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Dynamics of Trade Credit, Bank Credit Extension, Sustainable Economic Growth, and Imports: Evidence from the European Non-Financial Sector

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Abstract: This study investigates the relationship between trade credit and sustainable economic growth, bank credit extension, and imports in the context of 15 European non-financial sectors spanning 2005Q1 to 2019Q2. Furthermore, it attempts to unveil the nonlinear relationship between trade and bank credit extension. To achieve these aims, balanced panel data are constructed and second-generation panel data are used to analyze Panel AMG Estimation, and an improved panel causality test for heterogeneous panels is employed. To enhance the robustness of the study, the results are scrutinized on a country-specific basis. The findings revealed a positive relationship between trade credit and both sustainable economic growth and imports, whereas a negative correlation was found with bank credit extension. These divergent outcomes at the country level were thoroughly discussed. Finally, a bilateral causality is identified between trade credit and economic growth, bank credit extension, and total manufacturing production, whereas a unidirectional causality is found with import activities.

Keywords: trade credit; bank credit extension; sustainable economic growth; import; Panel AMG Estimation; heterogeneous panel causality

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1. Introduction

Trade credit (hereinafter referred to as trade credit investments) plays a vital role in providing financial assistance between firms, particularly during challenging times when obtaining external funding from banks and credit institutions becomes difficult [1,2]. Especially in developing and developed countries, trade credit holds a significant place in the balance sheets of companies. For instance, from the perspective of developing countries, trade credit is more predominant in South Africa than in other countries, accounting for nearly 32% of total assets [3]. In cases where access to bank loans is limited in China, trade credit gains great importance. Corporations' financial requirements are predominantly met by both trade and bank credit; however, the predominance of the former implies potentially superior accessibility to trade credit compared with bank credit [4].

When considering developed countries, it has been reported that trade credit in the United States accounts for approximately 18% of total assets and has shown increases at similar rates [5–7]. Interestingly, despite the strong structure of capital markets, developments in the banking system, and robust macroeconomic policies in Europe, the significant increase in trade credit is noteworthy. For example, in studies conducted by McGuinness, Hogan, and Powell [8], the trade credit investment, represented by the ratio of accounts receivable to total assets, averages around 30% across 13 European countries. This ratio ranges from a minimum of 13% in Latvia to a maximum of 49% in Greece. Similarly, research conducted by Karakoç [9] revealed that the same ratio in nine developed countries has an average of 19%. Within these countries, the ratio fluctuates, with Canada having the lowest at 12% and France having the highest at 26%. In this regard, it can be observed that trade credit in Europe has gained even more momentum compared to other countries, leading to an increase in empirical studies in this context.

There are many debates on the reasons behind trade credit. Numerous theoretical explanations have argued the issue of trade credit investment and financing from the perspectives of commercial, operational, and financial motivations [10–19]. These studies have primarily focused on examining internal financial factors. In addition to internal factors that influence trade credit, macroeconomic policies implemented by countries play a significant role in determining the level of trade credit, such as monetary policy [20–22], economic growth [21,23–26], substitution effect and countercyclical behavior [27–30], financial intermediation motivation [21,29,31,32], and imports [33–35]. The key question remains: which of these theories is dominant in each European country, and how do they influence sustainable economic policies?

To answer these questions, it is increasingly essential to examine recent scholarly insights and propositions in the field. In recent years, there has been a great deal of discussion over whether nations' trade credit policies are linked to their level of sustainable economic growth. For instance, trade credit serves as a significant financial resource for medium-sized green companies in some countries and contributes more to sustainable economic growth than traditional banking credit. This highlights the need for financial intermediaries to incorporate green parameters in assessing the creditworthiness of micro-enterprises (SMEs) to support their sustainable growth [36]. Similarly, the recent success of China in terms of sustainability can be related to its trade credit policy, which facilitates sustainable growth among enterprises in China by alleviating financing constraints and enhancing production efficiency [37]. It is also emphasized that suppliers can promote sustainability in supply chains by collaborating with customers in financing and offering incentives through advantageous payment conditions [38]. Additionally, the significance of trade credit and environmental considerations in making decisions about joint trade credit and inventory management is crucial for sustainable economic growth [39]. Furthermore, investigations are underway, delving even further into the impact of CO_2 emissions on international trade and sustainable economic growth [40]. Therefore, the possible significant role of trade credit in fostering sustainable economic growth, supporting firms' growth and profitability, and promoting sustainability within supply chains has been validated by many researchers. The rational integration of trade credit into financial assessments, policies, and business strategies may be crucial for achieving sustainable economic growth, and environmental responsibility.

Despite the possible benefits of increasing trade credit volume, few studies have considered the macroeconomic determinants of trade credits instead of internal financing factors. Based on these debates, this study examines the macroeconomic determinants of trade credits in European member countries for the non-financial sector. The reason for choosing countries is grounded in Europe's robust banking infrastructure, its prominence in spearheading economic expansion, and its forefront position in sustainable economic policies. Another reason for selecting EU countries is that trade credit continues to be a stable source of financing for companies in the Eurozone.

The contribution of this study is threefold. First, it stands out as the first study to reveal the relationship between trade credit and macroeconomic policies regarding economic growth, bank credit extension, and imports, specifically within the non-financial sectors of EU member countries. Second, this is the first study to investigate the possible parabolic relationship between bank and trade credits by including the square of bank credits in the empirical model as an independent variable. We can separate the impact of bank credits on trade credit for different levels of bank credits. Third, based on increasing globalization, ignoring the possible shock transfer among countries, especially for trade and financial variables, may lead to inconsistent results. Therefore, this study is the first to use second-generation panel data methodologies that allow possible cross-sectional dependence among EU member countries. However, despite the cross-sectional dependency, it is also well known that each country may have country-specific shocks; therefore, the heterogeneity issue is also considered in the empirical process.

The Section 2 of the study covers the theoretical background and hypothesis development, the Section 3 discusses the literature, and the Section 4 focuses on the data, variables, descriptive statistics, model, and methodology. The Section 5 presents the baseline results of the econometric analysis, followed by a robustness check. The Section 6 includes the conclusions and policy implications.

2. Theoretical Background and Hypothesis Development

This study elucidates the relationship between trade credit and bank credit extension, economic growth, and imports. Furthermore, to enhance the robustness of this research, it seeks to uncover the nonlinear relationship between trade credit and the extension of bank credits. Previous studies over an extended period have delved into the determinants of trade credits, emphasizing internal financial factors [5,41,42]. They also highlighted the commercial, operational, and financial benefits of trade credit for vendors. Various theories and incentives for providing trade credit have been identified in this research, including: (i) fostering sales during periods of low demand through easier credit terms [10], (ii) reducing transactional costs [11,12], (iii) alleviating financial strains on clients [20], (iv) price discrimination between cash-paying customers and those who use credit [14,17,43], (v) decreasing information asymmetry between purchasers and sellers [13,15,44], and (vi) serving as a testament to product quality [16,18]. Ultimately, providing credit can also strengthen the relationship between the vendor and buyer [19,45]. Consequently, offering trade credit can boost a company's sales [41]. In addition to the determinants of trade credit from an internal financial perspective, various theories have been proposed regarding their relationships with macroeconomic policies, such as the monetary policy effect [20–22], economic growth (under access to external sources) [21,23], substitution effect and countercyclical behavior [27–30], financial intermediation motivation [21,29,31,32], and imports [33–35]. In the following sections, general theories and motivations are discussed, and hypotheses relevant to these approaches are presented.

2.1. Trade Credit and Economic Growth

The existence of a relationship between trade credits and economic growth has been examined in various studies. In developed economies with a strong banking system, firms tend to rely more on bank loans for short-term debt financing and appear less willing to invest in trade credit. However, the limitations on bank loans due to state ownership of the banking system, coupled with limited access to external resources in developing countries, push firms toward the use of trade credit [21].

Moreover, during the periods of economic slowdown, developing countries can assume a financial intermediation role and increase their trade credit. The substitution effect and countercyclical motivation between trade credit and bank financing can come into play, leading to the use of trade credit instead of bank loans during economic downturns, and the relationship between them may be negative [29,30]. Similarly, it is stated that the relationship between trade credits and economic growth differs between small firms, where trade credit usage increases during periods of economic recovery (highlighting the characteristic of developing countries), whereas in developed countries, firms exhibit a decrease in trade credit due to the improvement in international competitive conditions [28,30]. In this context, the hypothesis testing the relationship between trade credit and economic growth is as follows:

Hypothesis 1. *There is a positive relationship that exists between trade credit and economic growth.*

If this hypothesis is confirmed, it can be concluded that the motivation for external sources access is valid in the selected sample; if not, it would indicate the validity of substitution and countercyclical motivation.

