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# A causal and nonlinear relationship between trade credit policy and firm value: Evidence from an emerging market

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**Abstract**

This study examines whether there is a causal and nonlinear relationship between trade credit policy and firm value. In line with this purpose, the 2005Q1–2018Q4 period data is examined for 103 companies operating in the manufacturing industry in an emerging market, Borsa Istanbul, and the relationships revealed. The nonlinear relationship between trade credit and firm value has been proved with the two-step System GMM (Generalized Moment of Methods) and causality with Dumitrescu-Hurlin (2012) heterogeneous panel causality tests. According to the findings, a nonlinear (inverted U-shaped) relationship has been found between trade credit policy and firm value. Moreover, the values of firms that have moved away from optimum trade credit levels are also negatively affected. One of the original aspects of this study is that the bidirectional causal relationship between trade credit policy and firm value has been revealed.

**Keywords**

- trade credit policy
- firm value
- emerging market
- system GMM
- nonlinearity
- panel causality

**JEL codes:** G30, G32, L25

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# Introduction

Firms extend and use trade credit simultaneously, making trade credit decisions an integral part of business decisions. Trade credit is created because of the exchange of goods by the two firms in business intercourse, establishing a lending-borrowing relationship. Due to this unique characteristic of trade credit, researchers have extensively investigated the reasons behind the firms' decisions to extend and use trade credit from both the supply-side and demand-side perspectives (Seifert et al., 2013). Policies related to both corporate finance and operations are all influential in trade credit decisions. The relations between the firms and their customers, suppliers and creditors as well as external factors such as legal systems, culture, and the economic situation determine the position of firms in extending and using trade credit (Kieschnick et al., 2013; Nam & Uchida, 2019). Moreover, even though trade credit-related decisions as part of working capital management decisions are considered to be short-term in nature, the persistence of working capital allocations is also documented in the literature questioning the value effects of working capital decisions, which include trade credit policies (Chauhan, 2019).

McGuinness et al. (2018) showed that trade credit investment, proxied by the accounts receivables to total assets ratio, in 13 European countries is 30% on average, ranging from 13% in Latvia to 49% in Greece.[2] Furthermore, it is demonstrated that trade credit investment, as measured by the ratio of accounts receivable to total assets, is 19% on average in 9 developed countries, ranging from 12% in Canada to 26% in France[3] (Karakoç, 2022). Based on the Turkish Central Bank Balance Sheets for the 2009–2021 period, the short-term accounts receivables to total assets ratio is approximately 23% and the ratio of accounts receivables to current assets is 37% in the manufacturing industry (CBRT, 2023). According to these findings, it is worth noting how significant trade credit investment is for both developing and developed countries.

These figures prove that trade credit extensions are an integral part of doing business in both developed and developing markets, especially in manufacturing firms listed on Borsa Istanbul, which has crucial implications for managers and financial investors. This also makes it an important issue for academic research. As more data has become available, trade credit research has primarily concentrated on investigating trade credit theories that attempt

[2] McGuinness et al. (2018) reported that other countries have accounts receivable to total assets ratio of 34% in Belgium, 16% in Finland, 29% in France, 20% in Germany, 19% in Hungary, 28% in Ireland, 37% in Italy 37%, 27% in Poland, 36% in Portugal, 30% in Spain, and 22% in the UK.

[3] Karakoç (2022) indicates that the other countries' trade credit investments are as follows: 15% in Australia, 21% in Germany, 25% in Italy, 23% in Japan, 21% in Korea, 18% in the UK, and 14% in the US.

to explain the motives for extending and using trade credit (Duliniec & Świda, 2021; Mian & Smith, 1992; Petersen & Rajan, 1997; Seifert et al., 2013). On the other hand, taking into account the tradeoff between benefits and costs of trade credit, another line of research has focused on the question of whether an optimal level of trade credit exists for firms. It is argued that optimal trade credit policy exists at the point where the marginal benefits and costs of trade credit financing are equal (Emery, 1984).

As explained above, there is extensive literature seeking answers to the question of why trade credit is extended or received. However, studies on the relationship between trade credit and its financial outcomes, such as its impact on firm performance or firm value, are scarce, especially in emerging markets (Hill et al., 2012; Kieschnick et al., 2013; Martínez-Sola et al., 2013) and inconclusive (Box et al., 2018; Chauhan, 2019). In such markets, and particularly in the manufacturing sector, where financial systems are not entirely developed and may be susceptible to economic crises, the use of trade credit becomes even more valuable. Hence, this study aims to contribute to the trade credit literature by investigating the relationship between trade credit and firm value using data for manufacturing firms in an emerging market, namely Borsa Istanbul, for the 2005Q1–2018Q4 period.

The contribution of this study is threefold. Firstly, it contributes to the existing literature by extending the limited number of studies on the relationship between trade credit and firm value, which are even scarcer in emerging markets, as Nam and Uchida (2019) emphasized. Secondly, the study extends the literature by providing evidence of the nonlinear (quadratic) relationship between trade credit and firm value, following studies by Aktas et al. (2015) and Martínez-Sola et al. (2013). The third contribution of this study is in its investigating the causal relationship between trade credit and firm value, which is not tested previously in terms of Borsa Istanbul manufacturing firms, even though Box et al. (2018) investigated the causal relationship between trade credit policies and profitability. Moreover, Chauhan (2019) argues that the current literature overemphasizes the value creation role of working capital and suggests that a cross-sectional analysis would be inadequate to address this aspect. In this respect, this study aims to fill the existing gap.

The remainder of the study is structured as follows: Section 1 develops the hypotheses of the study explaining the conceptual framework; Section 2 presents the data, variables, methodology, and models employed; Section 3 reports the findings of the study; last Section concludes by discussing the implications of the results and policy suggestions.

