrained during the crisis.

A few papers also look at how economic/financial crises affect firms' use of trade credit. One would expect trade credit usage to rise in crises periods as the financing advantage theory would be more relevant when firms' access to bank credit is restricted. In line with this expectation, Casey and O'Toole (2014) show that during the global financial crisis, bank-lending-constrained firms in the euro-area used more trade credit as an alternative to bank lending than their unconstrained counterparts did. Using a sample of Spanish SMEs, Carbó-Valverde et al. (2016) also show that credit constrained firms depended heavily on trade credit during the financial crisis. In a nutshell, this literature argues that bank-lending-constrained firms rely more on trade credit during bad economic times. To satisfy this increased demand for trade credit financing, more trade credit needs to be extended. Garcia-Appendini and Montoriol-Garriga (2013) show that larger US firms indeed extended more trade credit to their credit-constrained counterparts during the global financial crisis. Similarly, McGuinness et al. (2018) document a significant redistribution of credit from more liquid (unconstrained) European small and medium-sized enterprises to less liquid (constrained) firms during the early years of the financial crisis. As a result, the recipient firms were more likely to survive in the post-crisis period.

3 | CONTRIBUTION AND HYPOTHESES

We contribute to the literature surveyed above in two ways. First, we add to the general literature on the motives for extending credit by providing the first test of the inventory-management motive for extending trade credit within a cross-country setting based on euro-area firms. This is beneficial as our sample provides richer within-country and cross-country variation relative to single-country studies. We anticipate the inventory-management motive, which was tested for the UK (Bougheas et al., 2009) and China (Guariglia & Mateut, 2016) separately, to also hold for euro-area firms. To ascertain whether this is the case, we test the following hypothesis:

> **H1.** Euro-area firms show a negative association between inventories and trade credit extended.

Second, we extend the literature on economic crises in Europe, which, when it comes to financing effects largely focuses on bank lending (Acharya et al., 2018; Ferrando et al., 2017), by investigating, for the first time, how the recent turmoil in the euro-area affected the extension of trade credit in general and the trade-off between inventories and trade credit in particular. The literature has found evidence of a higher demand for trade credit by bank-lending-constrained firms during economic downturns (e.g., Carbó-Valverde et al., 2016; Casey & O'Toole, 2014). At the same time, during those periods, which are typically characterized by increased demand uncertainty,[9] it makes less sense for firms to hold costly inventories, as these may not be sold in the next period. Firms have therefore a higher incentive to sell their inventories on credit. This leads to our second hypothesis, which reads:

> **H2.** The negative association between euro-area firms' inventories and trade credit extended is stronger during the sovereign debt crisis.

Finally, we add to the above-mentioned literature by studying, for the first time, which firms drive the inventory-management motive for extending trade credit both in and out of the crisis, focusing in turn on the role of financing constraints and of the characteristics of the goods traded.

4 | DATA AND SUMMARY STATISTICS

4.1 | Data description

To construct our dataset, we use annual reports from Orbis-Europe, published by Bureau Van Dijk Electronic Publishing (*BvDEP*), which comprise financial information on public and private firms across European countries. Our dataset spans the following countries: Austria, Belgium, Finland, France, Germany, Greece, Ireland, Italy, the Netherlands, Portugal, and Spain.[10] We focus on manufacturing firms and cover the period 2006–2022.[11]

Following standard practice, we remove observations with negative sales and assets, as well as firms that do not have complete records on the variables used in our regressions. To minimize potential selection bias, we also exclude firms with less than three years of consecutive observations. Furthermore, in line with Mättö and

TABLE 1 Variable definitions.

Variable	Definition
TD	Ratio of accounts receivable to total sales
Age	Log of the difference between the present year and the firm's year of incorporation
Size	Log of real total assets measured in thousands of euros and deflated using each country's GDP deflator
Stock	Ratio of inventory stock to total sales
Profit	Ratio of operating profits (or losses) to total sales
Tang	Ratio of tangible assets to total assets
Liquidity	Ratio of cash and equivalents to total sales
Loans	Ratio of short-term debt to total sales, where short-term debt includes loans due within 1 year + liabilities to credit institutions due within 1 year
Public	Dummy variable equal to 1 if the firm is listed on the stock market, 0 otherwise
Crisis	Dummy variable equal to 1 in the years 2010–2011, 0 otherwise
FC	Dummy variable equal to 1 for financially constrained firms, 0 otherwise. Financing constraints are measured based on firms' age, size, and bank dependence

Niskanen (2021), we drop 98 firms that became public during the sample period. We control for the potential influence of outliers by excluding observations in the 1% tails of each of our regression variables. Our final panel consists of 503,395 firm-year observations, corresponding to 198,024 firms.

Our panel is unbalanced. Allowing for the entry and exit of firms partially mitigates potential selection and survivorship bias. The vast majority of firms in our dataset are not traded in the stock market. This is an appealing characteristic because unlisted firms are most likely to suffer from higher levels of information asymmetry. As such, they benefit from extending trade credit, which allows them to enhance demand for their products and to attract new customers (Emery, 1987).

4.2 | Summary statistics

Table 1 reports definitions of the variables used in our analysis. Table 2 presents means and standard deviations of relevant variables for the whole sample (column 1), for the European sovereign debt crisis period (column 2), and for other periods (column 3). We also present *p*-values for the tests of equality of means across the crisis and non-crisis periods (column 4).

Column 1 of Table 2 shows that the average ratio of accounts receivable to sales (*TD*) for firms in our sample is 30.0%. This is similar to the corresponding figure in Mateut et al. (2015) who sampled French manufacturing firms (21.2%).

From columns 2 and 3, we notice that the average *TD* is higher during the sovereign debt crisis compared to non-crisis years. This can be explained considering that during the crisis, bank-lending constraints and credit rationing likely increased firms' demand for trade credit (Casey & O'Toole, 2014), which led to more trade credit extended (Garcia-Appendini & Montoriol-Garriga, 2013). Moreover, in line with Nikolov (2013), the inventory-to-sales ratio (*Stock*) which is equal to 15.9% on average, is lower during the turmoil. The differences

TABLE 2 Descriptive statistics.

Variables	Full sample (1)	Crisis (2)	Non-crisis (3)	Diff. (4)
TD_{it}	0.300	0.302	0.295	0.000
	(0.164)	(0.163)	(0.168)	
$Stock_{it}$	0.159	0.158	0.160	0.006
	(0.130)	(0.127)	(0.130)	
$AgeNoLog_{it}$	28.808	28.874	28.790	0.263
	(14.78)	(14.73)	(14.80)	
$SizeNoLog_{it}$	7942.54	7940.47	7951.66	0.899
	(14,574.35)	(14,499)	(14,845.58)	
$Tang_{it}$	0.232	0.228	0.233	0.000
	(0.179)	(0.177)	(0.179)	
$Profit_{it}$	0.037	0.036	0.038	0.000
	(0.038)	(0.037)	(0.038)	
$Liquidity_{it}$	0.081	0.082	0.080	0.002
	(0.10)	(0.102)	(0.100)	
$Loans_{it}$	0.107	0.108	0.103	0.000
	(0.118)	(0.118)	(0.118)	
$Public_{it}$	0.108	0.123	0.090	0.000
	(0.080)	(0.097)	(0.079)	
Observations	503,395	108,699	394,696	

Note: The table reports the means of relevant variables with standard deviations in parentheses. *Crisis* equals 1 in 2010–2011, and 0 otherwise. $AgeNoLog_{it}$ is the difference between the present year and the firm's year of incorporation. $SizeNoLog_{it}$ represents real total assets, measured in thousands of euros and deflated using each country's GDP deflator. Note that age and size are not logged in this table for ease of interpretation. Table 1 contains definitions of all other variables. In column 4, *Diff.* represents the *p*-values of the *t*-test for whether the differences in the means of relevant variables between the crisis and non-crisis periods are statistically significant.

between the above-mentioned indicators during and outside the crisis period are statistically significant at conventional levels (column 4). Taken together, these statistics are consistent with the view that during crises periods, firms decrease inventories by channelling funds to financially constrained customers.