2.2. Trade Credit and Bank Credit Extension

Trade credit plays a significant role in providing funds for most businesses, and it is particularly vital for firms facing a shortage of bank credit [46]. The effects of bank credits on trade credits are based on two main approaches [21,22,27]. The first theory is examined through the Monetary Policy effect. It argues that businesses use trade credit in two ways to avoid the impacts of tight monetary policies implemented by central banks: (i) Trade credit facilitates the transfer of funds from cash-surplus businesses to those in need of cash, thereby creating a balance among businesses. This enables smoother financial transactions and regulates cash flow within businesses. (ii) When businesses purchase goods or services from each other, they typically finance these purchases using bank credit. However, in certain situations, banks may have limited lending capacity or businesses may face reduced access to bank credit. In such cases, businesses can use trade credit to make planned purchases [27]. In this context, the tight monetary policy of central banks pushes them toward credit restrictions, accelerating trade credit. Consequently, an inverse relationship exists between bank credit extensions and trade credits in this theory [22].

The second theory emerges from financial intermediary motivation. It argues that firms indirectly provide trade credit to their customers by acting as financial intermediaries for the bank loans they borrow [21,31]. In particular, during periods of financial crisis, the use of trade credit as a substitute for bank credit is also supported. Research on emerging markets and transitional economies suggests that trade credit can substitute for bank financing during financial crises. Love et al. [32] conducted a study on companies in six economies that have experienced financial crises since 1990. They found that firms with access to bank financing increased their utilization of trade credit to support other firms facing financing constraints immediately after the crisis. However, as the crisis deepened and bank credit sources dried up, the provision of trade credit decreased, affecting both firms reliant on bank financing and those that were previously able to borrow. As a result, the role of trade credit as a means of reallocating bank credit diminished [29]. In this regard, the following hypothesis has been developed to test the relationship between trade credit and bank credit extension:

Hypothesis 2. *There is a negative relationship between trade credit and bank credit extension.*

If this hypothesis is confirmed, it would suggest the validity of the monetary policy effect motivation in the selected sample; if not, it would indicate the prevalence of financial intermediation and substitution motivation

2.3. Nonlinear Relationship between Bank Credit Extension and Trade Credit

Upon a comprehensive review of these theories, it becomes evident that the expansion of bank credits is a salient topic within theoretical frameworks. In other words, the efficiency of trade credit at the sectoral level is intrinsically tied to a robust banking credit system. The question of interest here is whether the continuous extension of bank credits in a country has a linear impact on trade credits. In other words, it is highly significant to determine which of the following approaches is more dominant: the Monetary Policy Effect proposed by Brechling and Lipsey [27] and Mateut et al. [47], the Financial Intermediation Theory claimed by Demirgüç-Kunt and Maksimovic [21] and Delannay and Weill [31], or the Substitution Theory developed by Petersen and Rajan [48], Petersen and Rajan [17], Hay and Loury [49], Love et al. [32], and Huang et al. [29]. This is an area where a significant gap exists. The hypothesis developed to test the nonlinear relationship between bank credit extension and trade credit is as follows:

Hypothesis 3. *There is a nonlinear relationship that exists between bank credit extension and trade credit.*

As part of a country's international trade and financial networks, an increase in bilateral trade can enhance the accessibility of trade credit, and past levels of trade credit can help predict current import levels. Similarly, past import levels can assist in predicting current trade credit levels. For instance, the fundamental function of trade credit is noted to facilitate cross-border transactions of goods and services, and the dependence of imports on trade credit is emphasized to vary across regions and income levels. Furthermore, the positive relationship between trade credit and imports holds greater significance for countries with higher reliance on trade credit [33]. Moreover, firms are more likely to engage in export or import activities during periods of lower bank credit constraints. In addition, firms with better credit ratings (typically associated with lower debt ratios and stronger financial performance) exhibit a higher propensity to engage in export and import activities [29,32,34].

2.4. Trade Credit and Import

Financial distress experienced in countries may not be limited to bank credit constraints alone. Financial crises, recessions, and even certain shocks in economic conditions can lead to certain reflexes in a country's understanding of international trade. Therefore, trade credits can serve as a cushion against certain financial strains. Based on this, it is argued that trade credits can act as a buffer against financial shocks, and their usage can increase parallel to the growth of imports. An increase in trade credits can alleviate the financial pressure arising from import demand and mitigate the adverse effects of shocks on the economy [35]. With regard to these approaches related to imports, the following hypothesis has been developed for testing:

Hypothesis 4. *There is a positive relationship that exists between trade credit and imports (In testing this hypothesis and throughout the analysis process, not only import volumes but also export volumes were incorporated into the model. However, due to exports not being as dominant and significant in the model as imports, the hypothesis has been predominantly tested through the lens of import data).*

2.5. Causal Relationship between Trade Credit and Macroeconomics Policies

Upon reviewing previous studies, it is observed that, in general, econometric models have been developed considering both internal financial factors and macroeconomic policies to analyze trade credit usage. However, these studies have mainly relied on coefficient estimation through multiple regression analysis and have not directly focused on the causal relationship between trade credit and macroeconomic policies. Consequently, there is a significant gap in causality analysis between trade credit and macroeconomic policies. This study aims to fill this gap by using the panel causality test, which is specifically designed for heterogeneous panels. In this regard, the following hypothesis is developed to examine the causal relationship between trade credit and macroeconomic policies:

Hypothesis 5. *There is a causal relationship between trade credit and macroeconomic policy.*

3. Literature Review

Recent studies, along with the fundamental theory and motivations presented in the theoretical background, have explored trade credit determinants in many developed and developing economies, yielding a variety of results and policy implications. These differences stem from methodologies, data periods, and regional factors. Four main categories of such research are highlighted (Table 1).

Table 1. Recent research on trade credit and macroeconomic policies.

Reference	Period	Study Area	Method	Interpretations
Trade Credit—Macroeconomics Policy nexus				
[7] Wu et al. (2021)	-	Theoretical model solution	Stackelberg model	Optimal procurement: trade credit and backorders in supply chain, based on CVaR.
[39] Dye and Yang (2015)		Theoretical model solution	Algorithm-Based Theoretical Analysis	Sustainability in trade credit and inventory management is explored, emphasizing credit periods and environmental regulations under Carbon Cap-and-Trade and Carbon Offset policies.
[35] Esposito and Hassan (2023)	1991–1999 1999–2007 1970–1979 1979–1989	9 countries	Regression Analysis	Import competition from China led U.S. firms to use more trade credit, which mitigated job losses by 8–27% amid borrowing constraints.
[50] Baños-Caballero et al. (2023)	1996–2013	34 countries	Panel Fixed Effect regression	In crises, trade credit mainly rises in weaker creditor protection; stability maintains trade credit consistency across protection levels, positively correlating with GDP and negatively with bank credit.
[9] Karakoç (2022)	2000–2014	9 countries	Panel System GMM	Trade credit, driven by liquidity and economic factors, connects to growth, fostering supplier adaptation through information sharing and enhancing market influence of expanding firms
[23] Machokoto et al. (2022)	1990–2019	72 countries	Panel Fixed Effect Regression	Firms show a significant decrease in trade credit, especially in developed economies, with listing decade, institutional factors, and financial development as key influencers.
[36] Arcuri and Pisari (2021)	2010–2019	Italy	Panel Fixed Effect Regression	An inverse correlation emerges between trade credit, GDP, and employment rate, shedding light on trade credit's determinants and its role in sustainable financing among medium-sized environmentally focused Italian green firms.
[38] Canto Cuevas et al. (2019)	2008–2014	12 countries	Panel Fixed Effect Regression	The business life cycle notably affects trade credit in young firms, showing stage-specific variations influenced by non-linear trends and diverse firm-specific factors.
[4] Tang and Moro (2020)	2008–2016	China	SEM and Regression	Increases in inventory and receivables are financed by bank credit and trade payables, especially in financially fragile firms, showing consistent substitution throughout cycles.
[2] Tingbani et al. (2022)	2005–2014	United Kingdom	Panel Fixed Effect Regression	A concave relationship between trade credit and corporate growth. While trade credits positively respond to financial crises, they contribute to the growth strategies of financially constrained firms
[51] Detthamrong and Chansanam (2023)	2001–2020	Thailand	Panel OLS and GMM estimation	Trade credit increases operating performance significantly, firms decide trade credit investment through cost-benefit analysis, commercial, financing, and transaction theories are valid.

