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Trade credit in Europe: Financial constraint and substitution effect in crisis times

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Abstract

This paper aims to prove whether financial rationing condition leads European enterprises to increase trade debt during the period 2008–2016 and whether companies offering deferred payments to customers obtain trade debt from suppliers. The work contributes to the existing literature by finding new empirical evidence on the substitution and matching hypotheses in times of crises, measuring the specific rationing conditions for businesses and distinguishing large, medium, small and micro-sized companies. The results revealed that, in times of crisis, medium, small and micro firms, highly likely to be constrained, employ trade credit more extensively, as those granting deferred payment terms.

KEYWORDS

accounts payable, accounts receivable, crisis, financial rationing, trade credit

JEL CLASSIFICATION

D22, G30, G32

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1 | INTRODUCTION

The alternative financing to bank credit has taken up increasing importance over the past few years, especially in the aftermath of the recent subprime mortgage and sovereign debt crises (2008–2016). The alternative sources of financing may, indeed, contribute to forming a diversified financial structure that can improve the resilience of enterprises in times of financial shocks. Trade credit represents one of the leading alternative sources for European businesses.

The extensive spread of trade credit can be explained in many ways, especially in real and financial terms.

The real functions refer to credit supply as a tool to support sales policies. In this sense, trade credit embodies a tool to establish new customer relationships and strengthen existing ones (Schwartz, 1974), grant product quality, while reducing any information asymmetry between suppliers and buyers (Long et al., 1993), allow for price discrimination (García-Teruel & Martínez-Solano, 2010; Petersen & Rajan, 1997; Pike et al., 2005) and reduce transaction costs (Ng et al., 1999; Wilner, 2000). Deferred payments contribute to building customer loyalty and may represent a response to demand variability. Trade credit may effectively contribute to the system's growth (Du et al., 2012; Ferrando & Mulier, 2013) and to the companies' revenue generation capacity (Martínez-Sola et al., 2013).

From a financial standpoint, trade debt can represent a form of financing complementary or alternative to bank credit or third-party financing (i.e., non-intercompany financing provided by other financial institutions and lenders).

Conditions of complementarity can be identified if the supplying company can monitor the creditworthiness of the customer enterprises and thus grant payment deferrals to enterprises otherwise rationed because of imperfect information efficiency (Biais & Gollier, 1997; Demirguc-Kunt & Maksimovic, 2001). The deferred payments granted show the companies' creditworthiness, giving them better access to banks or third-party credit.

The financial function of trade debt as an alternative source to banks and third-party financing originates from imperfections in the credit market (Demirguc-Kunt & Maksimovic, 2001; Fisman & Love, 2003) that restrict the access to capital for firms, that, consequently, choose to replace third-party financing with trade debt. Companies resort to intercompany financing with the substitution function because of the rationing conditions imposed by the financial system. Therefore, the financial function of trade credit is a key factor for better functioning of the economic and financial system: the substitution of banks or third-party financing with intercompany financing contributes to stem the rationing effect due to factors of market imperfection (De Blasio, 2003; Casey & O'Toole, 2014; Chen et al., 2019; Cull et al., 2009; Engemann et al., 2014; García-Appendini & Montoriol-Garriga, 2013; García-Teruel & Martínez-Solano, 2010; Guariglia & Mateut, 2006; Huang et al., 2011).

The real and financial functions of trade credit have blurred demarcation lines. Granting deferred payments to increase the sales volume may have immediate effects, stimulating more purchases in the present, but it can also improve future sales as the trade credit granted might help customers solve liquidity issues and thus maintain greater soundness. In such cases, the real and financial functions are consistent and difficult to distinguish: granting deferred payments might financially support clients and preserve the customer relationship and future sales volumes. In addition, according to the matching hypothesis (Bastos & Pindado, 2013), when firms increase the supply of trade credit, they also demand more trade debt. Consequently, the financial function of accounts payable is also necessary to finance deferred payments. The relationship between the use and extension of trade credit has been widely

investigated, and the literature observes, in general, a positive relationship between the concession of trade credit and the resort to accounts payable.

The paper has two research objectives.

On the one side, it aims to investigate if and how trade debt can be a source of financing alternative to credit from banks or third-party financing (*substitution hypothesis)* for large, medium, small and micro European companies at times of adverse financial situations.

While on the other, it intends to find out if the large, medium, small and micro European companies offering deferred payments to their customers receive more deferred payments from their suppliers, thus financing accounts receivable with accounts payables (*matching hypothesis),* at times of systemic crises.

This study contributes to reference literature offering new evidence on the validity of the substitution hypothesis in the European financial system, for companies of different sizes and in a particular timeframe from the explosion of the subprime mortgage crisis to the sovereign debt crisis. These crises have had multiple repercussions on the European financial system, generating severe credit rationing conditions. Therefore, the period under observation is of particular importance for the purposes of this study and it is scarcely investigated in the literature, especially the years of the sovereign debt crisis. Conditions of efficiency, the very evolution of the financial system and cyclical economic conditions can significantly impact the evolutionary dynamics of accounts payable and accounts receivable, as observed during the recent financial crises.

This paper considers the importance of intercompany financing in times of crisis, appreciating the impact of each firm's specific rationing condition on its resort to accounts payable during stress situations. Indeed, the rationing conditions caused by systemic stress scenarios may vary their intensity depending on the location and specific financial characteristics and size of businesses.

Thus, the work's contribution consists of investigating whether the firms' specific rationing conditions may lead to a greater use of accounts payable, to prove a substitution relationship between banks or third-party and intercompany financing in times of crisis *and* for rationed firms of different sizes. Therefore, the existing literature's contribution consists of verifying the substitution hypothesis by considering the rationing condition of large, medium, small and micro European companies as the key determinant variable in crises times.

The companies' rationing condition (*financial constraint*, FC) is measured using the semiparametric model of *firm-specific FCs* (Ferrando & Ruggieri, 2015; Pal & Ferrando, 2010) that relies upon a classification scheme based on the firm's balance sheet and income statement. The model enables the classification of *absolutely constrained*, *relatively constrained* and *unconstrained* companies.

The index obtained from the classification mentioned above is then linked to the companies' specific features, such as the level of indebtedness, that are used extensively in the literature to approximate the rationing condition (Ferrando & Ruggieri, 2015). A logit estimate helps predict the likelihood for each sampled enterprise of falling into one of the three rationing conditions/classes.