5 | EMPIRICAL IMPLEMENTATION AND ESTIMATION METHODOLOGY

5.1 | Baseline specification

Our baseline model follows Giannetti et al. (2011) and takes into account the inventory-management motive proposed by Bougheas et al. (2009). It takes the following form:

$$\begin{aligned} TD_{it} = {} & \propto_i + \beta_1 TD_{it-1} + \beta_2 Age_{it} + \beta_3 Size_{it} + \beta_4 Stock_{it} \\ & + \beta_5 Tang_{it} + \beta_6 Profit_{it} + \beta_7 Liquidity_{it} \\ & + \beta_8 Loans_{it} + \beta_9 Public_{it} + \varphi_i + \varphi_t + \varphi_j + \varphi_{jt} + \varphi_c + e_{it} \end{aligned} \quad (1)$$

where, $i = 1, 2, \ldots N$, indexes firms and $t = 1, 2, \ldots T$, indexes years. TD_{it} is the ratio of accounts receivable to sales. Our main variable of interest is $Stock_{it}$, which is defined as the inventory-to-sales ratio, and accounts for the effect of holding costly inventories. A negative β_4 supports H1, implying a trade-off between inventories and trade credit extended.

We also control for various firm-specific characteristics that may influence the extension of trade credit. First, we include the logarithm of the firm's age (Age_{it}), defined as the difference between the current year and the year of incorporation of the firm; the logarithm of the firm's total real assets ($Size_{it}$); and a dummy variable indicating whether the firm is listed on the stock market ($Public_{it}$). These variable relate to two theories of trade credit extension. The first is the redistribution theory (Meltzer, 1960; Nilsen, 2002), according to which trade credit is used to channel funds from higher-credit-quality firms (i.e., larger, older, listed firms) to lower-credit-quality firms (i.e., smaller, younger, and unlisted firms). A positive coefficient associated with the *Size*, *Age*, and *Public* variables would support this theory. The second one is the theory according to which trade credit is extended to indicate the good quality of the goods sold (Lee & Stowe, 1993; Long et al., 1993). As younger, smaller, and unlisted firms typically face a higher degree of information asymmetry than their larger, older, and listed counterparts, they may need to extend trade credit to signal the quality of their products. A negative coefficient associated with the *Size*, *Age*, and *Public* variables would provide support to this theory. It would also provide support for the theory according to which firms extend trade credit for operational motives, that is, to attract and stimulate demand for their products (Daripa & Nilsen, 2011). In this case, firms would use trade credit as a marketing tool. The data will determine which of the two effects prevails.

Second, following Petersen and Rajan (1997), we include the firm's profitability, measured as the firms operating profit to total sales ($Profit_{it}$). More profitable firms have more internal finance at hand, and, as a result, are more likely to channel their earnings toward accounts receivable (Guariglia & Mateut, 2016). A positive association between profitability and trade credit extended can also be seen as providing support for Petersen and Rajan's (1997) price discrimination theory: profitable firms can offer highly priced trade credit. Creditworthy customers will repay it straight away, whilst riskier customers will accept the terms which may still be cheaper than other sources of finance they have access to.

Third, we control for the ratio of the firm's cash and equivalents to total sales ($Liquidity_{it}$) In line with Petersen and Rajan (1997), Mateut et al. (2015), and Guariglia and Mateut (2016), we expect liquidity to be negatively associated with the volume of sales on credit. A firm with low liquidity may in fact be better off increasing its credit sales by extending trade credit to customers rather than not selling at all.

Fourth, we account for firms' ratio of tangible to total assets ($Tang_{it}$). Previous studies show that firms with higher asset tangibility tend to extend less credit because they operate in industries with lower growth potential (Giannetti et al., 2011; Hovakimian, 2009). Alternatively, there could be a substitution effect between investing in fixed assets and investing in accounts receivable (Abdulla et al., 2020). Hence, we expect a negative relationship between asset tangibility and TD_{it}.

Fifth, we capture access to bank credit using the firm's ratio of loans and liabilities to credit institutions due within one year to total sales ($Loans_{it}$). Firms with higher access to bank credit have more external finance at hand, which they can use to fund the extension of trade credit. In line with Bougheas et al. (2009) and Mateut et al. (2015), we therefore expect a positive association between bank loans and TD_{it}.

Finally, the error term has the following four components. φ_i is a firm-specific component. φ_t is a time-specific component accounting for buiness cycle effects. φ_j is an industry-specific component accounting for industry dynamics. φ_{jt} is an industry-specific component that varies across time and accounts for industry-specific shifts across time periods. φ_c is a country-specific component, and e_{it}, an indiosyncratic component. We control for φ_i by estimating our equations in first differences; for φ_t, by including time dummies; for φ_j, by including industry dummies; for φ_c, by including country dummies; and for φ_{jt}, by including time dummies interacted with industry dummies in all our specifications. We believe that including all these fixed-effects in our models nets out the effect of common demand shocks (Ferrando et al., 2017).

5.2 | Accounting for the sovereign debt crisis

We next investigate how the trade-off between inventories and trade credit extended varies in and out of the sovereign debt crisis years. To this end, we augment Equation (1) with a sovereign debt crisis dummy ($Crisis_t$) and an interaction term between $Crisis_t$ and $Stock_{it}$. The crisis dummy equals 1 over the sovereign debt crisis period (2010–2011), and 0 otherwise. The model takes the following form:

$$\begin{aligned} TD_{it} = {} & \propto_i + \beta_1 TD_{it-1} + \beta_2 Age_{it} + \beta_3 Size_{it} + \beta_4 Stock_{it} \\ & + \beta_5 Crisis_t + \beta_6 Stock_{it} * Crisis_t + \beta_7 Tang_{it} \\ & + \beta_8 Profit_{it} + \beta_9 Liquidity_{it} + \beta_{10} Loans_{it} \\ & + \beta_{11} Public_{it} + \varphi_i + \varphi_t + \varphi_j + \varphi_{jt} + \varphi_c + e_{it} \end{aligned} \tag{2}$$

where, β_4 measures the association between the stock of inventories and trade credit extended outside the sovereign debt crisis period. The corresponding association during the crisis period is given by $\beta_4 + \beta_6$. For H2 to hold, we should observe negative β_4 and β_6 coefficients. This would imply that trade credit extended and the stock of inventories are negatively related, but more so during the sovereign debt crisis.