Table 1. *Cont.*

Reference	Period	Study Area	Method	Interpretations
[52] Nam and Uchida (2019)	2004–2014	40 countries	Panel Regression Analysis	Trade payables significantly reduce Tobin's Q and inventory investment during the financial crises.
[8] McGuinness et al. (2018)	2003–2012	13 countries	Binary choice regression, Robust probit regression Panel GMM	Trade credit strongly improves survival, 1 standard deviation rise cuts 21% financial distress risk; financially robust SMEs extend more net trade credit.
[37] Huang et al. (2019)	2003–2017	China	Two-stage instrumental-variable regression method	Trade credit boosts growth, notably in firms with internal control; private enterprises rely more, strong correlation in limited financial access regions.
[25] Ekanayake and thaver (2021)	1980–2018	138 Developing Countries	panel conitegration panel causality	Causal FD-GROWTH links in regions, revealing direct and reciprocal associations in developing countries and certain datasets, except some regions.
[40] Ji et al. (2022)	1986–2020	China	Gregory–Hansen cointegrationVECM-Granger Causality	Sustainable growth, linking exports to GDP enhancement, import capacity, and bidirectional causality between GDP and imports.
[24] Hobbs et al. (2021)	1992–2016	Albenia	Cointergration and granger causality	Persistent FDI-trade-economic growth linkage; Granger tests confirm unidirectional causality. Short-term, economic growth spurs exports and FDI, but not vice versa.
[26] Kang (2021)	2005–2015	OECD and Non-OECD coutries	Panel conitegration test, panel causality	CO_2 emissions in global trade correlate with growth such as Environmental Kuznets Curve. Developed nations import CO_2 emissions, while developing export more.

The first strand of research focuses on the theoretical approach to trade credit. Wu et al. [7] proposed a solution using the Stackelberg model, specifically addressing optimal procurement of trade credit and backorders in the supply chain, based on CVaR. Dye and Yang [39] examined the interplay between sustainability, trade credit, and inventory management, focusing on the influence of credit periods and environmental regulations, particularly under Carbon Cap-and-Trade and Carbon Offset policies.

The second strand of studies emphasized the empirical determinants of trade credits within the context of developing and developed economies using panel data analyses. Tang and Moro [4], in their study covering 2008–2016, emphasized that Chinese SMEs predominantly finance increases in inventory and receivables through bank credit and trade payables. This trend is particularly noticeable in financially fragile firms, illustrating a consistent substitution across cycles. In another study centered on Chinese firms, Esposito and Hassan [35] found that import competition from China has driven U.S. companies to leverage more trade credit, subsequently mitigating job losses between 8–27% among borrowing constraints. Moreover, the role of trade credits becomes especially salient during crises. Baños-Caballero et al. [50], in their research spanning from 1996 to 2013 across 34 countries, underscored that during crises, trade credit primarily rises in environments with weaker creditor protection. Stability, however, ensures trade credit consistency across different levels of protection, based on its positive correlation with GDP and inverse correlation with bank credit. The prominence of trade credits and their pivotal role in protecting creditors during financial shocks highlight their essential contribution to economic resilience. Canto Cuevas et al. [38] emphasized in their investigation of countries, including Austria, Belgium, Germany, Spain, Finland, France, Greece, Ireland, Italy, the Netherlands, Portugal, and Slovenia from 2008 to 2014, that the business life cycle significantly influences trade

credit for young firms. This effect exhibits stage-specific variations steered by nonlinear trends and a plethora of firm-specific factors. While the impacts of trade credits vary at the firm level, discrepancies also exist between country groups. Machokoto et al. [23], in their comprehensive analysis covering 72 countries from 1990 to 2019, posited that the decline in trade credit is more accentuated in advanced economies. Their hypotheses spotlight the listing decade, institutional frameworks, and financial progression as decisive factors, revealing diminished advantages in developed economies, notably the U.S., juxtaposed against their emerging counterparts.

The third strand examines the impact of trade credit on firm performance and sustainable growth. In particular, in developing countries, trade credit is valuable in terms of financial success. In this line, Detthamrong and Chansanam's [51] research spanning 2001–2020 on Thailand affirmed that trade credit significantly enhances firm performance and that firms' decisions on trade credit rely on cost-benefit analysis, underscoring the validity of commercial, financing, and transaction theories. Similarly, Huang et al. [37], examining Chinese firms between 2003 and 2017, found that trade credit enhances sustainable growth rates, especially in firms with strong internal controls, and observed a greater reliance by private enterprises in regions with limited financial access. McGuinness et al. [8] conducted a study on countries including Belgium, Finland, France, Germany, Greece, Hungary, Ireland, Italy, Latvia, Poland, Portugal, Spain, and the United Kingdom between 2003 and 2012. They indicated that trade credit investment significantly enhances a firm's survival, with a one standard deviation increase mitigating the risk of financial distress by 21%, and financially robust SME's tend to extend more net trade credit. On the other hand, Nam and Uchida [52] analyzed data from 40 countries between 2004 and 2014 and found that trade payables significantly reduce Tobin's Q and inventory investment during financial crises. Thus far, trade credit's significance for various country groups and firms has been demonstrated. However, one of the most important issues is whether there is a linear relationship between trade credit and firm performance. Tingbani et al. [2], examining the United Kingdom from 2005 to 2014, discovered a concave relationship between trade credit and corporate growth: it is positive at lower levels but negative at higher levels; moreover, while trade credit shows a positive response during financial crises, it supports the growth strategies of financially constrained firms.

The fourth strand of research focuses on trade credits in relation to macroeconomic policies and the impacts of international trade on macroeconomic indicators, yielding various outcomes. For instance, Karakoç [9] examined the period from 2000 to 2014 in nine developed countries, positing that slow-growing economies tend to increase trade credits under adverse debt conditions. Similarly, Machokoto et al. [23], in their study covering 72 countries over the 1990–2019 period, found that trade credit yields decrease, with this trend being notably stronger in developed economies such as the U.S. than in emerging markets. Arcuri and Pisani [36] identified that in Italian green firms, trade credits are negatively impacted by economic growth, short-term bank credits, and employment rates, while finding no relationship with long-term bank credits. On the other hand, Baños-Caballero et al. [50], analyzing the period from 1996 to 2013 across 34 countries, contend that there is no significant impact of economic growth and bank credits on trade credits. Ekanayake and Thaver [25] identified direct and reciprocal FDI and economic growth links in many developing nations, although some regions deviated. Ji et al. [40] highlighted the bidirectional causality between China's economic growth and imports, linking exports to GDP growth. Meanwhile, Hobbs et al. [24] validated unidirectional causality in Albania, where economic growth stimulates exports and foreign direct investment but not vice versa. Kang [26] emphasized the Environmental Kuznets Curve-like relationship in global trade's CO_2 emissions, with developed nations being net importers of emissions.

As presented throughout the literature review, studies have been conducted by considering the internal financial factors of firms from the respective countries and by adding macroeconomic factors to econometric models. From this perspective, no study has examined trade credit on a sectoral basis. However, no study has examined the relationship

between bank credit extension and trade credit using a nonlinear approach. Specifically, this study aims to elucidate the relationship between the expansion of bank loans and trade credits using a non-linear model and seeks to contribute to a well-functioning banking sector in EU countries. Simultaneously, when uncovering the relationship between trade credit and macroeconomic indicators and explaining their connection with the banking system, it is observed that not only the policies of EU countries but also country-specific policies are not extensively discussed in the literature. Separately evaluating country-specific results holds distinct importance in terms of heterogeneity and cross-sectional dependence. From this perspective, to the best of our knowledge, the literature addressed has employed panel linear regression methods for trade credit, neglecting long-term cointegration relationships, cross-sectional dependence, and causality analysis. Therefore, this study, spanning 2005Q1 to 2019Q2, examines the interplay between trade credit, bank credit expansion via a nonlinear approach, economic growth, and imports in non-financial sectors across 15 European countries, offering the first insights into sectoral heterogeneity, cross-sectional dependence, second-generation long-term cointegration, and causality for heterogeneous panels. In this respect, this study aims to fill an important gap in the literature.

4. Data, Variables, and Research Methodology

4.1. Sample and Data

This study, aiming to uncover the relationship between trade credit and macroeconomic indicators, comprises a sample of 15 European countries (Austria, Belgium, Czech Republic, Finland, France, Germany, Greece, Italy, Luxembourg, Netherlands, Poland, Portugal, Spain, Sweden, UK) with sector data available for 58 quarterly periods within the time interval of 2005Q1 to 2019Q2. The data on trade credit and economic growth are obtained from the EUROSTAT database using the NASQ_10_NF_TR code and ESA (2010) Quarterly National Accounts, while the data on bank credit, import, and total manufacturing product are obtained from the FRED Economic Database, resulting in a balanced panel dataset.

4.2. Variables

As presented in Table 2, the dependent variable of the study is comprised of trade credit, calculated as trade credit and advances to total assets (percentage of gross domestic product-GDP). This indicator is frequently used in the literature and serves as a representative variable for trade credit [15,17,28,44,53,54]. The study incorporates three key independent variables. First, gross domestic product (GDP) is employed as a measure of economic growth, as developed by Demirgüç-Kunt and Maksimovic [21], Machokoto et al. [23], Huang et al. [29], Ghoul and Zheng [30], and Niskanen and Niskanen [28], using Chain linked volumes (2010), million Euro at market prices format. Second, the measure of bank credit extension, denoted as CREDIT, is utilized, as developed by Demirgüç-Kunt and Maksimovic [21], Mateut et al. [47], Delannay and Weill [31], Love et al. [36], and Huang et al. [29], and is presented as Credit to Private Non-Financial Sector by Banks (% of GDP). Third, the IMPORT variable, addressed by Jinjarak [33], Muüls [34], Love et al. [32], Huang et al. [29], and Esposito and Hassan [35], represents imports of goods and services. All variables are used in their natural logarithmic form. TMP represents total manufacturing production and is used as a control variable since trade credit is directly related to the production of goods and services.