Finally, the substitution and matching hypotheses are verified through a hierarchical dynamic random effects model. In detail, the data had a clear hierarchical structure, that is, several time-dependent observations were collected for each company belonging to a Country. Accordingly, it was rather reasonable to consider a (dynamic) hierarchical model to fit regression parameters. Under the wide umbrella of mixed-effects modelling, we first fit a three-level random-effects multinomial ordinal logit to estimate the probabilities of belonging to any

of the classes of financial constraints and then consider a three-level random-effects linear model to investigate the relationships between trade payables and a range of economic variables. The parameters were estimated in a maximum likelihood framework, using an adaptive Gaussian quadrature algorithm.

The analysis results show that the more rationed medium, small and micro European companies during the crises are, the greater the use of intercompany credit and reaffirm the validity of the *substitution hypothesis*.

The study also reasserts the validity of the *matching hypothesis*: the companies that grant longer deferred payments to their customers also receive higher accounts payable from their suppliers, even in adverse financial conditions.

Both hypotheses, therefore, are valid in times of crisis and this goes to show that it is possible to claim that trade credit can take on a *second-best* function vis-à-vis the financing of banks or other financial institutions. In the event of inefficient markets or adverse conditions, smaller and weaker companies strive to find solutions to the financial system's disruption and extricate themselves from credit rationing.

While reaffirming the substitution hypothesis between intercompany and banks or third-party financing, the results also highlight the importance of sources of financing alternative to bank credit and propose policy implications. In particular, it is crucial to support the trade credit channel, especially in times of crisis, when intercompany financing becomes more urgent. Indeed, the harmonious evolution of intercompany financing can contribute to optimize the allocation of resources within the system.

The paper is structured as follows. Section 2 provides a brief review of prior studies that have led to the research hypotheses. Sections 3 and 4 illustrate the models and the methodology and describe the sample. Section 5 discusses the primary results and the final section provides brief conclusive assessments and the implications of the studied phenomenon.

2 | LITERATURE REVIEW AND RESEARCH HYPOTHESES

Trade credit is one of the main forms of short-term financing (Levine et al., 2018), whose functions have been extensively analyzed in the literature. The resort to trade credit can be motivated by real or financial reasons.

The real functions refer to the offer of credit as a tool to support sales policies, therefore, as a useful tool to forge new customer relations, reduce information asymmetries on product quality, implement price discrimination policies and reduce transaction costs (García-Teruel & Martínez-Solano, 2010; Long et al., 1993; Ng et al., 1999; Petersen & Rajan, 1997; Schwartz, 1974; Wilner, 2000). From this perspective, trade credit promotes growth (Du et al., 2012; Ferrando & Mulier, 2013) and corporate revenue-generation capacities (Martínez-Sola et al., 2013).

The financial functions are determined by the resort to accounts payable as a form of financing that complements or replaces banks or third-party financing.

The financial function as an alternative source to banks or third-party financing originates from imperfections of the financial market that may lead to rationing situations that force companies to resort to trade debt to replace other forms of banks or third-party financing. This function may take on more importance in adverse economic scenarios.

The real and financial functions of trade credit have blurred demarcation lines, as the concession of deferred payments to increase the sales volume or improve customer relations may be an important source of financing for the purchasing companies receiving payment deferrals, thanks to which they can solve or better manage any liquidity issue. Finally, the granting of payment deferrals can be financed by accounts payable; therefore, the incidence of trade credit in corporate balance sheets may be closely linked to intercompany debt.

2.1 | Financial function of trade credit

The financial function of trade debt is connected to the resort to intercompany debt as an efficient form of financing, triggered by insufficient and inadequate third-party or banks financing (Jaffe & Stiglitz, 1990; Petersen & Rajan, 1997). The following factors justify the relevance of the financial function of accounts payable: greater availability, possible lower costs and greater flexibility compared to other sources of financing, lack of complex contractual formulas and the possibility to extend the duration without additional charges.

The literature has constantly analyzed the financial function of trade credit in inefficient financial markets, considering information asymmetries, agency costs and the relative issues of adverse selection and moral hazard (Y. W. Lee & Stowe, 1993; Long et al., 1993).

Trade relationships are crucial to reduce information asymmetries between buyers and lenders in general, as they enable the acquisition of confidential information on the creditworthiness and default risks of purchasing companies. Duca (1986) and Jaffe and Stiglitz (1990) proposed analytical models describing a hierarchy of financial sources in which trade and bank credit could be replaced, with the former representing a fallback choice over the latter. Buyers initially and preferably draw on bank credit and only later resort to trade credit due to bank rationing.

Other authors, such as Petersen and Rajan (1997), emphasize the benefits of relationship lending and banking relationship, arguing that companies can also obtain funds through trade credit and proving that, in some cases, they can be financed by suppliers rather than financial institutions. Credit rationing, relative to information asymmetries, may lead to greater use of trade credit, as also argued in Schwartz (1974): the use of trade credit can mitigate the credit shortage incurred by companies that operate under imperfect information and credit rationing conditions, thus replacing other sources of financing (Danielson & Scott, 2004).

In line with Petersen and Rajan (1997), Schwartz (1974), Emery (1987), and Jain (2001) showed that when banks could not properly assess the corporate creditworthiness and monitoring costs were high, they might prefer to grant loans to businesses with information on their business partners, allowing them to activate the intercompany financing and, in this way, creating a second level of financial intermediation.

The substitutability between bank and trade credit is also determined by the companies' projections of their financial needs. If companies believe that their need for resources will continue over a medium to a long period, they shall turn to bank financing. On the contrary, they shall resort to trade credit if they experience short-term and unexpected liquidity needs (Miwa & Ramseyer, 2005). Suppliers can, therefore, act as liquidity providers and offer insurance against liquidity shocks that may threaten the customers' survival and, consequently, the survival of their relationship with the customers. Boissay and Gropp (2007) showed that companies with credit constraints could overcome more than a quarter of the liquidity shocks along the trade credit channel.

The financial function of trade credit and the resort to intercompany financing also depend on the companies' features: large companies with extensive self-financing capacity make less use of trade debt, while companies with a higher proportion of current assets, or subject to loan restructuring conditions, resort to trade credit to a greater extent (Niskanen & Niskanen, 2006). Companies with financial difficulties, smaller size and less market power employ trade credit extensively as a source of financing alternative to third-party or bank financing (Molina & Preve, 2012).

2.2 | Trade credit, financial crisis and FC

Trade credit relies upon long-term relationships predominantly and can lead to sunk costs (Cuñat, 2007). To maintain a long-term relationship, companies granting trade credit are interested in helping their customers maintain sound operating conditions and are willing to offer more credit than banks themselves to support companies (Wilner, 2000).