## 1. Literature review and hypothesis development

For many years, researchers have argued as to the motives for firms using trade credit. Trade credit research has mainly focused on testing trade credit theories, which aim to explain the reasons of extending and using trade credit as more data becomes available (Duliniec & Świda, 2021; Mian & Smith, 1992; Petersen & Rajan, 1997; Seifert et al., 2013). Researchers who approach trade credit from operational and marketing perspectives argue that firms can use trade credit to discriminate between their customers as part of their pricing and sales policy through credit terms (Brennan et al., 1988; Pike et al., 2005), enable their customers to test the quality of their products before any payment is made (Deloof & Jegers, 1996; Emery & Nayar, 1998; Lee & Stowe, 1993; Long et al., 1993; Ng et al., 1999; Petersen & Rajan, 1997; Seifert et al., 2013; Wilner, 2000), and for the purposes of product market positioning (Seifert et al., 2013). The literature on relationship lending hypothesis as well as on supply chain finance (SCF) and financial supply chain management (FSCM) emphasizes the simultaneity of financial flows in relation to physical and informational flows in their approach to trade credit (L. Zhang et al., 2015; T. Zhang et al., 2019). Since information asymmetry and trust factors are important ingredients in the decision to extend credit (Wang et al., 2015), the already established business relationship between the firms and their customers reduces the information asymmetry and forms a basis for trust as argued by the relationship lending hypothesis (Long et al., 1993; Pike et al., 2005; Uchida et al., 2013). Consequently, firms with the ability to lend can act as creditors to their customers by postponing their payments for their purchases, improving financial performance, lowering transaction costs and enhancing inventory management efficiency, as well as reducing financial distress for the trade credit receiver, especially during times of crisis (Box et al., 2018; Ferris, 1981; Kestens et al., 2012; Nam & Uchida, 2019; T. Zhang et al., 2019).

Another line of research argues that firms that can raise capital more easily supply trade credit to their customers who have limited access to capital, especially during times of financial crisis. This means that trade credit received from suppliers serves as a source of short-term finance, enabling firms to keep their cash and pay later. This makes trade credit a substitute for short-term finance forming the basis for the substitution hypothesis between short-term debt and trade credit (Bastos & Pindado, 2013; Huang et al., 2011; Meltzer, 1960; Petersen & Rajan, 1997; Schwartz, 1974). In this regard, trade credit serves as an investment through accounts receivables for the firm offering it (Long et al., 1993).

Despite its benefits, trade credit extension comes with risks and costs. Customers may delay or even default on payments, which causes the firms extending credit to lose revenues and reduce expected cash inflows. To avoid any negative impact from bad debts firms extending credit establish departments that follow payments and accounts receivables, incurring monitoring costs. Moreover, this situation increases the cash conversion cycle, and the company has more cash invested in net working capital than required. Consequently, financing costs rise, as the firms extending trade credit end up financing their investments in accounts receivables by additional borrowing and loosening credit terms, leading to negative impacts on firm performance and liquidity (Cheng & Pike, 2003; Mian & Smith, 1992). Therefore, firms should aim to balance the benefits and costs of extending trade credit (Martínez-Sola et al., 2013). Scherr (1996) provides a framework for setting trade credit limits to eliminate these costs and credit risk, and by focusing on trade credit limits, concludes that understanding how trade credit limits can increase shareholder wealth is crucial for practitioners and managers. Since credit limits and credit terms enable firms to limit the costs of high trade credit, the benefits exceed the costs, leading to positive effects on firm profitability and firm value. The contradictory findings provided by the researchers lead to the argument that the relationship between trade credit and firm value can be conditional on the country, the industry, and economic situation as well as the net benefits received (Bastos & Pindado, 2013; Çelik et al., 2016; Enqvist et al., 2014; Hill et al., 2012; Kim & Atkins, 1978; Nam & Uchida, 2019; Zeidan & Shapir, 2017).

The limited number of studies focusing on the relationship between trade credit and firm value provide inconclusive evidence, especially on the Borsa Istanbul stock market. Hill et al. (2012), Aktas et al. (2015), Zeidan and Shapir (2017), Box et al. (2018), Dary and James (2019), Boisjoly et al. (2020), and R. Zhang (2020) argue that trade credit supplied to customers has information value, decreasing information asymmetry. They conclude that trade credit has a positive effect on firm value and shareholder wealth. On the other hand, Wang (2002), Deloof (2003), Filbeck et al. (2007), García-Teruel and Martínez-Solano (2007), and Kieschnick et al. (2013) provide evidence that aggressive liquidity management, which requires low levels of trade credit, enhances value, thereby arguing that trade credit and firm value are negatively related. Lewellen et al. (1980) and T. Zhang et al. (2019) further suggest no relationship between trade credit and shareholder wealth. In the meantime, although there are many methods to measure firm value, the Tobin Q ratio developed by Chung and Pruitt (1994) is commonly used, which strongly represents firm value. Therefore, Tobin Q was chosen as the dependent variable in this study.

The contradictory evidence provided leads to the argument that there should be an optimal level of trade credit investment, where the marginal benefits of investing in trade credit exceed the marginal costs leading to positive effects on value (Aktas et al., 2015; Baños-Caballero et al., 2014; Ben-Nasr, 2016; Ek & Guerin, 2011; Emery, 1984). As firms extend trade credit, the initial benefits are greater than the costs. Firms experience a value-enhancing effect of increased sales, improved customer relations, and reduced inventory costs without substantial increases in their monitoring and financing costs. However, as the level of trade credit grows, these costs also rise and more investment is required in trade credit, thus diminishing the positive effect on value. Once the optimal level is exceeded, the effect becomes negative, since the firm also becomes risky, with it being perceived negatively by investors. Furthermore, based on the insights from Jory et al. (2020) examines the nonlinear relationship between trade credit policy and firm value during the Economic Policy Uncertainty (EPU) periods and enunciate keeping account receivable at low levels during EPU periods creates an increase in firm value, whereas excessive avoidance in account receivables negatively affects firm value by losing customers to competitors. All in all, the inverted U-shaped relationship that is suggested requires further investigation. Hence, following Martínez-Sola et al. (2013), Baños-Caballero et al. (2014), Aktas et al. (2015), Ben-Nasr (2016), and Jory et al. (2020), the first hypothesis of the study is expressed as follows:

**$H_1$:** There exists an inverted U-shaped relationship between trade credit and firm value.

Chauhan (2019) questions the implicit assumption in working capital and trade credit research that investment in working capital and, more specifically, in trade credit, is short-term in nature. He argues that the change created in value by the changes in investment in working capital is overemphasized, since a portion of these investments are permanent. Hence, the effect of deviations from the optimal level of trade credit on firm value deserves further investigation. When Martínez-Sola et al. (2013) investigated the nonlinear relationship between trade credit policy and firm value, they were inspired by the approach proposed by Tong (2008) and confirmed that an optimum trade credit policy exists within a firm. According to their study, deviations from the optimal trade credit level pull the firm value below its potential level. This study aims to reveal the presence of the optimal trade credit level in the event of the verification of $H_1$. In light of the studies by Martínez-Sola et al. (2013), Kroes and Manikas (2014), hypothesis 2, which aims to investigate the impact of deviations from optimal level of trade credit policy on firm value, is expressed as follows:

**$H_2$:** Deviations from optimal level of trade credit have a negative impact on firm value.

Studies on trade credit implicitly assume that changes in trade credit policy lead to changes in value in the subsequent years. In other words, trade credit policy is accepted as a determinant of firm value. However, it can also be argued that firms with high value may have better access to financial markets and can raise funds at a lower cost; therefore, they may provide credit to their customers more easily, as argued by the financial constraints hypothesis. Kroes and Manikas (2014) test the direction of the relationship between cash flow and the changes in performance of firms. In their study they provide evidence that reductions in accounts receivables, specifically measured as Days of Sales Outstanding (DSO), are found to be significantly associated with changes in Tobin's Q. They found no evidence of reverse causality. Hence, the direction of the relationship between trade credit and firm value deserves further investigation. From this viewpoint, no study has been found that establishes causality between trade credit policy and firm value for the manufacturing industries on Borsa Istanbul, which is one of the emerging markets. The third hypothesis of the study is expressed as follows:

**$H_3$:** There is a bidirectional causal relationship between trade credit investment and firm value.

# 2. Sample and methodology

## 2.1. Sample and data collection

The sample of the present study comprises 103 manufacturing firms with no missing data on Borsa Istanbul (BIST) for the period from the first quarter of 2005 (2005Q1) to the fourth quarter of 2018 (2018Q4). BIST manufacturing firms have adopted International Financial Reporting Standards (IFRS) since 2005. Hence, the study period starts in 2005 in order to avoid the unambiguous effects of IFRS adoption on firm value. A balanced panel of quarterly cross-sectional data is used in the analysis and includes 5,768 observations.

There are two motivations for focusing on the manufacturing sector of Borsa Istanbul in this study. Firstly, manufacturing is the locomotive of the Istanbul Stock Exchange and is divided into 9 sub-sectors under the control of manufacturing (1 – Food, Beverage and Tobacco, 2 – Textile, Wearing Apparel and Leather, 3 – Wood Products Including Furniture, 4 – Paper and Paper Products Printing, 5 – Chemicals, Petroleum Rubber and Plastic Products, 6 – Non – Metallic Mineral Products, 7 – Basic Metal, 8 – Fabricated Metal Products Machinery Electrical Equipment and Transportation Vehicles, 9 – Other Manufacturing Industry). Secondly, trade credit investments occupy an important place in manufacturing balance sheets (see Table 1).

The companies listed on Borsa Istanbul (BIST) continuously since 1986 are included in the sample. The data were retrieved from the Finnet database (FINNET, 2019) and the Public Disclosure Platform (PDP, 2019).

## 2.2. Model specifications and variables

To investigate the nonlinear relationship between trade credit and firm value, and to test the first hypothesis, Model 1 was developed, as follows:

$$FV_{it} = \beta_0 + \beta_1(\mathrm{FV}_{it-1}) + \beta_2(TC_{it}) + \beta_3(TC)^2_{it} + \beta_4(GROWTH_{it}) + \beta_5(LEV_{it}) + \\ + \beta_6(SIZE_{it}) + \beta_7(Crisis\,Dummy_t) + \mu_i + \gamma_t + I_{it} + \varepsilon_{it} \quad (1)$$

In Model 1, the dependent variable and firm value are demonstrated by two alternative measures. The first measure is Tobin's Q, calculated as the ratio of the sum of the market value of equity and total liabilities to the book value of assets (Baños-Caballero et al., 2014; Chung & Pruitt, 1994; Martínez-Sola et al., 2013; Nam & Uchida, 2019; T. Zhang et al., 2019). The second measure is the MARKET (market-to-book ratio), which is commonly used in the literature to measure firm value (Jory et al., 2020; Martínez-Sola et al., 2013).

The independent variable of the study was trade credit (TC). Since the study investigated the nonlinear relationship between trade credit and firm value, the trade credit variable was squared and included in the analysis as an independent variable. Trade credit level was also displayed using two alternative measures. It was measured as the ratio of accounts receivables to total sales (AR/NS), following Petersen and Rajan (1997), Niskanen and Niskanen (2006), and Martínez-Sola et al. (2013), and as the ratio of accounts receivables to current assets (AR/CA). Additionally, to test for the quadratic relationship, these ratios were squared and included in the analysis as AR/NS-squared $(AR/NS)^2$ and AR/CA-squared $(AR/CA)^2$. A negative relationship was expected between the trade credit proxies AR/NS and AR/CA and firm value at high trade credit levels. A positive relationship was expected at low levels of trade credit. The sign of the AR/NS and AR/CA variables was expected to be positive, whereas the $(AR/NS)^2$ and $(AR/CA)^2$ variables were expected to be negative in the model if hypothesis 1 is supported.

The control variables used in Model 1 are growth in sales (GROWTH), firm size (SIZE), leverage (LEV), and crisis dummy (CRISIS). (GROWTH) variable is demonstrated by the annual growth in sales and is calculated as the ratio of the difference between current-year sales and previous-year sales to previous-year sales (Martínez-Sola et al., 2013; Niskanen & Niskanen, 2006; Paul et al., 2018). The second control variable, firm size (SIZE), is demonstrated by the natural logarithm of net sales (Martínez-Sola et al., 2013; Mian & Smith, 1992; Petersen & Rajan, 1997). The third control variable, leverage (LEV), is measured as the total debt to total equity ratio. The crisis dummy has been added to the model as a control variable for the years 2008 and 2009 to control the effect of crisis periods on financial markets and trade credit policy (Bastos & Pindado, 2013; Enqvist et al., 2014; Nam & Uchida, 2019). $\mu_{it}$ is unobservable heterogeneity, $\gamma_t$ refers to the time effects and are year dummy variables, $I_{it}$ refers to the industry dummy, while $\varepsilon_{it}$ is the residuals.