Table 2. Definitions of the main variables.

Variables	Classification	Defininiition
REC	Unit	Percentage of gross domestic product (GDP)
	Sector	Non-financial corporations
	Financial Position	Assets
	Item	Trade credits and advances
	The source of data	Eurostat
GDP	Unit	Chain-linked volumes (2010), million euro
	Item	Gross domestic product at market prices
	The source of data	Eurostat
CREDIT	Unit	Credit to the Private Non-Financial Sector by Banks
	Frequency	Quarterly, End of Quarter
	The source of data	FRED Graph Observations, Federal Reserve Economic Data
IMP	Unit	Import (% of GDP)
	Frequency	Quarterly
	The source of data	FRED Graph Observations, Federal Reserve Economic Data
TMP	Unit	Total Manufacturing Production
	Frequency	Quarterly
	The source of data	FRED Graph Observations, Federal Reserve Economic Data

Source: Own elaboration.

4.3. Descriptive Statistics

Table 3 presents the descriptive statistics for five pivotal economic indicators: Trade Credit, GDP, Bank Credit, and Import values as well as Total Manufacturing Production. It illustrates that the average Trade Credit is observed at 3.017, with the middlemost value resting at 3.250. For GDP, the mean and median values are noted at 11.661 and 11.450, respectively. With regard to Bank Credit, the data reflect an average of 4.460 and a median of 4.510. Lastly, the mean value for imports stands at 3.563, coinciding with a median of 3.460.

Table 3. Descriptive Statistics.

	REC	GDP	CREDIT	IMPORT	TMP
Mean	3.017	11.661	4.460	3.563	4.618
Median	3.250	11.450	4.510	3.460	4.610
Maximum	4.110	13.530	5.130	4.530	4.980
Minimum	0.410	9.060	3.240	2.910	3.940
Std. Dev.	0.803	1.135	0.349	0.419	0.130
Skewness	−1.448	−0.130	−0.797	0.706	−0.582
Kurtosis	4.464	2.333	3.844	2.379	5.751
Jarque-Bera	381.75 [a]	18.55 [a]	117.94 [a]	86.25 [a]	323.48 [a]

Source: Based on data provided by author. "a" indicates the statistical significance at 1 percent level. Note: This table shows the values of descriptive statistics of the variables used in the analysis. Data are quarterly and from 2005Q1 to 2019Q2. REC, Trade credit as a percentage of GDP, which is measured as gross domestic product at market prices. CREDIT, Credit to Private Non-Financial Sector by Banks, IMP: Imports as a percentage of GDP, TMP, Total Manufacturing Production.

As delineated in Table 3, in the non-financial sector in Europe, trade credits were on a consistently declining trend from 2008 to 2016. However, they gained significant momentum after 2016. In parallel, a substantial extension in bank credits was observed

between 2006 and 2010, which then stabilized for two years, and the rate of extension in bank credits has been decelerating until recent years. On the other hand, a continual upward trend in Europe's GDP has been notable. In terms of imports, a significant decrease was observed during the financial crisis years of 2007, 2008, and 2009, while recent years have witnessed a continued trend of increase in imports.

A Pearson correlation matrix is conducted to discern the relationships among trade credit, economic growth, bank credit extension, imports, and total manufacturing products. The Pearson correlation matrix elucidates these associations, while also providing indications of potential multicollinearity. Upon the analysis of Table 4, it becomes clear that multicollinearity does not pose an issue as no high correlations between the independent variables are observed. The presence of multicollinearity in the model is examined not only through the correlation matrix but also using VIF and 1/VIF values. Given the results of VIF 1.23 and 1/VIF 0.811 for CREDIT; VIF 1.25 and 1/VIF 0.798 for GDP; and VIF 1.50 and 1/VIF 0.666 for IMPORT and VIF 1.21 and 1/VIF 0.827 for TMP, it can be concluded that the model does not exhibit multicollinearity issues.

Table 4. Correlation Matrix.

Variables	REC	GDP	CREDIT	IMPORT	TMP
REC	1.000				
GDP	−0.164	1.000			
CREDIT	−0.120	0.091	1.000		
IMPORT	0.258	−0.478	−0.341	1.000	
TMP	0.047	0.055	0.176	−0.258	1.000

4.4. Model and Methodology

Through the reviewed literature and the variables presented in previous sections, this study aims to examine the relationship between trade credit usage and economic growth, bank credit extension, and imports (Model 1), as well as uncover the nonlinear relationship between trade credit and bank credit (Model 2). Accordingly, the formulation of Model 1 is as follows:

$$REC_{it} = \varphi_0 + \varphi_1 GDP_{it} + \varphi_2 CREDIT_{it} + \varphi_3 IMPORT_{it} + u_{it} \quad (1)$$

Here, REC_{it} is trade credit and advances to total assets (% of GDP), GDP_{it} is Log of million Euro at market prices based on chain-linked volumes (2010), $CREDIT_{it}$ is Credit to Private Non-Financial Sector by Banks (% of GDP), $IMPORT_{it}$ is a log of import of goods and services. The developed Model 2 is as follows:

$$REC_{it} = \varphi_0 + \varphi_1 CREDIT_{it} + \varphi_2 CREDIT^2_{it} + \varphi_3 TMP_{it} + u_{it} \quad (2)$$

Here, REC_{it} is calculated as in Model 1, but in order to capture the nonlinear relationship between trade credit and bank credit, the measure of bank credit extension $CREDIT^2$ is included in the model, calculated as the square of Credit to Private Non-Financial Sector by Banks (% of GDP). TMP_{it}, represents the logarithm of the total manufacturing production of the sectors. REC and GDP are derived from the Eurostat database, while CREDIT, IMPORT, and TMP are obtained from the Federal Reserve Economic Database (both Model 1 and Model 2 have been rigorously constructed and thoroughly evaluated through extensive analysis. During the formation of Models 1 and 2, variables such as inflation, interest, and exports within the scope of foreign trade were placed in the models in different combinations based on literature references. However, these variables were omitted from the models as they did not show a significant impact on the 15 non-financial sectors in Europe).

The creation of two distinct models in this study, Model 1 and Model 2, is driven by specific analytical considerations. The need to account for the unique importance of TMP in identifying the nonlinear model and the absence of any consequential impact from

importation in the same necessitated such a separation. Thus, delineation into two models was critical to accurately capture these dynamics.

Due to the European Union (EU) countries' adherence to the EU constitution as well as their economic interdependence through the Maastricht Treaty and the Lisbon Treaty, it is likely that the countries within the EU exhibit heterogeneity and cross-sectional dependence. Based on this reason, this study examines the existence of cross-sectional dependence among countries using the LM test of Breusch and Pagan [55], the CD_{LM} and CD test of Pesaran [56], and the LM_{adj} test of Pesaran et al. [57]. In addition, slope homogeneity is examined with the Δ~ and Δ~ adj test of Pesaran and Yamagata [58]. In the second step, the stationary of the variables pertaining to the countries was tested using the IPS unit root test suitable for heterogeneous panels developed by Im. et al. [59], as well as the CIPS panel unit root test developed by Pesaran [60], which takes into account both heterogeneity and cross-sectional dependence.

The Panel IPS test statistic takes the average of all individual ADF test statistics. The hypotheses developed for the IPS test statistic are as follows:

$$H_0 = \rho_i = 1 \tag{3}$$

$$H_a = \rho_i < 1 \tag{4}$$

The Panel IPS Test is based on the following model:

$$\Delta Y_{it} = \rho_i Y_{it-1} + \sum_{L=1}^{p_i} \varnothing_{iL} Y_{it-L} + \mu_i' \gamma + u_{it} \tag{5}$$

Here, the *t*-statistic represents the average of individual ADF statistics and can be expressed as follows:

$$\bar{t} = \frac{1}{N} + \sum_{i=1}^{N} t_{pi} \tag{6}$$

where, t_{pi} in the equation represents individual ADF statistics. Additionally, to test the hypotheses, instead of using the standard normal t-distribution, a $\bar{t}$ statistic is obtained by taking the arithmetic mean of the calculated t-values for each group.

$$t_{IPS} = \frac{W_{\bar{t}}\left(\sqrt{N}\left(\frac{1}{N}\sum_{i=1}^{N} t_{iT}\right) - \frac{1}{N}\sum_{i=1}^{N} E\left[t_{iT} I \rho_i = 1\right]\right)}{\left(\sqrt{\frac{1}{N}\sum_{i=1}^{N} var[t_{iT} I \rho_i = 1]}\right)} \tag{7}$$

Thus, the Panel IPS test statistic, t_{IPS}, has been calculated and obtained as described above.