5.3 | Estimation methodology

We estimate our models using the system Generalized Method of Moments (GMM) estimator, which combines in a system the relevant equation in first-differences and in levels (Blundell & Bond, 1998). By estimating the model in first-differences, the estimator enables us to control for time-invariant firm-specific characteristics that might affect both the stock of inventories and trade credit extended. In doing so, it considerably reduces the risk of confounding. The estimator also enables us to take into account the possible endogeneity of the regressors, which may cause simultaneity bias. To this end, we use values of the endogenous regressors lagged three times as instruments in the differenced equation, and differences of the same regressors lagged twice in the levels equation. We treat the lagged dependent variable and all the regressors (except age; the crisis, public, time, country, and industry dummies) as endogenous.

To evaluate whether our instruments are legitimate and whether our models are correctly specified, we first use the Sargan test for overidentifying restrictions. Under the null of instrument validity/good model specification, it is asymptotically distributed as a chi-square with degrees of freedom equal to the number of instruments less the number of parameters. Our second criterion is based on the nth-order serial correlation in the differenced residuals, which is asymptotically distributed as a standard normal under the null of no nth-order serial correlation of the differenced residuals (Roodman, 2009).

6 | RESULTS

6.1 | Is there an inventory-management motive?

We begin our enquiry by estimating Equation (1), which aims at assessing whether a trade-off between inventories and trade credit exists. Column 1 of Table 3 presents the baseline results. We observe that the coefficient associated with the stock of inventories ($Stock_{it}$) is negative and statistically significant. The association between inventories and trade credit extended is also economically important: a one standard deviation drop in $Stock_{it}$ is associated with a 2.56% higher TD_{it} relative to the baseline mean.[12] This is consistent with our first hypothesis (H1), according to which, due to the uncertainty in product demand, firms have an incentive to minimize inventory costs by selling on credit. Hence, in line with the empirical evidence in Bougheas et al. (2009) for the UK, we confirm the importance of the inventory-management motive for euro-area firms.

The coefficient associated with TD_{it-1} is highly significant and indicates some persistence in the extension of trade credit. With the exception of Age_{it}, the control variables carry statistically significant coefficients at least at the 10% level. Their signs are broadly in line with the studies described in Section 5.1. The diagnostic tests generally do not indicate problems with the choice of instruments and the specification of our model.

6.2 | The role of the sovereign debt crisis

We next investigate whether the negative association between the stock of inventories and the extension of trade credit in the euro-area strengthens during the

TABLE 3 The inventory-management motive for extending trade credit.

	Baseline	Crisis
	(1)	(2)
TD_{it-1}	0.781***	0.766***
	(20.11)	(20.49)
Age_{it}	0.031***	0.015*
	(2.95)	(1.68)
$Size_{it}$	0.076**	0.022**
	(2.42)	(2.42)
$Stock_{it}$	−0.059**	−0.101***
	(−2.36)	(−4.45)
$Crisis_t$		0.012*
		(2.04)
$Stock_{it} \times Crisis_t$		−0.105***
		(−2.98)
$Tang_{it}$	−0.031**	−0.028**
	(−2.55)	(−2.39)
$Profit_{it}$	0.460***	0.204**
	(2.96)	(2.04)
$Liquidity_{it}$	−0.142***	−0.061**
	(−3.14)	(−2.45)
$Loans_{it}$	0.126***	0.141***
	(2.87)	(3.32)
$Public_{it}$	0.075***	0.052***
	(3.43)	(2.60)
Observations	503,395	503,395
Number of id	198,024	198,024
Ar(1)	0.000	0.000
Ar(3)	0.419	0.319
Sargan (p-value)	0.108	0.096

Note: All specifications are estimated using a system-GMM estimator. The figures in parentheses are *t*-statistics, asymptotically robust to heteroscedasticity. $Crisis_t$ equals 1 in 2010–2011, and 0 otherwise. See Table 1 for definitions of all other variables. We include country, industry, and time dummies, as well as time dummies interacted with industry dummies in all models. Instruments include the dependent variable and all regressors (with the exception of Age_{it}; $Crisis_t$; $Public_{it}$; and the time, industry, and country dummies) lagged three times or more in the differenced equation and differences of the same variables lagged twice in the levels equation. *Sargan* is a test of overidentifying restrictions, distributed as chi-square under the null of instrument validity. *Ar(j)* is a test of *j*th-order serial correlation in the first-differenced residuals, asymptotically distributed as *N*(0,1) under the null of no serial correlation. *, **, and *** indicate statistical significance at the 10%, 5%, and 1% level, respectively.

sovereign debt crisis period. To this end, we estimate Equation (2). The results are in column 2 of Table 3.

We observe that, once again, the coefficient associated with $Stock_{it}$ is negative and statistically significant. Furthermore, in line with our second hypothesis (H2), the coefficient associated with ($Stock_{it} * Crisis_t$), is also negative and significant. Hence, the negative trade-off between inventories and trade credit extended becomes stronger during the crisis.

To economically assess the extent to which the crisis affects the strength of the inventory-management motive for offering trade credit, we focus on the coefficients associated with ($Stock_{it} * Crisis_t$) and $Stock_{it}$. During tranquil periods, the relevant coefficient to assess the strength of the inventory-management motive is the latter (−0.101). During the crisis period, the relevant coefficient is given by the sum of the coefficients associated with ($Stock_{it} * Crisis_t$) and $Stock_{it}$ (i.e., −0.206). Hence, a one standard deviation drop in $Stock_{it}$ is associated with a 4.45% ([−0.101*0.130]/0.295) higher TD_{it} (relative to the baseline mean) in tranquil periods, but with a 8.66% ([−0.206*0.127]/0.302) higher ratio during the crisis. This reinforces the idea that during a crisis, as a result of higher demand uncertainty, firms face more incentives to sell their inventories on credit to boost sales.

Table 3 also shows that the coefficient associated with the *Crisis* dummy is positive and highly significant, suggesting that during the sovereign debt crisis, firms extended more trade credit. Considering that firms experienced increased financial difficulties during the crisis (Draghi, 2014), this is consistent with the idea that suppliers support customers that experience temporary financial difficulties, as they have an interest in their customers' survival (Cunat, 2007; Petersen & Rajan, 1997). This is also in line with previous empirical studies showing that the demand for trade credit increased in the euro-area during the financial crisis (Carbó-Valverde et al., 2016; Casey & O'Toole, 2014).

The control variables generally behave as conjectured. Furthermore, the Sargan test suggests the adequacy of the instruments, and there is no sign of third-order serial correlation in the error term of the first-differenced equation.