To test the hypothesis 2, initially, Model 2 was improved and estimated based on the literature on determinants of trade credit and is shown below:

$$TC_{it} = \beta_0 + \beta_1(GROWTH_{it}) + \beta_2(SIZE_{it}) + \beta_3\left(\frac{STD}{TS}\right)_{it} + \beta_4\left(\frac{FE}{TD}\right)_{it} + \\ + \beta_5\left(\frac{EBITDA}{TS}\right)_{it} + \beta_6\left(\frac{TA}{TS}\right)_{it} + \beta_7\left(\frac{NIA}{TS}\right) + \mu_i + \gamma_t + I_{it} + \varepsilon_{it} \quad (2)$$

In Model 2, trade credit (TC) variables AR/NS and AR/CA were estimated based on the literature on trade credit determinants. GROWTH and SIZE variables were calculated as in Model 1. Additionally, the determinants used in the estimation were short-term debt to total sales (STD/TS), based on Long et al. (1993), Deloof and Jegers (1996), García-Teruel and Martínez-Solano (2010), and financial expenses to total debt (FE/TD), earnings before interest, taxes, depreciation, and amortization to total sales (EBITDA/TS), total asset turnover (TA/TO) and net income plus depreciation and amortization to sales (NIA/TS) based on Petersen and Rajan (1997), Niskanen and Niskanen (2006), García-Teruel and Martínez-Solano (2010). $\mu_{it}$ is the unobservable heterogeneity, $\gamma_t$ refers to the time effects and are year dummy variables, $I_{it}$ refers to the industry dummy, $\varepsilon_{it}$ is the residuals. As shown above, Model 2 is initially estimated using a multiple linear fixed-effects regression method. The residuals that emerge as a result of the estimation are then obtained as "predict residual series" and the absolute values of the residuals are revealed as the DEVIATION variable and placed in Model 3. The reason for choosing such a method is to obtain econometric estimation residuals that will reveal whether there is an optimal level of commercial credit if the existence of the nonlinear relationship between commercial credit policy and firm value stated in Model 1 is proven, and whether deviations from this optimal commercial credit policy negatively affect firm value.

At this stage, to determine whether deviations from the optimal level of trade credit have a negative effect on firm value, Model 3 was developed, inspired by Chauhan (2019), Kroes & Manikas (2014), and Martínez-Sola et al. (2013). The developed model is as follows:

$$FV_{it} = \beta_0 + \beta_1(FV_{it-1}) + \beta_2(DEVIATION_{it}) + \beta_3(GROWTH_{it}) + \\ + \beta_4(LEV_{it}) + \beta_5(SIZE_{it}) + \beta_6(Crisis\,Dummy_t) + \mu_i + \gamma_t + I_{it} + \varepsilon_{it} \quad (3)$$

(GROWTH), (LEV) and (SIZE) variables in Model 3 are calculated as in Model 1. Because of the analysis, according to hypothesis 2, the coefficient of the (DEVIATION) variable is expected to be negative ($\beta_2 < 0$). Therefore, the aim is to prove a negative relationship between deviations from optimal level of trade credit level and firm values of the companies.

## 2.3. Methodology

The series used for econometric forecasting must be stationary, that is, it must contain no unit roots. Although the problem of superior regression is common in econometric estimates made for non-stationary series, these estimates reveal inconsistent results (Granger, 2003; Phillips, 1986). In this study, the stationarity tests of the series are carried out using the CIPS (Cross-sectionally Augmented IPS) panel unit root test developed by Pesaran (2007). This test is a cross-section-based and developed version of Im et al.'s (2003) unit root test (IPS) and calculates individual CADF test statistics. The CADF test statistic is revealed by the following regression:

$$\Delta Y_{it} = \alpha_i + \rho_i Y_{it-1} + d_0 \overline{Y}_{t-1} + \sum_{j=0}^{p} d_{j+1} \Delta \overline{Y}_{t-j} + \sum_{k=1}^{p} c_k \Delta Y_{i,t-k} + \varepsilon_{it} \quad (4)$$

where the $\alpha_i$ is the deterministic term of the model, $p$ is the lag length, $\overline{Y}_t$ and is the mean of all $N$ observations with respect to time $t$. Based on the above regression, CADF $t$ statistics are obtained by calculating individual ADF test statistics. Moreover, the CIPS test statistics for the panel are derived by taking the average of the CADF test statistics of each cross-section, which is calculated as follows:

$$CIPS = \frac{1}{N} \sum_{i=1}^{N} CADF_i \quad (5)$$

The critical values by which the CIPS test statistics are evaluated were suggested by Pesaran (2007).

Traditional econometric estimation methods such as panel OLS models, panel fixed effect models, and panel random effect models cannot yield effective results in trade credit policy decisions (Djebali & Zaghdoudi, 2020). In this study, dynamic panel data models were used to obtain more effective results and eliminate this problem. The dynamic panel data model is a generalized method of moments (GMM) estimation model first developed by Arellano and Bond (1991). In the next step, the first difference model was transformed by using the instrument variable matrix outlined by Arellano and Bover (1995) and Blundell and Bond (1998). The GMM approach uses lagged values of instrument variables in various differential equations and initial differences in level equations. Compared to the "Difference GMM" method developed by Arellano and Bond (1991), the estimators obtained from the one- and two-step System-GMM proposed by Arellano and Bover (1995) and Blundell and Bond (1998) are better predictors (Roodman, 2009). Therefore, in this study, the two-stage system GMM method was preferred in estimating the relationship between trade credit policy and firm value. On the other hand, other reasons for the preference of this method are simultaneity bias, omitted variables, and especially the problem of endogeneity. In addition, this method tests the validity of instrumental variables and takes the autocorrelation problem into account, as developed by Sargan (1958) and Arellano and Bond (1991), respectively.

If any relationship is found between any two variables, the question whether there is also a causal relationship between these two variables should be of interest. That is why the Dumitrescu and Hurlin (2012) panel causality test was used in order to detect the relationship between trade credit, control variables and firm value. The method used in the study is a similar but more developed version of the Granger causality test, and it was used for heterogeneous panel data. The model developed based on the panel VAR model is as follows:

$$Y_{it} = \alpha_i + \sum_{k=1}^{K} \gamma_i^{(k)} Y_{it-k} + \sum_{k=1}^{K} \beta_i^{(k)} X_{it-k} + \varepsilon_{it} \quad (6)$$

Here, lag length ($k$) is constant for each cross-section and when the panel data is balanced, the autoregressive parameter $\gamma_i^{(k)}$ and slope parameter $\beta_i^{(k)}$ vary according to the cross-section. The test statistics obtained through this method are shown below:

$$W_{N,T}^{HNC} = \frac{1}{N} \sum_{i=1}^{N} W_{i,T}$$

$$Z_{N,T}^{HNC} = \sqrt{\frac{N}{2K}} \left(W_{N,T}^{HNC} - K\right) \rightarrow N(0,1) \quad (7)$$

Here, the Wald statistic is represented by $W_{i,T}$, and by averaging the Wald statistics of each cross-section, and $W_{N,T}^{HNC}$ was found. Accordingly, there is no Granger relationship between the variables of all units considering the null hypothesis. However, there is a relationship between two variables in at least one unit regarding the alternative hypothesis. The model itself is heterogeneous, and while the alternative hypothesis provides heterogeneous results, the null hypothesis still provides a homogeneous result.