Pesaran [60] proposed a simple model to eliminate cross-sectional dependence. He extended the classic ADF model by adding lagged cross-sectional means. Thus, the difference ADF model became the Cross-Section Augmented Dickey Fuller (CADF) model. The null and alternative hypotheses of the test are derived as follows:

$$\begin{aligned} H_0 = &\quad \beta_i = 0 \text{ (Series non} - \text{stationary)} \\ H_a = &\quad \beta_i < 0 \text{ (Series stationary)} \end{aligned}$$

The simplified form of the CADF regression model is as follows:

$$\Delta Y_{it} = \alpha_i + \rho_i^* Y_{it-1} + d_0 \overline{Y}_{t-1} + d_1 \overline{Y}_t + \varepsilon_{it} \tag{8}$$

The expanded model with the inclusion of lagged first differences are presented as follows:

$$\Delta Y_{it} = \alpha_i + \rho_i^* Y_{it-1} + d_0 \overline{Y}_{t-1} + \sum_{j=0}^{p} d_{j+1} \Delta \overline{Y}_{t-j} + \sum_{k=1}^{p} c_k \Delta Y_{i,t-k} \varepsilon_{it} \tag{9}$$

The CADF test is applicable in both cases where T > N and N > T. The computed test statistics are compared with the critical values from Pesaran's [60] CADF table to obtain the results of stationary tests for each unit. If the CADF critical value is greater than the CADF statistic, the null hypothesis is rejected, indicating that only the series of that unit is stationary. For the entire panel, the stationary test result is obtained using the cross-sectionally augmented IPS (CIPS) test. The CIPS test statistic is calculated by taking the arithmetic average of the CADF test statistics.

$$CIPS = \frac{1}{N}\sum_{i=1}^{N} CADF_i \tag{10}$$

In the third step, the panel cointegration test developed by Pedroni [61] is used to determine the long-run relationship between variables and develop seven statistics with the null hypothesis of "no cointegration". While Pedroni [61] utilizes the ADF (Augmented Dickey-Fuller) and PP (Phillips-Perron)-based integration equation, these characteristics are also considered in the Kao [62] test based on the ADF approach. Therefore, in this study, both first-generation tests are examined under the "no-integration" hypothesis. However, first-generation cointegration tests are unable to generate reliable results in the presence of cross-sectional dependence. Therefore, the second-generation cointegration test, the panel cointegration test proposed by Westerlund [63], addresses this issue and eliminates the problem. Westerlund's [63] panel cointegration test offers several advantages due to its ability to handle heterogeneity and cross-sectional dependence through the use of bootstrap techniques developing the usual Newey-West [64] study. Unlike other tests, it is based on structural dynamics and does not rely on common factor restriction. Additionally, the test statistics exhibit a normal distribution and demonstrate favorable properties in small sample scenarios. The testing procedure involves four statistics (Gt, Gα, Pt, Pα) used to assess the null hypothesis of "no cointegration". The mean-group statistics (Gt and Gα) are calculated assuming unit-specific error correction parameters, while the remaining two statistics are computed under the assumption of common error correction parameters across different cross-sections.

In the fourth step, using the Augmented Mean Group (AMG) estimator devised by Eberhardt and Bond [65], and Bond and Eberhardt [66], this study considers cross-sectional dependence and country-specific heterogeneity among countries. Thus, by considering cross-sectional dependence and heterogeneity, the Panel AMG (Autoregressive Distributed Lag) method generates results that contribute to the robustness of the relationships among trade credits, sustainable economic growth, bank credit expansion, and imports. This is especially pertinent considering the presence of cross-sectional dependence and heterogeneity in non-financial sectors across Europe. This methodology's other merit is its ability to scrutinize non-stationary variables' parameters, thereby eliminating the need for preliminary testing methods such as unit root or cointegration. Moreover, research employing the Panel AMG method to explore the aspects of macroeconomic factors and provide insights into a range of issues is of significant importance [67,68].

The initial stage of the evaluation procedure includes estimating the primary panel model, as represented by Equations (1) and (2), using a first-differenced format, along with a dummy variable for the T-1 period. For model 1, the Panel AMG procedure is as follows;

$$\Delta REC_{it} = \gamma_1 \Delta GDP_{it} + \gamma_2 \Delta CREDIT_{it} + \gamma_3 \Delta IMPORT_{it} + \sum_{t=2}^{T} p_t(\Delta D_t) + u_{it} \tag{11}$$

In Equation (11), ΔD_t represents the first differences of T-1 period dummies, with p_t denoting the parameters correlated with these period dummies. In the succeeding phase, the estimated p_t parameters undergo a transformation to form the φ_t variable. This variable serves as an indicator of a shared dynamic process as follows;

$$\Delta REC_{it} = \gamma_1 \Delta GDP_{it} + \gamma_2 \Delta CREDIT_{it} + \gamma_3 \Delta IMPORT_{it} + d_i(\varphi_t) + u_{it} \tag{12}$$

$$\Delta REC_{it} - \varphi_t = \gamma_1 \Delta GDP_{it} + \gamma_2 \Delta CREDIT_{it} + \gamma_3 \Delta IMPORT_{it} + u_{it} \quad (13)$$

Initially, the group-specific regression model was tailored to align with φ_t. Subsequently, an arithmetic mean of the parameters derived from this group-specific model is calculated. For example, the parameter related to Gross Domestic Product (γ_1) can be computed as follows:

$$\gamma_{1,AMG} = 1/N \sum_{i=1}^{N} \gamma_{1,i} \quad (14)$$

For Model 2, the investigation of the Panel AMG and individual effects is executed in a manner analogous to the procedure implemented for Model 1.

Finally, this study employs the heterogeneous panel causality methodology of Dumitrescu and Hurlin [69] to investigate causal relationships between variables. This method examines the causal relationships among trade credits, sustainable economic growth, bank credit expansion, and imports in the 15 non-financial sectors in Europe, which exhibit both heterogeneity and cross-sectional dependence. It adapts well to the dataset of this study, providing a comprehensive analysis of these dynamics.

This approach is a modified Granger causality technique designed for heterogeneous panel data. Furthermore, Monte Carlo simulations have demonstrated its ability to deliver consistent results among the cross-sectional dependency. The statistical computation is carried out as follows:

$$W_{N,T}^{HNC} = \frac{1}{N} \sum_{i=1}^{N} W_{i,T} \quad (15)$$

$$Z_{N,T}^{HNC} = \sqrt{\frac{N}{2K}\left(W_{N,T}^{HNC} - K\right)} \rightarrow N(0,1) \quad (16)$$

where, $W_{i,T}$ represents the Wald statistic, and the $Z_{N,T}^{HNC}$ statistic is derived from the mean of all Wald statistics across cross-sections. The testing process involves comparing the null hypothesis of "no homogeneous causality" against an alternative hypothesis asserting heterogeneous causal relationships.

5. Results and Discussion

5.1. Baseline Results

In the first step of the analysis, cross-section dependency and country-specific heterogeneity are examined, and the results are presented in Table 5. Upon examining the results, it is observed that there is no cross-section dependency among the countries, as the null hypothesis of no cross-section dependency is rejected in all tests. This implies that shock occurring in one country of the panel is felt and transmitted to other countries. On the other hand, the homogeneity test for Models 1 and 2 indicates heterogeneity among the countries.

Table 5. Cross-sectional dependence and slope homogeneity.

	REC	GDP	CREDIT	IMPORT	TMP
Cross—Sectional Dependence					
LM	181.213 [a]	338.624 [a]	203.440 [a]	279.416 [a]	166.818 [a]
CD_{LM}	5.259 [a]	16.122 [a]	6.793 [a]	12.036 [a]	4.266 [a]
CD	−1.954 [b]	−1.922 [b]	−3.552 [a]	−1.244 [c]	−2.673 [a]
LM_{adj}	9.825 [a]	48.374 [a]	4.252 [a]	51.022 [a]	2.357 [a]
Homogeneity					
	Model I		Model II		
$\hat{\Delta}$	33.48 [a]	[0.000]	35.637 [a]	[0.000]	
$\hat{\Delta}_{adj}$	35.32 [a]	[0.000]	37.250 [a]	[0.000]	

Note: "a, b, and c" indicate the statistical significance at 1, 5, and 10 percent levels, respectively.

In the subsequent step, unit root analyses of the variables are conducted using a Cross-Sectionally Augmented IPS (CIPS) test, which allows for the cross-section dependency. In addition, for comparison and reinforcement of the results, first-generation methods such as the Levin-Lin-Chu (LLC) and Im-Pesaran-Shin (IPS) tests, developed by [70] and [59], respectively, were also employed and are presented in Table 6. This Table reveals that the LLC and IPS tests indicate the presence of unit roots in some variables under both trend and intercept models, while some variables do not exhibit unit roots. However, considering the presence of cross-section dependency in the variables, the CIPS results are considered. According to the CIPS test, the null hypothesis of a unit root process is accepted at a significance level of 1% for all variables in both the level and trended model. However, when the first differences of the variables are taken, the CIPS test clearly rejects the null hypothesis at a 1% significance level, indicating that all variables are [stationary/non-unit root].