6.3 | Robustness tests

6.3.1 | Using different definitions of the crisis

So far, following Becker and Ivashina (2018) and Fernandes et al. (2019), we have only considered 2010–2011 as sovereign debt crisis years, as this was the peak crisis period. Moreover, the European debt crisis largely ended following Draghi's announcement in July 2012 that the ECB was ready to do whatever it took to preserve the euro, and the resulting decline in sovereign borrowing costs. Yet, the first half of 2012 was characterized by a restructuring of debt in Greece as well as yields on

Italian and Spanish government bonds reaching levels normally considered unsustainable, which led to Draghi's announcement (Fernandes et al., 2019; Ferrando et al., 2017). Hence, 2012 could also be seen as part of the sovereign debt crisis. Some authors indeed include 2012 within the sovereign debt crisis years (e.g., Acharya et al., 2018; Ferrando et al., 2017). We therefore verify whether our main results are robust to redefining the sovereign debt crisis including 2012. We report estimates of Equation (2) based on this new definition of the crisis in column 1 of Table 4. The results suggest that there is still evidence of a trade-off between the stock of inventories and accounts receivable, which is amplified during the crisis. Yet, both this amplification effect and the direct effect of the crisis on trade credit extended are weaker than those reported in column 2 of Table 3. This may be explained considering that only the first half of 2012 was in fact a crisis period.

TABLE 4 Using different definitions of the crisis.

	Crisis: 2010–2012	Crisis: 2007–2011	Crisis: 2007–2012	Crisis: 2007–2012 + 2020–2021
	(1)	(2)	(3)	(4)
TD_{it-1}	0.762***	0.799***	0.783***	0.827***
	(19.79)	(21.35)	(20.56)	(31.80)
Age_{it}	0.018*	0.018**	0.014*	0.036***
	(1.96)	(2.03)	(1.75)	(2.99)
$Size_{it}$	0.012*	0.019**	0.012**	0.025**
	(1.96)	(2.37)	(2.08)	(2.32)
$Stock_{it}$	−0.101***	−0.057***	−0.067***	−0.051**
	(−3.56)	(−4.44)	(−5.26)	(2.00)
$Crisis_t$	0.040***	0.014***	0.016***	0.013***
	(9.07)	(4.95)	(6.06)	(5.10)
$Stock_{it} \times Crisis_t$	−0.116***	−0.066***	−0.094***	−0.100***
	(−5.06)	(−3.05)	(−4.01)	(−3.53)
$Tang_{it}$	−0.031***	−0.022*	−0.027**	−0.024**
	(−2.59)	(−1.86)	(−2.26)	(−2.08)
$Profit_{it}$	0.507***	0.208**	0.172*	0.282***
	(3.46)	(2.12)	(1.80)	(2.73)
$Liquidity_{it}$	−0.108***	−0.065***	−0.065**	−0.046*
	(−3.92)	(−2.89)	(−2.33)	(−1.78)
$Loans_{it}$	0.143***	0.103**	0.116***	0.091**
	(3.32)	(2.41)	(2.69)	(2.22)
$Public_{it}$	0.056***	0.068***	0.050***	0.024**
	(2.72)	(3.34)	(2.72)	(2.04)
Observations	503,395	503,395	503,395	503,395
Number of id	198,024	198,024	198,024	198,024
Ar(1)	0.000	0.000	0.000	0.000
Ar(3)	0.308	0.397	0.439	0.443
Sargan (p-value)	0.102	0.118	0.078	0.070

Note: All specifications are estimated using a system-GMM estimator. The figures in parentheses are *t*-statistics, asymptotically robust to heteroscedasticity. $Crisis_t$ equals 1 in 2010–2012 (column 1), 2007–2011 (column 2), 2007–2012 (column 3), 2007–2012 and 2020–2021 (column 4), and 0 otherwise. The 2020–2021 period relates to the COVID-19 crisis. Table 1 contains definitions of all other variables. We include country, industry, and time dummies, as well as time dummies interacted with industry dummies in all models. Instruments include the dependent variable and all regressors (with the exception of Age_{it}; $Crisis_t$; $Public_{it}$; and the time, industry, and country dummies) lagged three times or more in the differenced equation and differences of the same variables lagged twice in the levels equation. *Sargan* is a test of overidentifying restrictions, distributed as chi-square under the null of instrument validity. *Ar(j)* is a test of *j*th-order serial correlation in the first-differenced residuals, asymptotically distributed as *N*(0,1) under the null of no serial correlation. *, **, and *** indicate statistical significance at the 10%, 5%, and 1% level, respectively.

Furthermore, our dataset encompasses not only the European sovereign debt crisis, but also the 2007–2009 global financial crisis. We therefore verify whether our main results are robust to using a broader measure of the crisis, which includes both crises. To this end, we create a new *Crisis* dummy equal to 1 in the years 2007–2011, and 0 otherwise, and re-estimate Equation (2) including it. The results are reported in column 2 of Table 4. Once again, we observe evidence in favour of a trade-off between the stock of inventories and trade credit extended, which is magnified over the crisis years. Moreover, the positive and significant coefficient associated with the crisis dummy confirms that trade credit extended rises during turbulent periods. We find similar results in column 3 of Table 4, where the *Crisis* dummy is set equal to one in the years 2007–2012, and 0 otherwise, as well as in column 4, which also includes the COVID-19 years (2020–2021) within the *Crisis* dummy.[13]

6.3.2 | Using alternative definitions of trade credit extended

Cerqueiro et al. (2011) and Guariglia and Mateut (2016) define trade credit as the ratio of accounts receivable to total assets. Column 1 of Table 5 reports estimates of Equation (1) based on this alternative definition of trade credit, and column 2 reports estimates of Equation (2). We continue to observe a trade-off between inventories and trade credit extended, which is stronger during the crisis.

We further argue that managers should use both channels of trade credit (extended and taken) when deciding to generate profits via inventory management (Chod, 2017). To test whether this is the case, we explore whether there exists a trade-off between inventories and net trade credit (i.e., the difference between trade credit extended and trade credit received scaled by total sales). The estimates in Table 5 suggest that there is a trade-off between inventories and net trade credit (column 3), which is stronger during the sovereign debt crisis (column 4).[14]

7 | WHICH FIRMS DRIVE THE RELATIONSHIP BETWEEN INVENTORIES AND TRADE CREDIT EXTENDED?

7.1 | The role of financing constraints

We hereafter examine the extent to which financing constraints drive the association between inventories and trade credit extended. We proxy financing constraints using size, age, and bank dependency. Small and young firms are more likely to face asymmetric information in financial markets, leading to higher financial premiums (Hadlock & Pierce, 2010). As for bank-dependency, it can be seen as an indication of limited access to long-term debt (Fernandes et al., 2019). Furthermore, as banks significantly cut credit to firms during crises periods, bank-dependent firms are likely to suffer more (Acharya et al., 2018; Byrne et al., 2016).