# 3. Empirical results and discussion

## 3.1. Descriptive statistics and correlation matrix

Account receivables investment is crucial for companies in Europe. McGuinness et al. (2018) conducted a study in 13 European countries (Belgium 34%, Finland 16%, France 29%, Germany 20%, Greece 49%, Hungary 19%, Ireland 28%, Italy 37%, Latvia 13%, Poland 27%, Portugal 36%, Spain 30%, UK 22%) which revealed that the average total account receivable asset share is 30%. As in European companies, account receivables are crucial for Borsa Istanbul manufacturing firms. Within the framework of the sample of the research, it is understood from Table 1 that the accounts receivables of these companies account for 55% of sales and 41% of current assets. Here in Turkey, sales of account receivables have an important place in current assets. On the other hand, the Tobin Q average of the companies is 1.46, the average firm value/book value is 2.05, and the selected companies create value in the financial market. Furthermore, it can be seen that there is an average 14% expansion in the sales of the selected companies, and the leverage ratio is 1.52, and the companies benefit from the leverage effect.

**Table 1. Descriptive statistics**

| Variable | Observations | Mean | Standard deviation | Median | 10th percentile | 90th percentile |
|---|---|---|---|---|---|---|
| Tobin's *Q* | 5768 | 1.4679 | 1.2514 | 1.1600 | 0.3500 | 0.7700 |
| Market | 5768 | 2.0535 | 2.2568 | 1.4200 | 0.3000 | 0.6300 |
| AR/NS | 5768 | 0.5471 | 0.5582 | 0.3800 | 0.0100 | 0.1300 |
| AR/CA | 5768 | 0.4125 | 0.1853 | 0.4100 | 0.0200 | 0.1800 |
| Growth | 5768 | 0.1426 | 0.3087 | 0.1200 | –0.5300 | –0.1500 |
| Lev | 5768 | 1.5249 | 2.0175 | 0.8700 | 0.0600 | 0.2400 |
| Size | 5768 | 18.806 | 1.7979 | 18.750 | 14.000 | 16.780 |

Note: This table shows the values of descriptive statistics of the variables used in the analysis. Data is quarterly and ranges from 2005Q1 to 2018Q4. Tobin's *Q* – Tobin's *Q* ratio, Market – firm value/book value, AR/NS – the ratio of account receivables to total sales, AR/CA – the ratio of account receivables to total current assets, Growth – the growth in sales of each firm, Lev – the ratio of total debt to total equity, Size – the natural logarithm of total net sales.

Source: based on data provided by Finnet database (FINNET, 2019) and Public Disclosure Platform (PDP, 2019).

A high correlation between independent variables in multiple linear regression analysis leads to the problem of multicollinearity. Therefore, a high correlation between independent variables is undesirable in the analysis. The correlation matrix of the variables used in Model 1 is presented in Table 2.

As shown in this table, the analyses are carried out with the existing data set without any adjustment, since there is no high correlation between independent variables.

**Table 2. Correlation matrix**

| Variable | Tobin's *Q* | Market | AR/NS | AR/CA | Growth | Lev | Size |
|---|---|---|---|---|---|---|---|
| **Tobin's *Q*** | 1.000 | | | | | | |
| **Market** | 0.633*** | 1.000 | | | | | |
| **AR/NS** | –0.034* | 0.034* | 1.000 | | | | |
| **AR/CA** | –0.016 | –0.008 | 0.410*** | 1.000 | | | |
| **Growth** | 0.089*** | 0.083*** | –0.055*** | 0.030 | 1.000 | | |
| **Lev** | 0.022 | 0.507*** | 0.127*** | 0.067*** | 0.056 | 1.000 | |
| **Size** | –0.094*** | –0.112*** | –0.391*** | –0.045** | 0.141*** | –0.068*** | 1.000 |

Note: Significance at 1%, 5%, and 10% is indicated by the symbols ***, ** and *, respectively.

Source: based on data provided by the Finnet database (FINNET, 2019) and Public Disclosure Platform (PDP, 2019).

## 3.2. Panel unit root test results

The stationary of the series was tested using the Pesaran (2007) CIPS (cross-sectionally augmented IPS) test, which considers the cross-sectional dependency in the series to be used in the analysis of the study. Since the CIPS statistic calculated according to the results presented in Table 3 was greater than

**Table 3. Panel CIPS unit root test**

| | Tobin's *Q* | Market | AR/NS | AR/CA | Growth | Lev | Size |
|---|---|---|---|---|---|---|---|
| Lag=1 | –2.440*** | –2.663*** | –4.532*** | –3.680*** | –3.168*** | –2.692*** | –2.090*** |
| Lag=2 | –2.325*** | –2.556*** | –4.241*** | –3.358*** | –3.283*** | –2.596*** | –2.325*** |
| Lag=3 | –2.288*** | –2.579*** | –3.145*** | –3.233*** | –3.612*** | –2.168*** | –2.337*** |
| Lag=4 | –2.268*** | –2.554*** | –3.270*** | –3.359*** | –2.955*** | –2.215*** | –2.228*** |
| Lag=5 | –2.345*** | –2.577*** | –3.507*** | –3.363*** | –3.114*** | –2.289*** | –2.178** |

Note: The values in the table represent the CIPS test statistics. Significance at 1%, 5%, and 10% is indicated by the symbols ***, ** and *, respectively. Since no trends are detected in the variables, the constant model is preferred during unit root analyses Critical values for the test are based on the company and time section for each panel, from the 4th chapter, pp. 275–279, of Pesaran (2007) study for 1% –2.30; –2.16 for 5% and –2.08 for 10%.

Source: based on data provided by the Finnet database (FINNET, 2019) and Public Disclosure Platform (PDP, 2019).

the absolute value of the critical value, $H_0$ was rejected. It was decided that there is no unit root in the series forming the panel.

According to Table 3, it was concluded that all series are up to 5 lag lengths *I*(0), stationary at level. Since all of the series were stationary, the study hypotheses were tested and estimated with two-step system GMM developed by Arellano and Bover (1995), and Blundell and Bond (1998), as well as Dumitrescu and Hurlin's (2012) heterogeneous panel causality models.