Table 6. Panel Unit Root Analysis.

	LLC		IPS		CIPS	
Level	***t*-Stat ***	***t*-Stat ****	**W-Stat ***	**W-Stat ****	***t*-Stat ***	***t*-Stat ****
REC	−0.614	0.879	−1.476 [c]	−1.194	−1.920	−2.420
GDP	2.103	1.108	2.584	−3.862 [a]	−1.231	−1.934
CREDIT	−11.222 [a]	−3.802 [a]	−5.276 [a]	1.060	−0.985	−1.911
IMPORT	−2.300 [a]	−1.602 [b]	−4.468 [a]	−4.881 [a]	−1.676	−2.310
TMP	−1.366 [c]	−0.600	−1.368 [c]	−2.525 [a]	−2.130	−2.243
First Difference						
ΔREC	−24.171 [a]	−25.163 [a]	−24.291 [a]	−24.930 [a]	−5.803 [a]	−5.883 [a]
ΔGDP	21.355	26.831	−7.484 [a]	−5.923 [a]	−3.275 [a]	−3.343 [a]
ΔCREDIT	−11.431 [a]	−19.836 [a]	−13.694 [a]	−19.282 [a]	−4.238 [a]	−4.657 [a]
ΔIMPORT	−17.641 [a]	−16.886 [a]	−17.699 [a]	−16.087 [a]	−6.471 [a]	−6.500 [a]
ΔTMP	−3.065 [a]	1.042	−11.018 [a]	−9.564 [a]	−7.056 [a]	−5.247 [a]

Note: "a, b, and c" indicate the statistical significance at 1, 5, and 10 percent levels, respectively. * with intercept no trend, ** with intercept and trend.

The fact that the unit root tests indicate stationary at the $I(1)$ level for all variables raises the question of whether there exists long-term cointegration among the variables. To explore this, first-generation panel cointegration tests, namely Pedroni [61] and Kao [62] panel cointegration tests, were employed in the initial stage (Table 7). The Pedroni [61] ADF-based and PP-based tests, as well as the Kao [62] ADF-based test statistics and significances, were used to test the null hypothesis of "no-cointegration". However, these tests may yield weak results as they do not account for the cross-section dependency. Hence, in the second stage, the second-generation panel cointegration test proposed by Westerlund [63], which considers cross-section dependency, was used under the null hypothesis of "no-cointegration". The test statistics G_tau, G_alpha, P_tau, and P_alpha, along with their significance levels, are presented in Table 6 and compared with the results of the first-generation panel cointegration tests. Examining the results for Model 1, the Pedroni [61] ADF-based and PP-based tests as well as the Kao [62] ADF-based test statistics indicate significance at the 1% level, suggesting the existence of a long-term relationship among the variables. Additionally, the G_tau, G_alpha, and P_tau test statistics are significant at the 5% level, indicating a long-term cointegration among the variables under cross-section dependency. In Model 2, the Pedroni [61] ADF-based and PP-based tests, as well as the Kao [62] ADF-based test statistics, reveal significance at the 5% level, implying the presence of a long-term relationship among the variables. However, except for the G_tau test statistic, the other test statistics suggest the absence of long-term cointegration among the variables in Model 2. The disparities in these results stem from the assumptions of the error correction parameter estimation conducted for the panel and group. Fortunately, in this study, the weak form of the long-term relationship was not a significant issue as

Panel AMG estimation, which does not require pre-testing procedures such as unit root and cointegration, was preferred for estimating the long-term coefficients.

Table 7. Panel Cointegration Analysis.

Cointegration Tests	Model I		Model II	
	Statistic	*p*-Value	Statistic	*p*-Value
Pedroni—ADF	−2.176 [a]	0.014	−1.806 [b]	0.035
Pedroni—PP	−4.000 [a]	0.000	−3.415 [a]	0.000
Kao—ADF	−4.750 [a]	0.000	−1.859 [b]	0.031
G_tau	−5.129 [a]	0.001	−3.099 [c]	0.068
G_alpha	−3.629 [b]	0.035	−0.894	0.491
P_tau	−5.142 [b]	0.034	−3.080	0.194
P_alpha	−1.948	0.437	−0.938	0.593

Note: Pedroni-ADF, Pedroni-PP, and Kao-ADF indicate ADF-based, PP based test of Pedroni [61] and ADF-based test of Kao [62], respectively. Gt, Ga, Pt, and Pa stand for the cointegration test of Westerlund [63]. "a, b, and c" indicate statistical significance at the 1, 5, and 10 percent levels, respectively.

After examining the cointegration relationship among the variables using Table 5, the coefficient estimates are presented to determine the effects and direction of the relationship between trade credit and macroeconomic factors, as well as the hypothesis of credit extension. The levels of the impact of macroeconomic factors on trade credit are separately presented for two models and using the FMOLS-MS, DOLS-MG, and AMG methods in Table 8.

Table 8. Panel Mean Group Estimation Results.

	Model I			Model II		
	FMOLS-MG	DOLS-MG	AMG	FMOLS-MG	DOLS-MG	AMG
GDP	0.550 [a] [0.078]	0.409 [a] [0.093]	0.236 [c] [0.136]	-	-	-
CREDIT	−0.092 [c] [0.048]	−0.104 [c] [0.057]	−0.237 [a] [0.087]	−2.415 [a] [0.947]	−7.809 [b] [3.535]	−1.509 [a] [0.770]
$CREDIT^2$	-	-	-	0.262 [b] [0.107]	0.901 [b] [0.394]	0.156 [c] [0.093]
IMPORT	0.227 [a] [0.047]	0.180 [a] [0.057]	0.170 [b] [0.082]	-	-	-
TMP	-	-	-	0.410 [a] [0.051]	1.070 [a] [0.131]	0.311 [a] [0.087]

Note: "a, b, and c" indicate the statistical significance at 1, 5, and 10 percent levels, respectively. Numbers in brackets are standard errors.

In model 1, developed to reveal the relationship between trade credit and economic growth, bank credit extension, and imports, it is found that the coefficients are significantly positive at a 10% level for GDP in the overall panel. These results support the motivation of the external sources access put forward by Demirgüç-Kunt and Maksimovic [21] and Machokoto et al. [23] confirm the validity of Hypothesis 1. It can be concluded from the results that the limitations on bank loans due to state ownership of the banking system, coupled with limited access to external resources in developing and developed countries, push firms toward the use of trade credit. In the overall panel, CREDIT is significantly negative at a 1% level, supporting the view of Brechling and Lipsey [27] and Mateut et al. [47] with the motivation of the monetary policy effect and confirming Hypothesis 2. Thus, the validity of Monetary Policy Motivation is evident in all panels. When considering GDP and CREDIT in the overall panel, during periods when a tight monetary policy is implemented, banking credit restrictions in countries seem to push firms towards increasing their reliance on trade credits, and an increase in trade credits during these periods is observed. Finally, IMPORT is significantly positive at a 5% level, aligning with the motivation that large firms' trade credit and manufacturing activities move in a positive direction, as proposed by Jinjarak [33], Muüls [34], Love et al. [32], Huang et al. [29], and Esposito and Hassan [35]. Therefore, Hypothesis 3 is accepted. It is noteworthy that countries' import activities are carried out through trade credits.

On the other hand, Model 2, which examines whether the relationship between bank credit extension and trade credit is linear in an economy, provides the results shown in Table 5. When examined using FMOLS-MS, DOLS-MG developed by Pedroni [71,72], and Panel AMG methods in the overall panel, it is observed that the relationship between bank credit extension and trade credit, controlled for the total manufacturing production, is "U-shaped", confirming Hypothesis 4. From this observation, it can be concluded that during periods of tight monetary policy implementation, when bank credit is constrained, firms tend to increase their usage of trade credit among themselves. During periods of eased monetary policy, the extension of bank credit reduces firms' appetite for extending trade credit to their customers. When monetary tightening is lifted and intensive bank credit usage occurs, the level of trade credit provision reaches a minimum level. Up to this stage, it can be said that the monetary policy effect proposed by Brechling and Lipsey [27] and Mateut et al. [47] is valid across the 15 European countries. However, beyond this point, firms that continue to rely on more bank credit enter into a search for a new role due to high interest rates and transaction costs. The positive relationship between bank credit extension and trade credit beyond a certain threshold indicates that firms operate under the financial intermediation motivation proposed by Demirgüç-Kunt and Maksimovic [21]. When examining the results in general, it is observed that in EU countries, bank credit usage is negatively correlated with trade credits under the influence of a tight monetary policy effect and positively correlated with economic growth via access to external sources. Furthermore, a non-linear relationship between bank credit expansion and trade credit has been identified. However, at this juncture, it is crucial to ascertain which countries diverge from the prevailing policy within the EU and to determine the necessary measures to be adopted in these countries. From this perspective, a robustness check is employed to answer these questions.