We expect younger, smaller, and more bank-dependent firms to show a stronger trade-off between inventories and trade credit extended. This is because these firms will find it more difficult to afford inventory holding costs. Financially constrained firms are also more likely to benefit from the sales that follow the extension of credit to customers (Bougheas et al., 2009). In order to assess whether this is the case, we estimate the following equation[15]:

$$
\begin{aligned}
TD_{it} = {} & \propto_i + \beta_1 TD_{it-1} + \beta_2 Age_{it} + \beta_3 Size_{it} + \beta_4 Stock_{it} \\
& + \beta_5 Stock_{it} * FC_{it} + \beta_6 FC_{it} + \beta_7 Tang_{it} \\
& + \beta_8 Profit_{it} + \beta_9 Liquidity_{it} + \beta_{10} Loans_{it} \\
& + \beta_{11} Public_{it} + \varphi_i + \varphi_t + \varphi_j + \varphi_{jt} + \varphi_c + e_{it}
\end{aligned}
\tag{3}
$$

where, FC_{it} is a dummy equal to 1 if firm i is financially constrained (i.e., young, small, or bank-dependent) in year t, and 0 otherwise. Following Abdulla et al., 2020, we define a firm i as young (small) in a given year if its age (total assets) falls in the bottom 50% of the distribution of the age (total assets) of all firm operating in the same industry as firm i in that year. Next, we proxy bank dependency using the firm's ratio of short-term debt to total liabilities, where short-term debt is mainly made up of bank loans. This variable is typically known as the "mix" (Byrne et al., 2016; Kashyap et al., 1993). We create a dummy measuring bank dependency, which is equal to 1 if the mix of a given firm i in year t falls in the top half of the distribution of the mix of all firms operating in the same industry as firm i in that year, and 0 otherwise.[16] As firms can transit in and out of the financially constrained status every year, we estimate an equation with interactions rather than separate models for financially constrained and healthy firms. A stronger inventory-management motive for firms more likely to be financially constrained would translate itself in a negative and significant β_5 coefficient in Equation (3).

Estimates of Equation (3) are presented in the first three columns of Table 6. Column 1 defines financing

TABLE 5 Using alternative definitions of trade credit extended.

	TD = trade credit extended/ assets	TD = trade credit extended/ assets	TD = net trade credit	TD = net trade credit
	(1)	(2)	(3)	(4)
TD_{it-1}	0.391***	0.478***		
	(14.15)	(16.45)		
NTC_{it-1}			0.701***	0.745***
			(25.92)	(26.35)
Age_{it}	0.063***	0.062***	0.016**	0.013**
	(4.83)	(8.97)	(2.25)	(2.07)
$Size_{it}$	0.022***	0.014***	0.012***	0.011***
	(5.77)	(3.83)	(3.22)	(3.02)
$Stock_{it}$	−0.140***	−0.124***	−0.106***	−0.131***
	(−4.65)	(−4.55)	(−4.34)	(−6.93)
$Crisis_t$		0.037***		0.037***
		(8.15)		(7.05)
$Stock_{it} \times Crisis_t$		−0.132***		−0.149***
		(−4.86)		(−4.49)
$Tang_{it}$	−0.172***	−0.152***	−0.029**	−0.034***
	(−9.68)	(−9.22)	(−2.36)	(−2.91)
$Profit_{it}$	0.408***	0.228**	0.582***	0.268*
	(2.77)	(2.57)	(3.95)	(1.88)
$Liquidity_{it}$	−0.056*	−0.052**	−0.068***	−0.055***
	(−1.75)	(−2.19)	(−3.09)	(−2.60)
$Loans_{it}$	0.068**	0.063*	0.027	0.081**
	(1.97)	(1.83)	(0.65)	(1.98)
$Public_{it}$	0.030***	0.021***	0.024***	0.013***
	(6.04)	(5.11)	(5.17)	(3.31)
Observations	483,042	483,042	501,894	501,894
Number of id	190,124	190,124	197,433	197,433
Ar(1)	0.000	0.000	0.000	0.000
Ar(3)	0.571	0.587	0.062	0.177
Sargan (p-value)	0.052	0.053	0.093	0.112

Note: All specifications are estimated using a system-GMM estimator. The figures in parentheses are *t*-statistics, asymptotically robust to heteroscedasticity. $Crisis_t$ equals 1 in 2010–2011, and 0 otherwise. In columns (1) and (2), *TD* denotes the accounts receivable to assets ratio, whilst in columns (3) and (4), it denotes the net trade credit to sales ratio. Table 1 contains definitions of all other variables. We include country, industry, and time dummies, as well as time dummies interacted with industry dummies in all models. Instruments include the dependent variable and all regressors (with the exception of Age_{it}; $Crisis_t$; $Public_{it}$; and the time, industry, and country dummies) lagged three times or more in the differenced equation and differences of the same variables lagged twice in the levels equation. *Sargan* is a test of overidentifying restrictions, distributed as chi-square under the null of instrument validity. *AR(j)* is a test of *j*th-order serial correlation in the first-differenced residuals, asymptotically distributed as *N*(0,1) under the null of no serial correlation. *, **, and *** indicate statistical significance at the 10%, 5%, and 1% level, respectively.

constraints based on age; column 2, based on size; and column 3, based on the mix. In line with our expectations, in all three cases, we observe a negative coefficient associated with both $Stock_{it}$ and $(Stock_{it} * FC_{it})$. This finding suggests the presence of an inventory-management motive for extending trade credit, which is stronger for firms more likely to face liquidity constraints.

Next, in order to account for the effects of the crisis, we estimate the following model:

TABLE 6 Accounting for financial constraints.

	FC = Young	FC = Small	FC = Bank dependent	FC = Young	FC = Small	FC = Bank dependent
	(1)	(2)	(3)	(4)	(5)	(6)
TD_{it-1}	0.743***	0.810***	0.794***	0.766***	0.810***	0.797***
	(18.88)	(20.39)	(26.17)	(13.74)	(28.39)	(24.66)
Age_{it}	0.073***	0.050***	0.024***	0.057***	0.001	0.029**
	(5.06)	(4.02)	(3.72)	(2.79)	(0.11)	(2.58)
$Size_{it}$	0.025**	0.017***	0.009***	0.007**	0.011*	0.075***
	(2.26)	(2.71)	(2.90)	(2.02)	(1.65)	(9.75)
$Stock_{it}$	−0.065***	−0.220**	−0.127**	−0.143*	−0.063*	−0.250**
	(−2.91)	(−2.43)	(−1.98)	(−1.88)	(−1.85)	(−2.28)
$Stock_{it} \times FC_{it}$	−0.101***	−0.355***	−0.245**	−0.166***	−0.254***	−0.228***
	(−3.48)	(−2.76)	(−2.12)	(4.73)	(−2.83)	(−2.97)
$Stock_{it} \times Crisis_t \times FC_{it}$				−0.397***	−0.472*	−0.516*
				(−4.75)	(−1.83)	(−1.65)
$Stock_{it} \times Crisis_t$				−0.236**	−0.325*	−0.483**
				(−2.45)	(−1.83)	(−2.44)
$FC_{it} \times Crisis_t$				0.065***	0.050**	0.045**
				(5.25)	(2.51)	(2.01)
$Crisis_t$				0.015***	0.010*	0.010*
				(3.95)	(1.94)	(1.80)
FC_{it}	0.001	−0.033	−0.029	0.054	0.011	0.033
	(0.24)	(−1.50)	(−1.63)	(1.30)	(0.54)	(1.21)
$Tang_{it}$	−0.037***	−0.021*	−0.019*	−0.028	−0.027**	−0.072***
	(−3.05)	(−1.78)	(−1.71)	(−1.52)	(−2.30)	(−3.03)
$Profit_{it}$	0.224**	0.378***	0.139*	0.456***	0.254**	0.182**
	(2.28)	(3.24)	(1.73)	(4.80)	(2.53)	(2.16)
$Liquidity_{it}$	−0.277***	−0.218**	−0.096*	−0.056**	−0.212**	−0.138**
	(−4.33)	(−2.23)	(−1.85)	(−2.50)	(−2.18)	(−3.38)
$Loans_{it}$	0.169***	0.097**	0.045*	0.084**	0.119***	0.103***
	(3.96)	(2.22)	(1.85)	(2.14)	(2.74)	(3.17)
$Public_{it}$	0.015***	0.017***	0.013***	0.060***	0.013***	0.017***
	(3.58)	(2.85)	(2.76)	(5.30)	(2.90)	(4.58)
Observations	503,395	503,395	503,395	503,395	503,395	503,395
Number of id	198,024	198,024	198,024	198,024	198,024	198,024
Ar(1)	0.000	0.000	0.000	0.000	0.000	0.000
Ar(3)	0.395	0.398	0.240	0.221	0.459	0.201
Sargan (p-value)	0.098	0.066	0.064	0.064	0.054	0.092