A reduction in the system's liquidity or a contractionary monetary policy can exacerbate the problems resulting from information asymmetries and corporate opaqueness (Vermoesen et al., 2013). For these reasons, financial institutions may reduce the credit supply to companies, especially smaller ones. In such conditions, trade credit proves useful to mitigate credit rationing: in fact, rationed companies can replace bank credit with trade credit and this helps generate a trade credit channel for the transmission of the monetary policy.

Empirical evidence suggests that by granting deferred payments, suppliers can help financially rationed companies and mitigate the negative effect of financial crises. Therefore, when systemic liquidity is low, larger and more liquid companies can provide trade credit to their customers. Such companies, in turn, can also use intercompany financing as an alternative channel to the financial system, especially where access to the capital market is reduced (Nilsen, 2002).

Consequently, the financial crisis (Duchin et al., 2010; N. Lee et al., 2015) can provide an excellent opportunity to study the companies' possible responses to credit rationing conditions (inter alia: Almeida et al., 2012; Chava & Purnanandam, 2011; Chow & Dunkelberg, 2011) and to investigate the function of trade credit as an available source of financing, when other sources of the financial system are unavailable (Carbò-Valverde et al., 2016; McGuinness et al., 2018).

However, the studies conducted on the relevance of the financial reasons that lead to the use of trade debt in times of crisis and the existence of a substitution function have provided ambiguous results.

Empirical analyses on the impact of the 1998 financial crisis in four East Asian countries do not support the hypothesis whereby trade debt replaces bank financing in times of crisis. Love and Zaidi (2010) noted that, after the crisis, the companies rationed by the financial system received fewer payment deferrals from their suppliers and reduced the deferrals granted to their customers.

Sheng et al. (2013) analyzed the use of intercompany debt as a substitute for bank financing during the crisis in Latin America. The authors noted that the substitution hypothesis could not be rejected for small companies but was not confirmed consistently for companies operating in different countries.

Studies have more recently focused on the 2007–2008 years, that is, the severe recession that affected the global economy and caused a reduction in international trade and a widespread financial crunch.

García-Appendini and Montoriol-Garriga (2013) focused on the effects of the 2007–2008 financial crisis on trade credit, noting that after a negative shock on bank financing, rationed

companies increasingly resorted to trade debt. Companies with high precrisis liquidity granted more deferred payments to other companies and achieved a better performance than companies with lower precrisis liquidity. The results of this study are consistent with the substitution function of trade credit. Kestens et al. (2012) and Casey and O'Toole (2014) also focused on the 2007–2008 crisis. Kestens et al. (2012) showed that the financial crisis negatively affected the availability of trade credit and noted that companies with easier access to short-term third-party financing experienced a greater reduction in trade debt. Casey and O'Toole (2014) analyzed Euro area businesses, testing the increased propensity of small and medium enterprises (SMEs) to use alternative sources of financing, including trade credit. Their indicators identified both enterprises rationed by the system and self-rationed enterprises (enterprises that refused credit because of its high cost). The study results observed that the companies rationed by the system were more likely to use trade credit and that intercompany credit played a substitute function for bank financing.

Companies generally adopt a combination of trade receivables and payables consistent in terms of both amount and duration (Cosci et al., 2020; Fabbri & Kappler, 2016).

During a financial crisis, such a close relationship may lead to a contagion effect if companies with a high level of trade payables grant payment deferrals to their customers and these, in turn, postpone payments to their customers. According to this interpretation of contagion (*contagion channel*), we might expect that, during financial crises, the (positive) relationship between financial rationing and recourse to trade payables and the (positive) relationship between trade receivables and payables could both increase (Bastos & Pindado, 2013).

However, suppliers of financially rationed companies may also suffer liquidity shocks during a systemic financial crisis. The companies that generally have access to the financial market may be severely affected by the crisis (more than companies that are rationed even under stable market conditions) and may reduce the accounts receivable they offer to customers because they themselves are rationed. Thus, the reduction of accounts receivable can propagate financial shocks, exacerbating the impact of a financial crisis. Ultimately, the matching hypothesis does not necessarily occur in periods of financial instability, as argued in the redistribution approach (Love et al., 2007) or might be weakened (Bussoli & Marino, 2018).

The redistribution approach (Petersen & Rajan, 1997; Nilsen, 2002) argues that companies with better access to financial markets can redistribute credit to other companies by granting deferred payments. However, during a financial crisis, the resources of the financial system may decline resulting in less liquidity to distribute through accounts receivable. Therefore, Love et al. (2007) extended the general considerations of the *redistribution view* and deduced that during a financial crisis, the companies that cannot obtain credit could not redistribute it. During periods of crisis, such a chain could amplify liquidity shocks (Love & Zaidi, 2010) because companies reduce the credit granted to their customers.

Trade debt, especially for smaller companies, can be complementary rather than an alternative to bank debt during a financial crisis. This concludes Psillaki and Eleftheriou's (2015) work which further supports the redistribution notion of trade credit.

2.3 | Research hypotheses

In line with the reference literature, it is possible to reassert the importance of the financial function of trade credit and the importance of the recourse to payables as a source of financing alternative to banks or other third-party financings.

There is a wide consensus in the literature in support of the substitution hypothesis (Chen et al., 2019; Cull et al., 2009; Engemann et al., 2014; García-Teruel & Martínez-Solano, 2010; Palacín-Sánchez et al., 2019). In contexts of imperfect markets, the literature observes that the companies with financial difficulties, smaller size and less market power resort to intercompany financing as a substitute for third-party or bank financing (Molina & Preve, 2012).

This substitution function is also present in stress scenarios, but the literature consensus is not unanimous in this regard. Some studies endorse the presence of the substitution conditions between trade debt and banks or other third-party debt and show that companies make greater use of trade debt during systemic crises (inter alia: Atanasova & Wilson, 2003; Choi & Kim, 2005; Love et al., 2007; Nilsen, 2002). Other authors show mixed or conflicting results (Kestens et al., 2012; Sheng et al., 2013).

This paper aims to obtain new empirical evidence on the validity of the substitution hypothesis in stress contexts and investigate whether trade debt can represent a source of financing alternative to other sources of financing even in adverse economic periods *and* under conditions of corporate credit rationing.