5.2. Robustness Check

In this stage of the study, in order to enhance the robustness of the research, the relationships between trade credit and economic growth, credit extension, and imports (Model 1), as well as the nonlinear relationships between trade credit and credit extension (Model 2), are examined at the country level and analyzed in Table 6. The use of the Panel AMG estimator provides country-specific results that not only reveal the relationship between trade credit and economic policies at the European level but also contribute to increasing the level of originality in this study.

When examining the results of Model I Individual Panel AMG Estimation Analysis in Table 9, it is observed that in terms of trade credit policy, GDP is insignificant for Austria, Greece, the Netherlands, Poland, and Sweden. However, GDP is positive and significant for Belgium, Finland, France, Italy, Luxembourg, and Spain. These findings support the views proposed by Demirgüç-Kunt and Maksimovic [21] and Machokoto et al. [23], indicating the validity of Hypothesis 1 for these countries compatible for all panels. In these countries, during periods when developed nations faced challenges accessing external resources, the utilization of trade credit can be confirmed to be effective. On the other hand, the GDP is negative and significant for the Czech Republic, Germany, Portugal, and the UK. These results suggest the rejection of Hypothesis 1 in these countries, supporting the substitution effect and countercyclical motivation put forward by Niskanen and Niskanen [28], Huang et al. [29], and Ghoul and Zheng [30]. It has been observed that, during periods of economic slowdown or recession, firms undertake a financial intermediation role, circumventing economic hardships by utilizing trade credits. It can also be posited that in developed countries, there is a tendency to resort to trade credit usage to overcome the challenges posed by intense international competition. However, in these countries (supporting the substitution effect and countercyclical motivation), it is important whether adopting policies divergent from those generally implemented across the panel resulted in sustainable economic growth. The impact of such a divergence can be elucidated by examining their responses to the expansion of bank loans. In Table 9, it has been determined

that bank credit extension has no significant effect on trade credit in Austria, the Czech Republic, Germany, Greece, Poland, and the UK, as the CREDIT is found to be insignificant, similar to GDP. The lack of response from Austria, Poland, and Greece to economic growth and the expansion in bank loans can be explained either by limited access to credit or by the inefficiency of firms in their financial intermediation role. While the Czech Republic, Germany, and the UK remain unresponsive to bank loans in their trade credit policy, they are distancing themselves from trade credit in terms of economic growth and international competitive conditions.

Table 9. Model I Individual Panel AMG Estimation Analysis.

	GDP	CREDIT	IMPORT
Austria	0.045	−0.389	1.133 [a]
	[0.351]	[0.305]	[0.202]
Belgium	0.889 [a]	−0.171 [b]	0.168 [c]
	[0.174]	[0.070]	[0.103]
Czech Republic	−0.333 [a]	−0.055	0.261 [a]
	[0.129]	[0.066]	[0.089]
Finland	0.564 [a]	−0.588 [a]	0.029
	[0.145]	[0.112]	[0.072]
France	0.442 [b]	−0.339 [a]	−0.139 [c]
	[0.184]	[0.127]	[0.075]
Germany	−0.408 [a]	−0.241	0.285 [a]
	[0.133]	[0.155]	[0.069]
Greece	0.406	−0.069	−0.367 [c]
	[0.281]	[0.150]	[0.208]
Italy	1.166 [a]	0.201 [b]	−0.015
	[0.343]	[0.102]	[0.140]
Luxembourg	0.619 [c]	−0.578 [a]	0.166
	[0.347]	[0.175]	[0.192]
Netherlands	0.034	−0.473 [a]	0.248 [b]
	[0.239]	[0.143]	[0.103]
Poland	−0.067	0.064	0.109
	[0.076]	[0.043]	[0.113]
Portugal	−0.326 [c]	0.303 [a]	0.198 [a]
	[0.179]	[0.041]	[0.074]
Spain	0.980 [a]	−0.130 [a]	0.113
	[0.153]	[0.049]	[0.071]
Sweden	−0.007	−1.020 [a]	0.323 [a]
	[0.120]	[0.133]	[0.116]
United Kingdom	−0.453 [a]	−0.072	0.048
	[0.156]	[0.113]	[0.072]
PANEL	0.236 [c]	−0.237 [a]	0.170 [b]
	[0.136]	[0.087]	[0.082]

Note: "a, b, and c" indicate the statistical significance at 1, 5, and 10 percent levels, respectively. Numbers in brackets are standard errors.

In Italy and Portugal, CREDIT is positive and has a significant effect on trade credit. From this perspective, it is observed that financial intermediation and substitution motivation are valid in these countries, rejecting Hypothesis 2. According to the results of economic growth and bank credit extension, particularly during times of crisis, Italy and Portugal may assume a financial intermediation role, augmenting trade credit to support companies that struggle to access bank loans. In this context, Italy and Portugal appear to have pursued distinct policies compared to other European nations. These countries seem to be driven by a financial intermediation motivation. Italy has effectively utilized bank loans to provide credit to its clients, contributing to economic growth through a successful policy approach. However, even though Portugal followed a similar path, it has underperformed in terms of economic growth (GDP coefficient—0.326). In the Netherlands and Sweden, CREDIT is negative and has a significant effect on trade credit, indicating

the validity of Hypothesis 2. In these countries, during periods when a tight monetary policy is implemented and bank credit limits are restricted, there tends to be an inclination to increase trade credit. However, due to insufficient economic growth in terms of trade credit policy, GDP is insignificant and fails to meet the expected situation for sustainable economic growth. In Belgium, Finland, France, Luxembourg, and Spain, CREDIT has a negative impact and GDP has a positive significant impact on trade credit. This indicates the dominance of the Monetary Policy theory in these countries, confirming the validity of Hypothesis 1 and 2 being coherent for all panels. Here, the policies implemented in these countries pursue a successful strategy in leveraging trade credits during periods when bank loans are restricted. Due to the reflection of more predictable policies in imports and stability in economic growth back to trade credits, the establishment of a sustainable economy seems likely.

With regard to Model 1, it is revealed that the impact of import activities on trade credit is insignificant in Finland, Italy, Luxembourg, Poland, Spain, and the United Kingdom. However, in Austria, Belgium, Czech Republic, Germany, Netherlands, Portugal, and Sweden, this impact is positive and significant. From this perspective, it can be observed that the approach suggesting that imports stimulate and increase the use of trade credit is dominant in these countries, supporting Hypothesis 3. Interestingly, notably in France and Greece, this effect is negative and significant. This suggests that in these countries, imports are financed not through trade credit but through alternative payment methods.

Model 2, aimed at determining whether the relationship between country-specific trade credit and bank credits is linear, aims to demonstrate the originality of the study, and the estimation results are examined in Table 10. According to the obtained estimation results, no significant nonlinear relationship could be detected between trade credit and bank credits in Austria, Belgium, Finland, France, Germany, Greece, Italy, the Netherlands, Portugal, Sweden, and the United Kingdom. Interestingly, in the Czech Republic, Luxembourg, and Spain, a U-shaped relationship between trade credit and bank credits is observed. Based on the country-specific results (Table 9), the U-shaped hypothesis is confirmed in these countries. These results indicate the harmonious validity of the Monetary Policy Effect asserted by Brechling and Lipsey [27] and Mateut et al. [47] and the Financial Intermediation Theory claimed by Demirgüç-Kunt and Maksimovic [21] and Delannay and Weill [31]. In these countries, it is evident that during periods of monetary tightening, there is an increasing trend in trade credit, and the extension of bank credits through monetary extension leads to a decrease in trade credits. However, after reaching the minimum point of trade credits, if the extension of bank credits continues, it indicates a role shift in the sector, where they transform the bank credits they use into indirect trade credit for their customers by assuming a financial intermediation role. One of the most intriguing aspects of the study is Poland's distinctiveness in having an inverted U-shaped relationship. In Poland, two noteworthy trends emerge. First, the country shows no response to GDP and CREDIT, suggesting a lack of an active trade credit policy. Moreover, economic growth and bank loans seemingly have no impact on trade credits, warranting a reassessment. Second, an inverted U-shaped trend in bank credit expansion indicates trade credits only emerge with bank loan availability. However, excessive bank loan expansion seems to deter banks from offering trade credits due to nontransferable interest costs. These observations underline the necessity for a robust trade credit strategy to foster sustainable growth.