### 3.3. Baseline of the estimation results

As can be understood from Table 4, the findings support the quadratic relationship (concave) between account receivables and market values, i.e. hypothesis 1. In other words, trade credit investment increases firm value up to a certain point (turning point), but after a certain point, increases in trade credit negatively affect firm value. Increases in low trade credit positively affect firm value due to the incentive to take advantage of trade credit advantages to increase market share, and the desire to establish new customer relations. In contrast, increases in high trade credit investment negatively affect firm value due to the cost and financial risks brought about by trade credit. These results support the hypotheses put forward by Martínez-Sola et al. (2013) based on Spanish firms, and this study's hypothesis 1 is also valid for Borsa Istanbul manufacturing firms.

Based on the results in Table 4, it was proved that trade credit investment positively affects firm value up to a certain point but negatively after this limit is reached. From this point of view, it should be determined to what extent the companies included in the sample should invest in account receivables and help them develop financial policies in this regard. Inspired by the study of Martínez-Sola et al. (2013), in this study it was calculated that the account receivables level of the firms should not exceed 54.13% of the current assets and the account receivables level should not exceed 47.15% of the current assets (turning point) in terms of market value (vertex calculated by taking the first derivative).

GROWTH, one of the control variables, has a statistically significant and negative coefficient of 1% in the model where both dependent variables are used. This result is compatible with Jensen's (1986, 1988) agency and governance theories. It is understood from this result that changes in sales negatively affect firm value on Borsa Istanbul. Moreover, the conclusion is that the opinions suggesting that it may increase the value of the firms utilizing growth opportunities are not valid in Borsa Istanbul Manufacturing firms, as proposed by Claessens et al. (2002), Porta et al. (2002), Durnev and Kim (2005), Maury and Pajuste (2005) and Tong (2008). The LEV variable was significant

**Table 4. Nonlinear relationship between trade credit and firm value**

| Variables | Tobin's *Q* | | Market | |
|---|---|---|---|---|
| AR/NS | 0.155***<br>(–0.004) | | 0.322***<br>(–0.01) | |
| $(AR/NS)^2$ | –0.020***<br>(–0.001) | | –0.044***<br>(–0.003) | |
| AR/CA | | 1.282***<br>(–0.062) | | 1.740***<br>(–0.241) |
| $(AR/CA)^2$ | | –1.184***<br>(–0.068) | | –1.845***<br>(–0.280) |
| Growth | –0.130***<br>(–0.006) | –0.142***<br>(–0.006) | –0.202***<br>(–0.017) | –0.205***<br>(–0.013) |
| Lev | –0.004<br>(–0.002) | –0.003<br>(–0.002) | 0.187***<br>(–0.006) | 0.203***<br>(–0.005) |
| Size | 0.041***<br>(–0.001) | 0.019***<br>(–0.001) | 0.076***<br>(–0.004) | 0.034***<br>(–0.002) |
| Crisis dummy (2008–2009) | –0.112***<br>(–0.003) | –0.121***<br>(–0.003) | –0.240***<br>(–0.009) | –0.264***<br>(–0.009) |
| AR(–1) | –2.3565<br>[*p* = 0.0184] | –2.3559<br>[*p* = 0.0185] | –3.6843<br>[*p* = 0.0002] | –3.6898<br>[*p* = 0.0002] |
| AR(–2) | 0.17081<br>[*p* = 0.8644] | 0.13881<br>[*p* = 0.8896] | –0.07652<br>[*p* = 0.9390] | –0.10447<br>[*p* = 0.9168] |
| Sargan Test | 93.94<br>[*p* > 0.10] | 97.10<br>[*p* > 0.10] | 92.52<br>[*p* > 0.10] | 99.74<br>[*p* > 0.10] |
| Year dummy | YES | YES | YES | YES |
| Industry dummy | YES | YES | YES | YES |

Note: Four lags and a two-step system GMM estimator were used to conduct all estimations. All the variables are endogenous, and the instruments are lagged independent variables. Market value of equity plus book value of total debt to total assets, which is the dependent variable *Q* (Tobin's *Q*), are presented in columns 1 and 2. The percentage of market capitalization of the company to equity book value, demonstrated in columns 3 and 4, is used as the dependent variable in the proxy firm evaluation process. Accounts receivable are measured by AR/CA and AR/NS. Growth, the Lev, and Size are the control variables. All regressions include industry and time dummies. Statistically insignificant sector dummies are excluded, and it is calculated by not using a constant term. Under the null hypothesis of no serial correlation, AR(–1) is a test statistic for first-order autocorrelations, while AR(–2) is second-order in residuals, distributed as standard normal *N*(0, 1). Under the null hypothesis of instrument validity, the Sargan test is used to over-identify the constraints, distributed as chi-squares. Significance at 1%, 5%, and 10% is indicated by the symbols ***, ** and *, respectively.

Source: own work.

in two of the four regression models used. The fact that the LEV coefficient is statistically positive and significant at 1% when the dependent variable is MARKET shows that it is consistent with the tax argument of Modigliani and Miller (1963) and the free cash flow argument of Jensen (1986).

The SIZE variable has a statistically significant and positive coefficient at 1% in both dependent variables. This result supports the idea put forward by Berger and Ofek (1995) that net sales may positively affect firm value. Finally, the crisis dummy variable, which examines the effects of the 2008–2009 global crisis, is statistically significant and negative at the 1% level. Thus, the global crisis in Turkey had a negative effect on firm value. This evidence is in line with the ideas expressed by Bastos & Pindado (2013), Enqvist et al. (2014), and Nam & Uchida (2019).

In Table 5, the results regarding hypothesis 2 are tested with Model 3. In other words, the relationship between the deviations from optimal level of trade credit level and firm value is presented. Accordingly, a negative association was found between DEVIATION and firm value at the 1% statistical significance level. The Deviation AR/NS and DEVIATION AR/CA results are shown in columns 1 and 2 in Table 5 with both dependent variables.

Arguing that these results are moving away from the firm's targeted trade credit levels and the decrease in market value, Martínez-Sola et al. (2013) also supports the opinion and this study's $H_2$ is also valid for Borsa Istanbul manufacturing firms. While the control variables LEV are insignificant for Tobin's *Q*, they positively affect MARKET at a statistical significance level of 1%. The SIZE independent variable coefficients were estalished as being positive at the 1% statistical significance level. However, a negative relationship was found between the GROWTH independent variable and the firm value at a statistical significance level of 1%. These results are consistent with the results put forward for Model 1.