The empirical analysis contributes to the existing literature: (i) investigating the presence of the substitutability conditions between intercompany and bank or third-party financing in Europe in the context of the subprime mortgage crisis and the more recent and severe sovereign debt crisis, that is still scarcely investigated and (ii) verifying the substitution hypothesis, for the first time in our knowledge, also considering the size of the firms *and* the impact of the specific rationing conditions, suffered by companies during the crises, on the choice to resort to intercompany debt.

Therefore, the following research hypothesis is formulated:

HP1: *Intercompany debt may substitute banks or third-party financing under credit rationing conditions*

This paper also intends to verify whether companies offering deferred payments to their customers receive more deferrals from their suppliers even in systemic stress conditions.

The literature has investigated the relationship between trade payables and receivables. According to the *matching hypothesis* (Bastos & Pindado, 2013), when companies grant longer payment deferrals, they use trade debt to a greater extent.

However, when the resort to the capital market is limited, companies can reduce payment deferrals *and,* at the same time, increase intercompany debt. Thus, the system's inefficiency or adverse cyclical situations may affect the relationship between supply and demand for deferred payments.

This paper intends to focus on the existence of a matching effect for large, medium, small and micro European companies during the subprime mortgage and sovereign debt crises, that is still scarcely investigated in the literature, with the following research hypothesis:

HP2: *The concession of deferred payments affects the resort to trade debt in systemic stress conditions.*

3 | METHODOLOGY

This paper investigates a sample of European companies observed during the subprime mortgage and sovereign debt financial crises (2008–2016).

To verify the research hypotheses, the study starts by classifying the enterprises in micro, small, medium and large and considering the rationing condition of firms using a semiparametric model of *firm-specific financial constraints* (Ferrando & Ruggieri, 2015; Ferrando & Ruggieri, 2018; Pal & Ferrando, 2010). The semiparametric model relies upon a classification scheme based on the firm's balance sheet and income statement. The index obtained from the classification scheme is then linked to the companies' specific features through a logit estimate to predict the likelihood for each sampled enterprise of falling into one of the rationing conditions/classes. Finally, the empirical analysis is carried out through a hierarchical dynamic random effects model, which allows the two research hypotheses to be verified.

The FC condition was measured by applying a semiparametric firm-specific FC index (Ferrando & Ruggieri, 2015, 2018; Pal & Ferrando, 2010). This index relies upon a classification scheme of the companies' financial situations and considers information derived from the companies' balance sheets and income statements. This index helps distinguish between absolutely constrained, relatively constrained and unconstrained companies, depending on the different scenarios based on the relationship among total investment, financial gap, financial debt, share issuance and average payment on debt compared to the rate applied on the local credit market.

The classification scheme is contained in Table 1 (Ferrando & Ruggieri, 2015, 2018).

Companies that cannot obtain external financing are considered absolutely constrained. Companies are considered *constrained* in absolute terms if, despite a financing gap (Total Investments minus cash flow) positive or equal to zero, they do not obtain any additional credit or capital from the stock market (case 6). In the case of asset liquidation (negative investments),

TABLE 1 Classification scheme to define corporate rationing conditions.

This table reports how the different levels of constraints are obtained, by looking at a series of variables (in the columns). These levels of constraint define the outcome variable, analyzed using model (2): a three-level categorical variable (unconstrained, relatively constrained, absolutely constrained) is thus obtained and modelled. [a]*Source*: Bank of Italy—Harmonized interest rates—loans to nonfinancial companies.

Rationing condition	Total investment	Financing gap	Changes in the total debt	Issuance of new shares	Cost of borrowing money
Absolutely constrained					
6	≥0	≥0	≤0	≤0	-
5	<0	<0	≤0	-	-
Relatively constrained					
4	≥0	≥0	≤0	>0	-
3	≥0	≥0	>0	-	≥Market rate[a]
Unconstrained					
2	≥0	≥0	>0	-	≤Market rate[a]
1	<0	<0	>0	>0	-
0	≥0	<0	-	-	-

the classification helps distinguish between the case of absolutely *constrained* companies (case 5) and the case of *unconstrained* companies (case 1) based on their relationship with external sources due to the change in total debt and the sale of new shares. It is impossible to define whether the investment is rationed for redemption or whether companies do not invest due to a lack of profitable investment opportunities. Therefore, these companies are included in the constrained category if total debt is not increasing and share issuance data are missing. The companies that can only access expensive sources of financing are considered relatively constrained. Case 4 includes the companies that finance their investment not through credit but through the issuance of new shares, which is more expensive due to asymmetric information. The companies that can only obtain expensive credit tend to use fewer external sources of financing than *unconstrained* companies; such companies are deemed *constrained* in a relative sense (case 3). *Unconstrained* companies have access to sources of financing and pay, on average, the best price in the market. Companies are considered unconstrained when they can use external financing resources in favourable conditions, so they can increase their leverage, when necessary, with low financing costs relative to the market conditions (case 2). When the financing gap is negative, the companies' total investment is lower than the current cash flow and the companies are considered financially unconstrained if they are still increasing their total investment (case 0).

The measurement of the rationing condition described above represents an a priori classification separate from firm-specific variables, such as degree of leverage, that may affect access to funding sources. Ignoring such variables may produce a distorted analysis that over or underestimates the rationing condition. For this reason, in line with Ferrando and Ruggieri (2015), this paper intends to overcome these limits by linking the index based on the classification scheme mentioned above to specific corporate features used extensively in the literature to estimate the rationing condition.

It is then necessary to formally specify the statistical modelling to quantify the effects of rationing conditions on the payables. The theoretical modelling framework starts defining a set of generalized linear models (McCullogh & Nelder, 1989), widely applied to model continuous, discrete and categorical outcomes in a regression framework. In the basic model, a monotone function of the mean known as the link function is regarded as a linear combination of known covariates; conditionally on these, the outcomes are assumed statistically independent. Nevertheless, in our empirical framework, this independence assumption is untenable. Indeed, the data at hand have a longitudinal/hierarchical structure. Firms/companies are nested within countries and one can generally assume that firms/companies belonging to the same country are more similar than are those belonging to different countries. Moreover, due to the longitudinal structure of the data, outcomes collected on the same firm must be generally regarded as correlated. These data features call for the use of generalized mixed-effects multilevel models (Goldstain, 2011), allowing for firm and country-specific effects.