The relationship between trade credit and economic growth, bank credit, and import activities is examined, revealing the presence of a nonlinear relationship. In this stage, to ensure robustness, the Dumitrescu and Hurlin [69] panel causality test, developed for heterogeneous panel data, is applied, and the results are presented in Table 11. The findings indicate a bidirectional relationship between trade credit and economic growth, bank credit extension, and total manufacturing production. On the other hand, a unidirectional causal relationship is detected from trade credit to import activities. However, there is no causal relationship between import activities and trade credit. Thus, it is understood that Hypothesis 5 is strongly valid.

Table 10. Model II Individual Panel AMG Estimation Analysis.

	CREDIT	CREDIT^2	TMP
Austria	1.750	−0.177	0.874 [a]
	[3.575]	[0.410]	[0.232]
Belgium	−1.157	0.121	0.663 [a]
	[1.776]	[0.216]	[0.129]
Czech Republic	−4.656 [a]	0.650 [a]	0.051
	[1.653]	[0.233]	[0.103]
Finland	1.478	−0.236	0.354 [a]
	[1.573]	[0.183]	[0.071]
France	0.077	−0.052	0.146 [b]
	[1.242]	[0.144]	[0.070]
Germany	0.730	−0.134	−0.037
	[1.157]	[0.133]	[0.069]
Greece	−3.685	0.436	0.712 [b]
	[6.442]	[0.715]	[0.313]
Italy	−4.629	0.536	0.152
	[2.861]	[0.327]	[0.131]
Luxembourg	−8.235 [b]	0.918 [b]	0.763 [a]
	[3.384]	[0.383]	[0.166]
Netherlands	−0.618	0.042	0.467 [a]
	[1.742]	[0.181]	[0.126]
Poland	2.710 [b]	−0.371 [b]	−0.097
	[1.301]	[0.180]	[0.140]
Portugal	−0.463	0.084	0.068
	[1.178]	[0.122]	[0.101]
Spain	−3.836 [a]	0.398 [a]	0.559 [a]
	[1.501]	[0.153]	[0.076]
Sweden	−2.092	0.120	0.147 [c]
	[2.209]	[0.242]	[0.083]
United Kingdom	−0.008	0.009	−0.161
	[1.276]	[0.139]	[0.133]
PANEL	−1.509 [b]	0.156 [c]	0.311 [a]
	[0.770]	[0.093]	[0.087]

Note: "a, b, and c" indicate the statistical significance at 1, 5, and 10 percent levels, respectively. Numbers in brackets are standard errors.

Table 11. Heterogeneous Panel Causality Test Results.

Variables			Walt Stat.	*p* Value
REC	⇏	GDP	8.81166 [a]	0.000
GDP	⇏	REC	11.7477 [a]	0.000
REC	⇏	CREDIT	13.7963 [a]	0.003
CREDIT	⇏	REC	14.2063 [a]	0.001
REC	⇏	IMPORT	3.47535 [a]	0.013
IMPORT	⇏	REC	2.9685	0.113
REC	⇏	TMP	12.5704 [a]	0.005
TMP	⇏	REC	10.6617 [a]	0.000
GDP	⇏	CREDIT	21.5820 [a]	0.000
CREDIT	⇏	GDP	14.3589 [a]	0.001
GDP	⇏	IMPORT	8.40420 [a]	0.001
IMPORT	⇏	GDP	17.6642 [a]	0.000
CREDIT	⇏	IMPORT	9.39880 [a]	0.003
IMPORT	⇏	CREDIT	9.21475 [a]	0.006

Note: "a" indicates statistical significance at 1percent level.

6. Conclusions and Policy Implications

This study examines the relative effects of economic growth, bank credit extension, and imports on trade credit, as well as the nonlinear relationship between trade credit

and bank credit extension. In this regard, drawing upon extensively studied theories and motivations found in the literature, hypotheses have been developed and tested both across European countries and on a country-specific basis. The study uses quarterly data from the period 2005 to 2019 for 15 non-financial sectors in Europe, applying both first- and second-generation panel cointegration, and estimation and causality tests to account for cross-sectional dependence among countries.

In accordance with the obtained findings, it is observed that during periods of tight monetary policy in non-financial sectors across 15 European countries, there is a constraint on bank loans. Meanwhile, trade credit has shown an increasing trend, bolstered by the moderating effect of imports, and this trend accelerated even more with economic growth (model 1). Accordingly, the effect of monetary policy appears to be dominant in EU countries. Additionally, it is noteworthy that trade credit responds to expansions in bank loans with a non-linear, U-shaped relationship (model 2). In other words, as countries ease monetary restrictions and increase credit limits, companies initially move away from trade credits. This trend continues until trade credit usage reaches its lowest level. While the influence of monetary policy remains predominant up to this juncture, sectors thereafter shift their strategies by taking on the role of financial intermediaries. Sectors aiming to capitalize on the excessive expansion of bank loans transfer these bank loans to their customers as trade credits, adjusting both interest costs and the maturity structure. In doing so, they demonstrate a commitment to sustainable economic growth. At this juncture, it is notable that some countries have crafted policies divergent from those of the 15 European nations, and the success of these policies must be examined.

In the study's robustness check section, country-specific results are scrutinized to ascertain the policies each nation implemented, highlighting differences and potential gaps compared to the 15 European Union (EU) member states. The results suggest that Belgium, Finland, France, Luxembourg, and Spain utilize trade credits within an environment marked by a limited monetary policy impact and constrained bank loans. This approach appears to be geared toward sustainable economic growth. Their effective utilization of these restricted bank loans, combined with an increase in economic growth that in turn amplifies trade credits, fosters stable sectoral growth. The solid sectoral framework further paves the way for sustainable economic growth opportunities. Notably, Luxembourg and Spain demonstrate a concave pattern in their bank loan expansions, positioning them as frontrunners among EU countries, especially in the realm of trade credit policies. In contrast, Italy and Portugal set themselves apart by embracing a financial intermediation role, thereby indirectly transitioning bank loans into trade credits for their clientele. Their relative advantage stems from a more lenient monetary policy and more accessible external resources for companies. As a result, Italy capitalizes on the expansion of bank loans through its financial intermediation, effectively harnessing trade credits to drive sustainable economic growth. Although Portugal treads a similar path to Italy, it lags in economic growth and seemingly struggles to reap the full benefits of the sustainable growth strategy linked to trade credits. While the Netherlands and Sweden ostensibly align with other EU nations, their apathy towards trade credits in the context of economic growth manifests in a subpar performance within the sustainable growth strategy underpinned by these credits. Interestingly, in the Czech Republic, Germany, and England, trade credits do not readily respond to bank loan expansions, leading to detrimental impacts on economic growth. Factors such as fierce international competition, Germany's import-related pressures, and the Czech Republic's challenges in achieving robust economic growth might account for this. Similarly, Austria, Poland, and Greece exhibit no discernible links between bank loans, economic growth, and trade credits, potentially placing them in a vulnerable position against EU and non-EU countries. While Poland's reaction to bank loan expansions mirrors that of France and Luxembourg, its inability to significantly influence economic growth precludes it from leveraging the benefits of sustainable growth associated with trade credits.

In regard to policy implications, the following measures should be taken based on our findings: (i) Unnecessary bank credit restrictions in countries such as Luxembourg and

Spain, as well as Belgium, Finland, and France, should be removed. To ensure sustainable economic growth in these countries, an overly tight monetary policy should be avoided. (ii) The Netherlands and Sweden should implement additional measures for economic growth to make trade credits more effective, and achieving this is feasible through the optimal expansion of bank credits. (iii) Portugal should reassess the provision of bank credits through a more effective financial intermediation role and should advance economic growth to a point where trade credits are efficiently utilized. (iv) The connection between bank credits and trade credits in the Czech Republic, Germany, and the United Kingdom should be established. By doing so, resilience can be developed against the intense international competitive conditions, and sustainable growth can be achieved with trade credits playing an effective role. (v) Austria, Poland, and Greece need to thoroughly review their trade credit policies. Establishing a connection between bank credits and trade credits, taking additional measures for economic growth, and developing new projects targeting the sectors of these countries are essential to pave the way for trade credits by European banks. (vi) The European Council, the central banks of the EU, and the banking sector should predominantly focus their measures on supporting the trade credit policy in countries such as Austria, Poland, the Czech Republic, Greece, and Portugal, in that order. In terms of international competitive advantage, utmost support should be directed towards Germany, the United Kingdom, the Netherlands, and Sweden. Moreover, the greatest flexibility in tight monetary policy should be applied to countries such as Belgium, Finland, France, Luxembourg, and Spain.

One of the main limitations of this study is the unavailability of a common dataset encompassing all member countries of the European Union. Although data have been obtained from the Eurostat database for a long time, it was not possible to adapt a balanced panel dataset to all countries in terms of both time and country coverage, and the analysis is specifically conducted for the 15 countries. Another limitation is that the scope of the study could not be expanded further, and therefore, trade credit has only been examined from an investment perspective. In future studies, trade credit usage can be considered from both an investment and financing perspective. Furthermore, in subsequent studies, trade credit investments and financing can be separately evaluated for different sectors in European Union member countries using different econometric methods.

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