Revealing the relationship between trade credit policy and firm value raises the question of whether there is causality between them. In this context, Table 6 shows the results of the Dumitrescu and Hurlin (2012) Heterogeneous Panel Causality Test. When the results are examined, a statistically bidirectional causal relationship at a 1% significance level is determined between AR/NS and AR/CA referring to trade credit and Tobin's *Q* and MARKET referring to firm value. Within the framework of the findings obtained, hypothesis 3 is supported. This causal evidence is consistent with Kroes and Manikas' (2014) approach. The causal relationship is not limited only to the relationship between trade credit and firm value. The causal relationships between control variables Growth, the Lev and Size and firm value are also examined, and statistically significant bidirectional causal relationships are determined. The fluctuations in the companies' sales and total net sales cause the abovementioned relationships in firm value. Moreover, changes in the debt/equity structure of companies may have caused the firm value previously mentioned.

**Table 5. Deviations from optimal level of trade credit and firm value**

| Variables | Tobin's *Q* | | Market | |
|---|---|---|---|---|
| AR/NS | 0.074***<br>(0.005) | | 0.206***<br>(0.011) | |
| $(AR/NS)^2$ | 0.002***<br>(0.001) | | 0.005***<br>(0.002) | |
| AR/CA | | 1.059***<br>(–0.122) | | 2.154***<br>(0.268) |
| $(AR/CA)^2$ | | –0.597***<br>(0.138) | | –1.598***<br>(0.311) |
| DEVIATION AR/NS | –0.129***<br>(0.009) | | –0.336***<br>(0.018) | |
| DEVIATION AR/CA | | –0.500***<br>(0.043) | | –0.931***<br>(0.053) |
| Growth | –0.076***<br>(0.005) | –0.100***<br>(0.006) | –0.190***<br>(0.011) | –0.221***<br>(0.010) |
| Lev | 0.000<br>(0.002) | 0.001<br>(0.001) | 0.228***<br>(0.004) | 0.239***<br>(0.004) |
| Size | 0.025***<br>(0.002) | 0.003<br>(0.002) | 0.041***<br>(0.004) | –0.005***<br>(0.003) |
| Crisis dummy (2008–2009) | –0.144***<br>(0.005) | –0.163***<br>(0.005) | –0.231***<br>(0.007) | –0.262***<br>(0.007) |
| AR(–1) | –2.0491<br>[*p* = 0.0405] | –2.0521<br>[*p* = 0.0402] | –3.4885<br>[*p* = 0.0005] | –3.4789<br>[*p* = 0.0005] |
| AR(–2) | 0. 27759<br>[*p* = 0. 7813] | 0.24773<br>[*p* = 0.8043] | 0.5042<br>[*p* = 0.6141] | 0.38774<br>[*p* = 0.6982] |
| Sargan test | 94.5309<br>[*p* > 0.10] | 94.6322<br>[*p* > 0.10] | 92.0565<br>[*p* > 0.10] | 95.1865<br>[*p* > 0.10] |
| Year dummy | YES | YES | YES | YES |
| Industry dummy | YES | YES | YES | YES |

Note: Four lags and a two-step system GMM estimator are used to conduct all estimations. All the variables are endogenous, and the instruments are lagged independent variables. Market value of equity plus book value of total debt to total assets, which is the dependent variable is *Q* (Tobin's *Q*), are in columns 1, 2, 3 and 4. The percentage of market capitalization of the company to equity book value, demonstrated in columns 1, 2, 3 and 4, is used as the dependent variable in the proxy firm evaluation process. Deviation is measured by Deviation AR/CA and AR/NS. Growth, the Lev, and Size are the control variables. All regressions include industry and time dummies. Sector insignificant is excluded, and it is calculated by not using a constant term. Under the null hypothesis of no serial correlation, AR(–1) is a test statistic for first-order autocorrelations, while AR(–2) is second-order in residuals, distributed as standard normal N (0,1). Under the null hypothesis of instrument validity, the Sargan test is used to over-identify the constraints, distributed as chi-squares. Numbers in brackets are standard errors. Significance at 1%, 5%, and 10% is indicated by the symbols ***, ** and *, respectively.

Source: own work.

**Table 6. Dumitrescu-Hurlin (2012) heterogeneous panel causality test**

| Null hypothesis: | | | Walt Statistics | Zbar Statistics | *p*-value |
|---|---|---|---|---|---|
| **Dependent variable: Tobin's *Q*** | | | | | |
| AR/NS | ⇏ | Tobin's *Q* | 1.63912 | 4.01067 | 0.0001*** |
| Tobin's *Q* | ⇏ | AR/NS | 1.46678 | 2.85700 | 0.0043*** |
| $(AR/NS)^2$ | ⇏ | Tobin's *Q* | 1.34091 | 2.01441 | 0.0440** |
| Tobin's *Q* | ⇏ | $(AR/NS)^2$ | 1.41357 | 2.50081 | 0.0124*** |
| AR/CA | ⇏ | Tobin's *Q* | 1.83542 | 5.32476 | 0.0000*** |
| Tobin's *Q* | ⇏ | AR/CA | 1.56642 | 3.52400 | 0.0004*** |
| $(AR/CA)^2$ | ⇏ | Tobin's *Q* | 1.82303 | 5.24187 | 0.0000*** |
| Tobin's *Q* | ⇏ | $(AR/CA)^2$ | 1.46982 | 2.87735 | 0.0040*** |
| **Dependent variable: Market** | | | | | |
| AR/NS | ⇏ | Market | 1.50918 | 3.14085 | 0.0017*** |
| Market | ⇏ | AR/NS | 1.77017 | 4.88795 | 0.0000*** |
| $(AR/NS)^2$ | ⇏ | Market | 2.81571 | 3.40786 | 0.0007*** |
| Market | ⇏ | $(AR/NS)^2$ | 3.48056 | 6.50898 | 0.0000*** |
| AR/CA | ⇏ | Market | 1.56792 | 3.53405 | 0.0004*** |
| Market | ⇏ | AR/CA | 2.09444 | 7.05873 | 0.0000*** |
| $(AR/CA)^2$ | ⇏ | Market | 1.57463 | 3.57895 | 0.0003*** |
| Market | ⇏ | $(AR/CA)^2$ | 2.08676 | 7.00735 | 0.0000*** |

Note: Significance at 1%, 5%, and 10% is indicated by the symbols ***, ** and *, respectively.

Source: own work.