Moreover, data show a clear time dependence. Thus, we specify an adequate definition of the association structure in the data, further distinguishing between true and apparent contagion. In the former case, the occurrence of a certain trade payable changes subsequent occurrences, that is, actual and future outcomes are directly influenced by past values. This can be modelled by including autoregressive terms of any order in the linear predictor. Instead, the latter case arises when firms/companies are drawn from heterogeneous populations and the random effects capture such heterogeneity. However, such a model requires efficient parameter estimation by properly handling the initial conditions problem (Aitkin & Alfó, 2003; Heckman,1981; Rabe-Hesketh & Skrondal, 2013; Wooldridge, 2005). This is because the

presence of both these components implies that the model should be defined taking into account the distribution of the random effect given the initial conditions and this fact complicates, even more, the form of the resulting likelihood. We solve this point considering the approximate conditional approach introduced, in a different setting, by Follmann and Wu (1995).

The empirical analysis is then carried out through the definition of a hierarchical dynamic random effects model in which the recourse to trade payables for each company (Payab) is a function of the following factors: (i) the delayed value of the accounts payable payab_{t-1fc} (in tables: Lag_payab) and the initial value of the accounts payable payab_{0fc} (in tables: Base_payab); (ii) the likelihood for companies to be rationed (fc_{it}); (iii) accounts receivablereceive_{tfc} (in tables: Receiv) and (iv) the control variables referring to the companies and the country of origin that the literature generally considers as determinants of accounts payable. The control variables include *country-level* variables to assess macroeconomic performances and factors affecting the trade credit market, which are, however not due to corporate features. The country-level variables are as follows: (iv) the growth rate of the gross domestic product (GDP) gdp.growth_{tfc} (in tables: Gdp_growth) and (v) the growth rate of the credit flow towards the private sector, $\text{credit . flow . ratio}_{tfc}$, measured as a share of the country's GDP (in tables: Credit_flow).

Formally, let us consider a continuous random variable z_{tfc}, that is, trade payables, measured at time t, for firm f clustered in the c-th Country, $t = 1, ..., T_f$, $f = 1, ..., F$, $c = 1, ..., C$. We assume that z_{tfc} are realizations of a Normal random variable with parameters μ_{tfc} and σ_z^2. In a regression context, the interest lies in modelling μ_{tfc} as a function of some covariates. To account for the dependence between observations, a linear mixed model was considered, that is,

$$\mu_{tfc} = \sum_{p=1}^{P} w_{tfcp}\gamma_p + u_f^* + \tilde{u_c},$$

where $w_{tfc} = (w_{tfc1}, ..., w_{tfcp})'$ is a set of observed covariates and γ the corresponding vector of regression parameters, u_f^* and $\tilde{u_c}$ are firm- and country-specific random effects, respectively, with $u_f^* \sim N(0, \sigma_{u^*}^2)$ and $\tilde{u_c} \sim N(0, \sigma_{\tilde{u}}^2)$, capturing unobserved heterogeneity at the different levels of the hierarchy. Model's parameters were obtained via maximum likelihood, without too many efforts, as standard algorithms are available in most existing software. In detail, the working model is given by

$$\begin{aligned}\mu_{tfc} = {} & \gamma_0 + \gamma_1 \times \text{payab}_{t-1fc} + \gamma_2 \times \text{payab}_{0fc} + \gamma_3 \times \text{receive}_{tfc} + \gamma_4 \times \hat{\pi_{1tfc}} + \gamma_5 \times \hat{\pi_{2tfc}} \\ & + \gamma_6 \times \text{gdp . growth}_{tfc} + \gamma_7 \times \text{credit. flow . ratio}_{tfc} + u_f^* + \tilde{u_c},\end{aligned} \tag{1}$$

where an identity link function is considered, and $\hat{\pi_{rtfc}}$ are the estimates of the probability of a certain level of constraints π_{rtfc}. These probabilities are not observed and should be estimated. We start assuming that the observed categorical variable y_{tfc}, that is, the levels of constraint, measured at time t, for firm f clustered in the c-th Country, $t = 1, ..., T_f$, $f = 1, ..., F$, $c = 1, ..., C$, are realizations of an ordinal random variable with parameter π_{rtfc}, with $r = 1, ..., R$

denoting the number of different observed categories (here, $R = 3$). To estimate the parameter vector π_{rtfc}, a cumulative link mixed model results (Agresti, 2002, 2007, 2010), having the following general form, is considered:

$$G^{-1}[\Pr(y_{tfc} \le r)] = G^{-1}[\pi_{rtfc}] = \alpha_r - \sum_{p=1}^{P} x_{tfcp}\beta_p - b_f^* - \tilde{b_c},$$

where $\beta = \{\beta_1, ..., \beta_p\}$ is the vector of the regression coefficients associated to the set of p covariates $x_{tfc} = (x_{tfc1}, ..., x_{tfcp})'$, α_r is the threshold for category r, $r = 1, ..., R$ for an ordinal variable with R categories, and G^{-1} is the link function, b_f^* and $\tilde{b_c}$ are firm- and country-specific random effects, respectively, with $b_f^* \sim N(0, \sigma_{b^*}^2)$ and $\tilde{b_c} \sim N(0, \sigma_{\tilde{b}}^2)$. The working model is now given by

$$\begin{aligned}\text{logit}(\pi_{rtfc}) = \alpha_r - (&\beta_1 \times \text{cash . hold}_{tfc} + \beta_2 \times \text{leverage}_{tfc} + \beta_3 \text{interest. burden}_{tfc} \\ &+ \beta_4 \times y_{t-1fc,r=2} + \beta_5 \times y_{t-1fc,r=3} + \beta_6 \times y_{0fc,r=2} + \beta_7 \times y_{0fc,r=3} + b_f^* + \tilde{b_c}),\end{aligned} \tag{2}$$

where leverage = noncurrent liabilities/total assets; Cash hold = (cash and cash equivalent)/total assets; interest burden = interest paid/earnings before interests and taxes (EBIT).

We consider size-specific models to account for differences across companies of different sizes for both the working models. This is equivalent to assuming regression size-specific coefficients and capturing heterogeneity in how exogenous covariates affect the outcomes.

Both the working models are also linked to and motivated by the existing empirical literature. In alignment with prior studies (e.g., Bastos & Pindado, 2013; Love et al., 2007), Payab represents the number of days-to-pay accounts payable and corresponds to the average number of days of deferred payment, measured by the ratio of total accounts payable to operating revenue, multiplied by 360. Similarly, Receiv represents the average number of days of deferred collections of accounts receivable, measured by the ratio of total accounts receivable to operating revenue, multiplied by 360.

If trade credit is an alternative source of financing and acts as a substitute for other sources of financing (*substitution hypothesis*), a significant and positive relationship is expected between the likelihood of rationing and accounts payable: the more likely the rationing condition, the greater the recourse to trade debt, while the less likely the rationing condition, the lower the recourse to trade debt.