Note: All specifications are estimated using a system-GMM estimator. The figures in parentheses are *t*-statistics, asymptotically robust to heteroscedasticity. The variable FC_{it} indicates in turn a dummy equal to 1 if firm *i*'s age falls in the bottom 50% of the distribution of the age of all firms which belong to the same industry as firm *i* in year *t*, and 0 otherwise (*young*; columns 1 and 4); a dummy equal to 1 if firm *i*'s size falls in the bottom 50% of the distribution of the size of all firms which belong to the same industry as firm *i* in year *t*, and 0 otherwise (*small*; columns 2 and 5); and a dummy equal to 1 if firm *i*'s mix (defined as the ratio of short-term debt to total liabilities) falls in the top 50% of the distribution of the mix of all firms which belong to the same industry as firm *i* in year *t*, and 0 otherwise (*bank-dependent*; columns 3 and 6). We include country, industry, and time dummies, as well as time dummies interacted with industry dummies in all models. $Crisis_t$ equals 1 in 2010–2011, and 0 otherwise. Table 1 contains definitions of all other variables. Instruments include the dependent variable and all regressors (with the exception of Age_{it}; $Crisis_t$; $Public_{it}$; and the time, industry, and country dummies) lagged three times or more in the differenced equation and differences of the same variables lagged twice in the levels equation. *Sargan* is a test of overidentifying restrictions, distributed as chi-square under the null of instrument validity. *Ar(j)* is a test of *j*th-order serial correlation in the first-differenced residuals, asymptotically distributed as *N*(0,1) under the null of no serial correlation. *, **, and *** indicate statistical significance at the 10%, 5%, and 1% level, respectively.

TABLE 7 Industrial classification based on the characteristics of the goods produced.

US SIC code	Sectors	Differentiated
10	Metal mining	0
20	Food and kindred products	0
22	Textile mill products	0
23	Apparel and other finished products made from fabrics and similar materials	0
24	Lumber and wood products, except furniture	0
25	Furniture and fixtures	1
26	Paper and allied products	0
27	Printing, publishing, and allied industries	1
28	Chemicals and allied products	0
29	Petroleum refining and related industries	0
30	Rubber and miscellaneous plastics products	1
31	Leather and leather products	0
32	Stone, clay, glass, and concrete products	1
33	Primary metal industries	0
34	Fabricated metal products, except machinery and transportation equipment	1
35	Industrial and commercial machinery and computer equipment	1
36	Electronic and other electrical equipment and components, except computer equipment	1
37	Transportation equipment	1
38	Instruments; photographic, metal, and optical goods; watches and clocks	1
39	Miscellaneous manufacturing industries	1

Note: This table presents the classification of industry groups, distinguishing between differentiated and standardized products in the manufacturing sector. This classification follows Giannetti et al. (2011) and is based on Rauch (1999). In column 3, the number 1 denotes firms in differentiated sectors, whereas 0 represents firms in standardized sectors.

$$\begin{aligned} TD_{it} = {} & \propto_i + \beta_1 TD_{it-1} + \beta_2 Age_{it} + \beta_3 Size_{it} + \beta_4 Stock_{it} \\ & + \beta_5 Stock_{it} * FC_{it} + \beta_6 Stock_{it} * Crisis_t * FC_{it} \\ & + \beta_7 Stock_{it} * Crisis_t + \beta_8 FC_{it} * Crisis_t \\ & + \beta_9 Crisis_t + \beta_{10} FC_{it} + \beta_{11} Tang_{it} \\ & + \beta_{12} Profit_{it} + \beta_{13} Liquidity_{it} + \beta_{14} Loans_{it} \\ & + \varphi_i + \varphi_t + \varphi_j + \varphi_{jt} + \varphi_c + e_{it} \end{aligned} \tag{4}$$

The β_6 coefficient associated with $(Stock_{it} * Crisis_t * FC_{it})$ enables us to assess the extent to which the inventory-management motive for extending trade credit is magnified during the crisis for financially constrained firms. We expect this coefficient to carry a negative sign.

Columns 4–6 of Table 6 report estimates of Equation (4), defining in turn financial constraints based on age, size, and bank-dependence. We observe negative and significant coefficients associated with both $(Stock_{it}*FC_{it})$ and $(Stock_{it}*Crisis_t*FC_{it})$ in all columns. This indicates that financial constraints enhance the inventory-management motive in all periods, but more so in crises periods. Taken together, these findings suggest that especially during the crisis, financially constrained firms will be more likely than their financially healthier counterparts, to get rid of their costly stock of inventories by issuing trade credit. This can be explained considering that financially constrained firms may find it increasingly difficult to hold costly inventories (Dasgupta et al., 2019). Moreover, these firms will also be more likely to benefit from the sales that follow the extension of credit to customers (Bougheas et al., 2009).[17] Financing constraints could therefore be seen as a mechanism underpinning the association between inventories and trade credit extended.

7.2 | The role of the characteristics of the traded goods

We hereafter examine whether the trade-off we observed between inventories and trade credit extended is driven by the characteristics of the goods transacted by the firm. The motivation behind this exercise stems from the diversion-value hypothesis proposed by Giannetti et al. (2011),

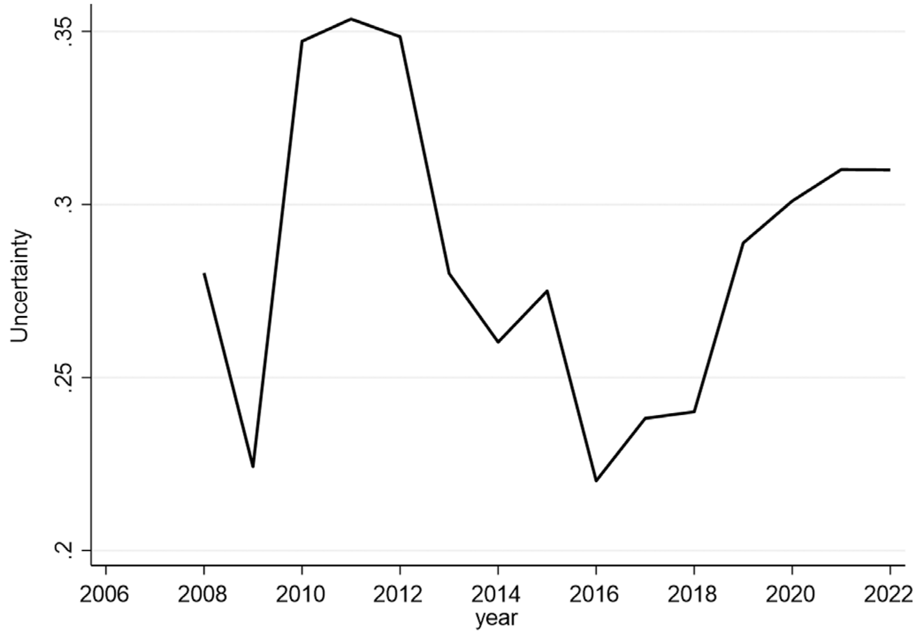
TABLE 8 Accounting for the type of goods traded.