# Conclusions

Trade credits are crucial, as they constitute a significant part of the company's balance sheets and are included in the working capital elements. Trade credits have been a large and growing source of finance in all sectors of the world since the Second World War, especially in the United States economy (Nadiri, 1969). There is growth in Turkey as well; this funding source has reached a considerable level. One of the many factors contributing to this importance is that the development of financial and capital markets is limited or not developed in large volumes. In cases where market conditions cannot adequately meet companies' financial needs, companies meet these needs among themselves through trade credit financing. Consequently, there are indications that constraints in financial markets can affect companies' decisions regarding trade credit, and such decisions may, in turn, influence the firm's value (Lewellen et al., 1980). For this reason, this study focuses on the relationship between trade credit policy and firm value, with quarterly data of 103 selected firms in an emerging market such as Borsa Istanbul manufacturing industries in Turkey for 2005Q1–2018Q4.

Firms that try to increase their market value by taking advantage of trade credit face financial risks after a certain point. Therefore, this study claims that there is a nonlinear (quadratic) relationship between trade credit investments and firm value. In addition, Martínez-Sola et al. (2013) suggested a nonlinear relationship between trade credit investments and firm value in their study on SME's in Spain. Thus, the present study reveals that the results obtained from study by Martínez-Sola et al. (2013) are valid for manufacturing companies operating on Borsa Istanbul. One of the striking results of this study is that there is a cost-benefit balance in trade credit. Account receivables investments increase firm value with certain motivations and benefits. However, after a certain stage, investors force the firms to reduce trade credit due to liquidity constraints, decreased profits, financial risk, and opportunity cost. Although the finance manager demands an expansion in trade credit due to operational, financial and commercial benefits, the trade credit will be stopped by the investors when the firm value is at its maximum level. Therefore, it is concluded that there is an inverted U-shaped relationship between trade credit and firm value.

Another interesting finding of the study is that the financial crisis had a negative effect on firm value by including the years 2008–2009 as a crisis dummy in the model. The adverse effects on the market values of firms in times of crisis enable trade credit to expand. For example, a firm invests at low levels of trade credits. In that case, it may take advantage of trade credits to eliminate the negative impact of the financial crisis on the firm's value and prevent a decline in firm value. Moreover, it can be said that Modigliani and Miller's optimal capital structure, Modigliani and Miller (1963)'s argument tax and Jensen's (1986) free-cash-flow are valid in BIST manufacturing firms. Finally, one of the original aspects of the present study is that the bidirectional causal relationship between trade credit policy and firm value was revealed. While investment in account receivables causes changes in firm value, firm value changes also generate changes in account receivables investments. In reality, it is no surprise that this relationship exists. Significantly, the idea of increasing firm value by using falling market values as a lifeline during crisis periods shows that there is a causal relationship between them. This study reveals the existence of this relationship. On the other hand, the increase in sales, net sales of the company, and the use of leverage can be explained as the dynamics that determine the firm value of the companies. Due to these features, this study makes a significant contribution to the literature and is the first to express this view.

From the standpoint of policy recommendation, in this study, the turning point of the account receivables of 103 Borsa Istanbul manufacturing companies included in the sample is examined. From this perspective, for BIST manufacturing firms, this study has identified a sectoral average that will maximize both the firm and market values through trade credit policy. With the calculated turning point identified, it becomes possible for the aforementioned firms to develop policies within this framework. When compared to (Martínez-Sola et al., 2013), which is one of the most important studies conducted in the literature, account receivables investment is more crucial in terms of the account receivables investment of BIST manufacturing companies, with a more elastic structure and among working capital elements.

The most important constraint of this study is that it only deals with trade credit investment, financial crises, sales and fluctuations, optimal capital structure, and firm value relations. Undoubtedly, many internal and external factors affect firm value. These relationships can be evaluated together with macroeconomic indicators, trade loans, and net trade credit. Moreover, this study's analysis can be expanded with more recent econometric tests on different sub-sectors and countries.

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# Appendix

**Table A1. Variable definitions**

| No. | Proxy | Variable definitions | Unit and measurement |
|---|---|---|---|
| 1 | Q | The Ersatz for firm value is identified as Tobin's Q (Chung and Pruitt, 1994). The ratio of a company's book value to its market value. It is calculated as the ratio of total assets to the market value of equity plus the entire book value of debt. | ratio |
| 2 | Market | The market-to-book ratio is the proportion of equity's book value to market value. | ratio |
| 3 | AR/NS | Accounts receivable. Accounts Receivable as a percentage of Net Sales | ratio |
| 4 | AR/CA | Accounts receivable. Accounts receivable to Current Assets Ratio | ratio |
| 5 | Growth | Growth opportunities, or a rate of annual sales growth, calculated as $[(t_2 - t_1) / t_1]$ | ratio |
| 6 | Size | The natural logarithm of net sales is used for calculating firm size. | natural log |
| 7 | Lev | Total debt divided by total assets pertains to leverage. | ratio |
| 8 | STD/TS | Short-term financing is measured as current liabilities to net sales to determine short-term leverage. | ratio |
| 9 | FE/TD | The ratio of financial costs to outside financing less trade creditors is the cost of external financing. | ratio |
| 10 | NIA/TS | Internal finance, or cash flow, is calculated as earnings after tax plus depreciation, and amortization divided by total sales. | ratio |
| 11 | TA/TO | The ratio of sales to assets minus accounts receivable is used to determine a company's asset turnover. | ratio |
| 12 | EBITDA/TS | Earnings before interest, taxes, depreciation, and amortization divided by total sales is referred to as the profit margin. | ratio |
| 13 | Crisis | The Crisis Dummy is equal to "1" in 2008 and 2009 and "0" otherwise. | dummy |
| 14 | Industry($I_{it}$) | Industry Dummy: Divided into 9 sub-sector(1 – Food, Beverage and Tobacco, 2 – Textile, Wearing Apparel and Leather, 3 – Wood Products Including Furniture, 4 – Paper and Paper Products Printing, 5 – Chemicals, Petrol Rubber and Plastic Products, 6 – Non-Metallic Mineral Products, 7 – Basic Metal, 8 – Fabricated Metal Products Machinery Electrical Equipment and Transportation Vehicles, 9 – Other Manufacturing Industry | dummy |
| 15 | ($u_{it}$) | Unobservable heterogeneity | real number |
| 16 | ($Y_t$) | Refers to the time effects and are year dummy variables | real number |
| 17 | ($u_{it}$) | Residuals | real number |

Source: own elaboration and inspired by (Martínez-Sola et al., 2013).

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