In addition, a significant and positive relationship between accounts receivable (Receiv) and accounts payable (Payab) was also expected to ascertain the second research hypothesis (*matching hypothesis*).

4 | SAMPLE

A panel of European firms extracted from the *Amadeus* Bureau van Dijk database was used to estimate models (1) and (2).

We collected data on 6252 firms from 11 different European countries over 9 years (2008–2016) to investigate our main hypotheses. Due to missing data, the final model on the Payab variable was developed on 3758 firms only and 14,394 observations.

The companies present the following features:

- Status: active companies
- Standardized legal form: private limited companies

The sample does not include financial companies.

The sample is segmented into four subsamples referring to companies of micro, small, medium and large size:

- Micro size = number of employees < 10 and total assets ≤ 2000.000 euro;
- Small size = 10 < number of employees < 50 and total assets ≤ 10,000.000 euro; or number of employees < 10 and total assets > 2000.000 euro;
- Medium size = 50 < number of employees < 250 and total assets ≤ 43,000.000 euro; or 10 < number of employees < 50 and total assets > 10,000.000 euro;
- Large size = number of employees ≥ 250 and total assets > 43,000.000 euro.

Tables 2 and 3 feature the descriptive statistics and the correlation matrix among the variables, respectively.

To provide more insights into the data structure, focusing on the dependent variable, we describe the distribution of the payables over time and across countries, stratified by firm sizes, see Figure 1. This simple graphical description shows the presence of a strong dependence over time of the observed payables (Figure 1a), which have similar distributions at the different years, conditioned on the firm's sizes. Similarly, it is possible to appreciate the heterogeneity across countries (Figure 1b), which may play a crucial role in the analysis and bias the estimates if neglected. At last, it should be noticed that not all countries are represented in the size classes.

5 | RESULTS

The estimate results on the logit model (2), related to the four sub-samples, are presented in Table 4. The multilevel dynamic model estimation (1), referred to as the confirmation of the research hypotheses and related to the four subsamples, is reported in Table 5.

We are aware that more firm-specific controls or country-specific measures could be further included in the modelling (see e.g., Beck et al., 2020; Palacin-Sanchez et al., 2019) like, for example, institutional factors and cross-country norms. However, the methodology adequately controls for the firm- and country-specific effects that are unlikely to be adequately captured by the FC indicator or macros, including GDP and bank credit extension to the private sector. A simple way to account for these aspects is through omitted variables (for a detailed discussion of this topic, see Aitkin et al., 2004). We assume that some fundamental covariates were not considered in model specification and that their joint effect can be summarized by adding a set of unobserved variables (the random effects), that is, taking into account unobserved heterogeneity (Aitkin et al., 2004).

Moving on to the analysis of the results of the first research hypothesis, we observe, in line with the prevailing literature (Atanasova & Wilson, 2003; Choi & Kim, 2005; Guariglia & Mateut, 2006; Love et al., 2007; Nilsen, 2002), the presence of the substitutability conditions between trade debt and third-party financing. There is a significant and negative relationship

TABLE 2 Descriptive statistics

This table reports descriptive statistics over the period 2008–2016, stratified by firm size and marginalized over all countries. Payab = accounts payable; Base_payab = the initial value of the accounts payable; Receiv = accounts receivable; Gdp_growth = the growth rate of the gross domestic product (GDP); Credit_flow = the growth rate of the credit flow towards the private sector measured as a share of the country's GDP. Micro size = number of employees < 10 and total assets ≤ 2000.000 euro. Small size = 10 < number of employees < 50 and total assets ≤ 10.000.000 euro; or number of employees < 10 and total asset > 2000.000 euro. Medium size = 50 < number of employees < 250 and total assets ≤ 43,000.000 euro; or 10 < number of employees < 50 and total assets > 10,000.000 euro. Large size = number of employees ≥ 250 and total assets > 43,000.000 euro.

Variables	Min	Mean	Max	SD
Large companies				
Payab	0.573	25.266	162.832	24.11
Base_payab	1.554	26.888	178.336	25.804
Receiv	0.008	38.043	331.793	40.416
Gdp_growth	−5.600	0.645	4.100	2.605
Credit_flow	−11.200	0.663	23.000	3.444
Medium companies				
Payab	0.060	52.836	354.806	52.836
Base_payab	0.060	49.072	334.164	49.073
Receiv	0.017	67.903	359.274	67.902
Gdp_growth	−9.100	0.593	25.100	0.593
Credit_flow	−15.600	1.324	22.000	1.324
Small companies				
Payab	0.003	62.624	359.655	61.936
Base_payab	0.025	62.512	348.500	59.891
Receiv	0.004	97.390	360.00	80.917
Gdp_growth	−9.100	−0.417	25.100	2.248
Credit_flow	−15.600	0.183	23.000	5.055
Micro companies				
Payab	0.003	62.704	359.945	70.734
Base_payab	0.010	63.432	358.494	70.567
Receiv	0.003	79.460	360.000	80.389
Gdp_growth	−14.400	−0.708	25.100	2.475
Credit_flow	−11.200	1.880	23.000	3.751

TABLE 3 Correlation matrix

The table reports pairwise linear correlations. Payab = accounts payable; Base_payab = the initial value of the accounts payable; Receiv = accounts receivable; Gdp_growth = the growth rate of the gross domestic product (GDP); Credit_flow = the growth rate of the credit flow towards the private sector measured as a share of the country's GDP. *Significant correlation at $p < 0.05$.