	Differentiated (1)	Standardized (2)	Differentiated (3)	Standardized (4)
TD_{it-1}	0.565***	0.770***	0.679***	0.793***
	(8.24)	(19.00)	(10.60)	(19.27)
Age_{it}	0.037***	0.027***	0.014*	0.068***
	(3.11)	(3.39)	(1.69)	(9.84)
$Size_{it}$	0.021***	0.008**	0.014**	0.093***
	(3.07)	(2.12)	(2.16)	(3.95)
$Stock_{it}$	−0.204***	0.009	−0.129**	−0.002
	(−5.37)	(1.64)	(−2.11)	(−0.52)
$Crisis_t$			0.018*	0.001
			(1.67)	(0.15)
$Stock_{it} \times Crisis_t$			−0.165***	0.062
			(−3.48)	(1.52)
$Tang_{it}$	−0.081***	−0.038***	−0.058***	−0.024*
	(−3.97)	(−2.69)	(−2.80)	(−1.76)
$Profit_{it}$	0.260***	0.305***	0.304***	0.262***
	(2.97)	(3.41)	(3.38)	(2.65)
$Liquidity_{it}$	−0.077*	−0.058**	−0.032	−0.041*
	(−1.81)	(−2.46)	(−0.82)	(1.72)
$Loans_{it}$	0.284***	0.115**	0.196***	0.095*
	(4.11)	(2.33)	(2.78)	(1.90)
$Public_{it}$	0.035***	0.018***	0.020***	0.019***
	(4.24)	(3.93)	(2.74)	(3.21)
Observations	279,482	223,913	279,482	223,913
Number of id	90,822	107,202	90,822	107,202
Ar(1)	0.000	0.000	0.000	0.000
Ar(3)	0.162	0.766	0.192	0.687
Sargan (p-value)	0.103	0.098	0.402	0.192
Diff-test1	0.000		0.000	
Diff-test2			0.000	

Note: All specifications are estimated using a system-GMM estimator. The figures in parentheses are *t*-statistics, asymptotically robust to heteroscedasticity. We include country, industry, and time dummies, as well as time dummies interacted with industry dummies in all models. $Crisis_t$ equals 1 in 2010–2011, and 0 otherwise. Table 1 contains definitions of all other variables. Table 7 provides details of which industrial sectors are classified as differentiated and standardized. Instruments include the dependent variable and all regressors (with the exception of Age_{it}; $Crisis_t$; $Public_{it}$; and the time, industry, and country dummies) lagged three times or more in the differenced equation and differences of the same variables lagged twice in the levels equation. *Sargan* is a test of overidentifying restrictions, distributed as chi-square under the null of instrument validity. *Ar(j)* is a test of *j*th-order serial correlation in the first-differenced residuals, asymptotically distributed as *N*(0,1) under the null of no serial correlation. *Diff-test1* (*Diff-test2*) represents the *p*-values of the *t*-tests (Acquaah, 2012) for whether the differences in the coefficients associated with *Stock* (*Stock*Crisis*) between firms producing differentiated and standardized goods are statistically significant. *, **, and *** indicate statistical significance at the 10%, 5%, and 1% level, respectively.

who associate trade credit extended with the nature of the goods traded. In particular, they note that suppliers of differentiated goods typically provide more credit to their customers than suppliers of standardized goods. There are three possible explanations for this. First, bearing in mind that, in differentiated industries, repossessed goods are worth more to trade credit providers than to banks, trade credit providers typically have an advantage

FIGURE 2 Average level of uncertainty faced by non-financial euro-area corporations over the period 2008–2022. Source: Authors' calculations based on the Orbis database (see endnote 9 for details).



relative to banks in financing their customers. Second, within differentiated industries, customers are less likely to default on trade credit suppliers as the inputs they provide are unique, highly customized, and, hence, hard to replace (Cunat, 2007). Third, producers of differentiated goods typically have fewer alternative customers due to the specialized nature of their products. Compared to producers of standardized goods, they will therefore show higher incentives to generate sales by offering trade credit (Mateut et al., 2015).[18] One way to do this is by selling their stock of inventories on credit. Suppliers of differentiated goods will show a higher tendency to do so in crises periods, when they will be increasingly concerned with losing crucial customers and, as a result, will do everything possible to support them (Wilner, 2000).

To assess whether the trade-off we found between inventories and trade credit extended, is driven by producers of specialized goods, we estimate Equations (1) and (2) separately for firms operating in standardized and differentiated industries. Table 7 presents the classification of industries based on the characteristics of the goods produced. The results are presented in Table 8. Columns 1 and 3 refer to firms operating in differentiated industries, whilst columns 2 and 4 refer to firms in standardized industries. Focusing on columns 1 and 2, we can see that the coefficient associated with $Stock_{it}$ is only significant for firms operating in the differentiated sector. In other words, the trade-off between inventories and trade credit extended is only apparent for firms producing differentiated goods.[19] This can be explained in light of the arguments discussed above. Furthermore, especially in tranquil periods, firms producing standardized goods may find it difficult to sell on credit as their customers may prefer cheaper bank loans.

We also observe a positive coefficient associated with the crisis dummy in column 3, whilst the corresponding coefficient in column 4 is not significant. This suggests that only firms in the differentiated sector are able to extend more trade credit during the crisis period. As they have fewer alternative customers, in crises periods which are characterized by high demand uncertainty, these firms will in fact show higher incentives to offer trade credit to support their customers who may be facing temporary financial difficulties. Their customers are unlikely to default on them, even in crises periods, as the products they supply are hard to replace, making switching costs high (Cunat, 2007). By contrast, in crises periods, suppliers of standardized goods may prefer not to sell their inventories on credit for fear of their customers' default.

Finally, in column 3, both the coefficient associated with $Stock_{it}$ and $(Stock_{it} * Crisis_t)$ are negative and significant, whilst the corresponding coefficients in column 4 are not significant. This suggests that, due to higher demand uncertainty associated with the crisis, for the reasons outlined above, only firms selling differentiated products have a higher incentive to sell their inventories on credit.[20]

In a nutshell, our results suggest the trade-off we observed between the stock of inventories and the provision of trade credit is driven by firms producing specialized goods.