	Payab	Payab_baseline	Receiv	GDP growth	Credit flow ratio
Large companies					
Payab					
Base_payab	0.8962*				
Receiv	0.5005*	0.5021*			
Gdp_growth	−0.1415*	−0.1221*	−0.0343		
Credit_flow	−0.0785	−0.0594	−0.0335	0.2560*	
Medium companies					
Payab					
Base_payab	0.7007*				
Receiv	0.5171*	0.4271*			
Gdp_growth	−0.1529*	−0.1594*	−0.1473*		
Credit_flow	0.0471	0.0243	0.0532*	0.0940*	
Small companies					
Payab					
Base_payab	0.6164*				
Receiv	0.2553*	0.2133*			
Gdp_growth	−0.0605*	−0.0444*	−0.0393*		
Credit_flow	0.0196*	0.0127	−0.0350*	0.2255*	
Micro companies					
Payab					
Base_payab	0.7305*				
Receiv	0.3397*	0.2634*			
Gdp_growth	−0.0520*	−0.0377*	−0.0828*		
Credit_flow	−0.0102	0.0016	−0.0255*	0.2009*	

between the dependent and *prob_unc* variables, which indicates the likelihood of being unconstrained. Consequently, the more likely companies are not rationed by the financial system, the lower the incidence of payables due to suppliers. This effect is particularly relevant for the medium, small and micro firms, while no effect is estimated for the large firms. Thus the following could be added to the existing knowledge for the SMEs, for which the substitution hypothesis holds. In contexts of systemic crisis, intercompany debt substitutes banks or third-party financing under firm-specific rationing conditions. Under conditions of inefficient

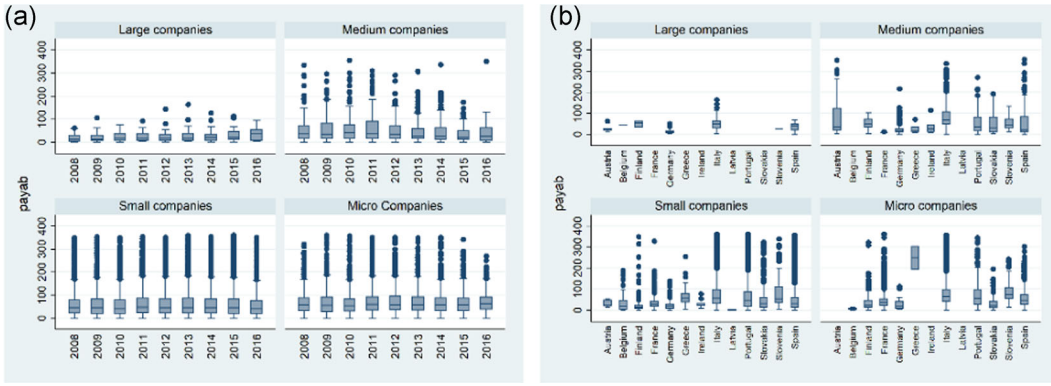

FIGURE 1 Descriptive statistics. The boxplots summarize the main descriptive statistics, that is, the minimum, the quartiles and the maximum, of the payables (payab) stratified by firm sizes and reported by year (a) and countries (b). If a boxplot is not displayed for a specific country, information on payables is not available

TABLE 4 Multinomial Logit mixed-effects model results: financial constraints regression

This table reports the results of the multinomial logit mixed-effects regression model (2). Estimated coefficients are reported along with the corresponding p values. A $p < 0.05$ indicates a significant effect of the corresponding variable on the probability of financial constraint. We report the estimated variance of the firm-specific random effects distribution (σ^2_{b*}) and its standard deviation. We report the estimated variance of the country-specific random effects distribution (σ^2_b) and its standard deviation. Lag rel_constr and lag abs_constr are the first order lagged variables of the relative and absolute constraint categories, respectively. Similarly, base rel_constr and base abs_constr collect the baseline values, that is, the values at the first time period, of the relative and absolute constraint categories, respectively. Leverage = noncurrent liabilities/total assets. Cash hold = (cash and cash equivalent)/total assets. Interest burden = interest paid/EBIT.

	Large		**Medium**		**Small**		**Micro**	
Variables	**Estimate**	***p* Value**	**Estimate**	***p* Value**	**Estimate**	***p* Value**	**Estimate**	***p* Value**
Cash_hold	−1.549	0.239	−1.516	0.000	−2.179	0.000	−1.744	0.000
Leverage	−4.882	0.002	−1.242	0.000	−1.379	0.000	−1.350	0.000
Interest burden	5.184	0.012	−0.031	0.390	−0.001	0.447	−0.008	0.252
Lag rel_constr	−0.517	0.229	−0.061	0.665	0.245	0.000	0.355	0.000
Lag abs_constr	−0.631	0.126	0.003	0.983	0.271	0.000	0.148	0.077
Base rel_constr	−0.392	0.555	0.123	0.454	−0.029	0.634	0.150	0.110
Base abs_constr	0.172	0.723	0.280	0.026	0.190	0.000	0.356	0.000
	Estimate	**SD**	**Estimate**	**SD**	**Estimate**	**SD**	**Estimate**	**SD**
σ^2_{b*}	0.001	0.001	0.257	0.185	0.043	0.025	0.142	0.095
σ^2_b	1.653	0.892	0.455	0.136	0.452	0.053	0.482	0.089
N. obs.	262		2077		13752		5155	

TABLE 5 Multilevel dynamic model results: accounts payable regression

This table reports the results of the dynamic linear mixed-effects model (1). The recourse to trade payables for each company (Payab) is a function of the following factors: (i) the delayed value of the accounts payable (Lag_payab) and the initial value of the accounts payable (Base_payab); (ii) the likelihood for companies to be rationed; (iii) accounts receivable (Receiv) and (iv) the control variables (Gdp_growth, Credit_flow). Estimated coefficients are reported along with the corresponding p values. A $p < 0.05$ indicates a significant effect of the corresponding variable on the probability of financial constraint. We document the estimated variance of the firm-specific random effects distribution (σ^2_{u*}) and its standard deviation. We report the estimated variance of the country-specific random effects distribution ($\sigma^2_{\tilde{u}}$) and its standard deviation. The π1, π2 and r π3 refer to estimated probabilities of different levels of constraints as defined by model (2).

	Large		**Medium**		**Small**		**Micro**	
Variables	**Estimate**	***p* Value**	**Estimate**	***p* Value**	**Estimate**	***p* Value**	**Estimate**	***p* value**
Lag_payab	0.052	0.377	0.439	0.000	0.438	0.000	0.411	0.000
Base_payab	0.946	0.000	0.272	0.000	0.257	0.000	0.324	0.000
Receiv	0.153	0.000	0.164	0.000	0.095	0.000	0.121	0.000
π1 prob_unc	−1.617	0.744	−42.440	0.065	−26.010	0.000	−12.218	0.050
π2 prob_rel_constr	−67.255	0.001	124.323	0.076	−13.617	0.526	−39.898	0.032
π3 prob_abs_constr	-	-	-	-	-	-	-	-
Gdp_growth	−0.179	0.284	−0.765	0.041	−0.227	0.118	−0.331	0.043
Credit_flow	−0.130	0.491	0.935	0.023	0.027	0.798	0.0273	0.033
Constant	10.454	0.044	−13.760	0.270	14.961	0.000	16.086	0.000
	Estimate	**SD**	**Estimate**	**SD**	**Estimate**	**SD**	**Estimate**	**SD**
σ^2_{u*}	0.001	0.001	22.684	24.362	20.603	12.991	9.211	8.670
$\sigma^2_{\tilde{u}}$	62.661	18.783	245.545	70.790	464.778	31.541	318.015	31.710
N. obs.	262		2077		13752		5155	

financial markets or adverse contexts, smaller companies strive to find solutions to a malfunctioning financial system.