8 | CONCLUSION

Using a dataset covering 198,024 euro-area firms over the period 2006–2022, we find a negative relationship between the extension of trade credit and inventories, which becomes stronger during the 2010–2011 European sovereign debt crisis. These findings, which are robust to using different measures of the crisis and trade credit extended, can be explained in light of the inventory-management motive (Bougheas et al., 2009), according to which firms prefer to extend trade credit as opposed to holding on to costly inventories. This motive is strengthened during crises periods when demand uncertainty heightens and bank lending dries up, hence increasing the demand for alternative sources of external funding.

We next show that financial constraints enhance the inventory-management motive in all periods, but more so in crises periods. This can be explained bearing in mind that in periods of crises, financially constrained firms find it increasingly difficult to fund inventory holding costs. Moreover, they are more likely to benefit from the sales that follow the extension of credit to customers. Finally, we find that the trade-off between stock of inventories and trade credit extended is only apparent for firms producing differentiated products. A likely reason is that these firms have fewer customers, which they will want to support, especially in turbulent periods. In summary, to fully explain why firms extend trade credit, beyond the inventory-management motive, it is important to also consider the role of economic/financial crises, as well as the characteristics of the firms.

One limitation of our work is that we are unable to differentiate between raw materials, work-in-process, and finished goods inventories. Looking at how different types of inventories relate to trade credit extension is on the agenda for future research when more data becomes available. Future research will also focus on firms in industries other than manufacturing as well as firms headquartered in other countries.

Our findings have important managerial and policy implications. They highlight the important "lender of last resort" role that firms play as liquidity providers, particularly during financial crises, when bank loans dry up. Given that euro-area firms are particularly bank-dependent (European Commission, 2013) and in light of the increased level of fragmentation in the European banking system during the recent sovereign debt crisis (ECB, 2018; Gabrieli & Labonne, 2018), the role of trade credit was crucial to maintain supply chains and reduce the potential economic fallout. Thus, we agree with Casey and O'Toole (2014) who reinforce the need of a more diverse financing environment for European firms.

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CONFLICT OF INTEREST STATEMENT

The authors declare no conflict of interest.

DATA AVAILABILITY STATEMENT

The data used in this study are available from the Orbis-Europe database provided by Bureau van Dijk (BvD). Restrictions apply to the availability of these data, which were used under licence for this study. Data are available from the authors with the permission of BvD.

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ENDNOTES

[1] This figure is obtained from our dataset. Trade credit extended is also referred to as accounts receivable or trade debit. Hereafter, we will use these terms interchangeably.

[2] Inventories (hereafter also referred to as *stocks*) include finished goods produced but unsold, work-in-progress, and raw materials. In our dataset, we only observe total inventories and cannot distinguish between these three categories. See Mateut et al. (2015) for an analysis of the links between inventory composition and trade credit in France.

[3] Firms have in fact to pay the costs of storing the inventories in warehouses, as well as handling expenses, insurance and so on.

[4] The focus of Guariglia and Mateut (2016) is, however, not the testing of the inventory-management motive for extending trade credit. They simply include the stock of inventories as a control variable in their models for the determinants of accounts receivable.

[5] Trade credit has been found to be a significant source of funds, particularly for firms running out of bank credit (Nilsen, 2002; Petersen & Rajan, 1997).

[6] In the context of the European sovereign debt crisis, this is particularly important as different countries were affected differently by the crisis. For instance, Fernandes et al. (2019) argue that periphery countries (i.e., Greece, Ireland, Italy, Portugal, and Spain) were affected much more strongly than other countries.

[7] There is overall agreement that bank-credit-constrained firms turn to trade credit during financial crises (Carbó-Valverde et al., 2016; Casey & O'Toole, 2014; Garcia-Appendini & Montoriol-Garriga, 2013). Theoretical models also suggest that in the presence of ample liquidity, firms tend to finance themselves using relatively cheap bank credit, but when liquidity dries up, they make use of more expensive trade credit (Nilsen, 2002). A related strand of literature considers how monetary policy tightening increases the utilization of trade credit, which helps firms absorb the effect of credit contractions (Choi & Kim, 2005; Mateut et al., 2006).

[8] See Abdulla et al. (2020) for a full account of these and other motives.

[9] We verified whether the sovereign debt crisis was indeed associated with an increase in uncertainty by constructing a firm-specific measure of uncertainty based on sales. Specifically, following Byrne et al. (2016), we estimated an AR(1) model of sales augmented with time, country, and industry dummies. We then computed uncertainty as the three-year moving standard deviation of the unpredictable part of firms' total real sales. Figure 2, which plots the average values of firm-specific uncertainty per year, shows a significant increase in uncertainty associated with the sovereign debt crisis.

[10] We chose these countries as these were the only euro-area countries which had a sufficient number of observations for our key variables over the period 2006–2022. Casey and O'Toole (2014) and Ferrando et al. (2017) use these same countries to analyse financing choices of euro-area firms during the financial crisis and the sovereign debt crisis, respectively.

[11] To avoid double counting, we only include data from unconsolidated financial statements in our sample. We focus on firms in the manufacturing sector to ensure comparability with Bougheas et al. (2009) and Guariglia and Mateut (2016) and to exploit the differentiation between firms producing differentiated and standardized goods (Section 7.2).

[12] This figure is calculated multiplying the coefficient associated with $Stock_{it}$ in column 1 of Table 3 (0.059) by the standard deviation of $Stock_{it}$ (0.130, Table 2) and dividing the resulting figure by the baseline mean of TD_{it} (0.300, Table 2).

[13] Although the COVID-19 pandemic was not a financial crisis, it is important to include it in our broadest version of the crisis for two reasons. First, focusing on 19 countries world-wide, Khan (2022) finds that liquidity-constrained firms were more likely to use trade credit over the pandemic years. Second, Figure 1 indicates a sharp rise in trade debit coupled with a sharp drop in the stock of inventories over that period, which suggests that the inventory-management motive for extending trade credit may have been at play.

[14] All our results were also robust to including an indicator of legal environment in our model (e.g., Mättö & Niskanen, 2021).

[15] In the models where financing constraints are measured using size and age, all results were robust to removing the FC_{it} dummy non-interacted, which could show collinearity with size and age.

[16] All our results were robust to using a 75 percent instead of a 50 percent threshold to differentiate small, young, and bank-dependent firms from their financially healthier counterparts.

[17] It is also noteworthy that in columns 4–6 of Table 6, both the coefficients associated with $Crisis_t$ and $Crisis_t$*FC_{it} are positive and significant. This suggests that there is a higher incentive to extend trade credit during crises periods, which, is, magnified for financially constrained firms. This finding, which is consistent with Coricelli and Frigerio (2019), can be explained considering that extending trade credit enables firms to inflate sales and to avoid losing important clients, which is particularly important for financially constrained firms during crises periods.

[18] Unreported statistics show that, on average firms in the differentiated sector sell on credit more than manufacturers producing standardized goods.

[19] The *p*-value reported at the foot of the table (*Diff-test1*) suggests that the difference between the coefficients associated with $Stock_{it}$ for firms producing differentiated and standardized goods is statistically significant.

[20] The difference between the coefficients associated with ($Stock_{it}$*-$Crisis_t$) for the two types of firms is statistically significant (see *Diff-test2*).

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