The greater the probability of being financially unconstrained, the less recourse to intercompany debt and this effect is higher as the size of SMEs (i.e., micro, small, medium) grows. Thus, the financial function of trade debt plays a major role in contributing to greater systemic efficiency: substituting banks or third-party financing with intercompany financing reduces the rationing conditions caused by market imperfections or systemic crises. It is particularly important for smaller companies.

The considerations that can be drawn from the dynamics described are twofold. On the one hand, a diversified financial structure can improve the resilience of companies to financial shocks. The sources of financing alternative to bank credit are the means to achieve such diversification, and among these, trade debt plays a key role.

On the other hand, there is a close connection between the efficiency of the financial system and the evolution and functioning of the trade credit channel: it is impossible to fully

understand the multiple functions of trade credit without considering the conditions of evolution and the dynamics of the financial system.

The estimated results show a similarly significant relationship between the initial conditions of recourse to intercompany financing and its incidence in the subsequent years. Therefore, the recourse policies to intercompany financing are connected over time and linked in a close dynamic relationship.

The results on the control variables help grasp the importance of the system's conditions in the choice to resort to trade debt.

There is a significant and negative relationship between the growth rate of the GDP and the incidence of trade payables: for medium and micro firms, the better the systemic conditions, the lesser the recourse to intercompany financing. Although referred to as control variables, this result allows and helps understand the importance of systemic conditions in the recourse to intercompany debt and reiterates the relevance of the evolutionary dynamics of the economic–financial system.

Considering the results of the second research hypothesis, a significant and positive relationship is observed between the incidence of trade receivables and the recourse to trade payables.

It is possible to argue, in line with the literature (Bastos & Pindado, 2013; Bussoli & Marino, 2018), that the second research hypothesis is proven and that the concession of deferred payments affects the use of trade debt in systemic stress conditions for micro, small, medium and large enterprises. The granting of deferred payments is a tool to support sales policies (real purposes), encouraging more purchases in the present. The trade credit granted can also improve future sales, in those cases where it helps customers solve liquidity issues and, therefore, pursue and maintain a proper management balance, determining a more stable commercial relationship between customer and supplier. In these cases, deferred payments' real and financial functions are consistent and difficult to distinguish since granting deferred payments is useful to support business customers continuously and flexibly, contributing to their financial stability.

However, this relevant accounts receivable function may be hampered by the difficulty for companies that grant deferred payments to access credit. In this sense, the relationship between trade receivables granted and the recourse to intercompany debt is crucial. The existence of a positive relationship between the incidence of trade receivables and the incidence of trade payables, as observed in the results of the empirical analysis, proves that deferred payments may also be financed by intercompany debt. In this sense, intercompany debt has emerged once again as a relevant source of alternative financing, useful to form a diversified and balanced financial structure for the companies that grant deferred payments, thus generating a virtuous channel of trade credit.

6 | CONCLUSIONS

The work carried out aimed to investigate the relationship between intercompany financing and banks or third-party financing to provide new empirical evidence to support the substitution hypothesis. In particular, it aimed to find out, for the first time in literature to the best of our knowledge, whether trade debt could represent a source of financing alternative to other sources—for micro, small, medium and large European enterprises—even in crises periods *and* under conditions of credit rationing for companies (substitution hypothesis).

It also sought to establish whether companies offering payment deferrals to their customers receive more payment deferrals from their suppliers, financing trade receivables through trade payables; the study contributes to the existing literature on the matching hypothesis in systemic stress conditions considering the recent sovereign debt crisis and firm's size that are scarcely investigated.

The empirical results confirm the presence of conditions of substitutability between banks or third-party financing and trade debt in credit rationing conditions during financial crises. They reiterate, therefore, the validity of the substitution hypothesis and the importance of the financial function of trade debt for the micro, small and medium firms. Resorting to intercompany financing can be the way to achieve an effective diversification of sources of financing, which help smaller companies to overcome financial stress situations and, above all, credit rationing conditions.

The results also support the validity of the matching hypothesis, according to which the duration of trade receivables granted should balance the duration of trade payables received from suppliers. The empirical analysis is in line with the second research hypothesis, showing that, even in conditions of systemic crisis, the concession of deferred payments leads to greater recourse to trade debt, which represents an important alternative source of financing.

This paper confirms the importance of the financial use of trade debt: accounts payable can represent a vital financing channel in credit rationing conditions during financial crises; trade debt, financing the granting of deferred payments, represents a tool for achieving more stable relationships with customers.

Therefore, the real and financial functions have blurred boundaries and can contribute to forming a virtuous channel of trade credit that is useful to improve the financial balances of European companies even during periods of systemic crisis and in conditions of rationing for micro, small and medium enterprises.

The considerations that can be drawn from the dynamics described above and from the results of the empirical analysis have policy implications.

First, considering that a diversified financial structure can improve the resilience of enterprises to financial shock conditions, it is observed that sources of financing alternative to bank credit are the instrument to achieve such diversification and, among these, a crucial role is played by intercompany financing.

According to the relevant literature and the above-mentioned financial dynamics, the close connection among an efficient financial system, the credit system in particular, and the evolution and functioning of a system of intercompany financing appear clearly. It is impossible to fully understand the multiple functions of trade credit without considering the evolution and efficiency and the economic dynamics of the financial market.

In recent years, the observation of the reality and the dynamics of the financial markets in the sub-prime and sovereign debt crises have revealed that the recourse to trade debt has increased in adverse economic conditions and credit rationing situations imposed by the financial system.

The results of the empirical analysis confirm the evidence, as well as the importance, of the substitution of trade debt with other sources of financing when firms are small, weak and financially constrained. This provides policy indications to foster the harmonious development of trade credit to overcome the inefficiencies of the financial system, help companies achieve an effective diversification of their financial structure, strengthen relationships with customers and improve their resilience.

DATA AVAILABILITY STATEMENT

Data subject to third-party restrictions: The data that support the findings of this study are available from https://amadeus.bvdinfo.com/. Restrictions apply to the availability of these data, which were used under license for this study. Data are available from the authors with the permission of Bureau Van Dijk.

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