

# Inventory management and performance of Brazilian firms (2010-2016)

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## **Resumo:**

*The inventory management faces a trade-off which affects firms in the relationship between maintaining high inventories and decreasing the probability of stock-outs or keeping inventory levels lower and applying the excess cash to other investments. Thus, this paper will investigate the relationship that exists between inventory management and performance between-financial Brazilian firms listed in the BM&FBovespa from 2010 to 2016. Inventory is not a relevant factor in the revenues of all the firms of the initial sample. The sample is refined through a simple linear regression to only comprise firms with a significant relationship between inventory and revenue. The results indicate that the model which considers Tobin's Q measurement of performance shows that there is no relationship between inventory and performance. However, a robustness check was done using the ROA to measure the performance and in this scenario, there is a statistically inverted U-shaped relation between the profitability, the net trade cycle and its square. This means that H1 and H2 would be confirmed and from these results the study found an optimal level of 244.87 days. These findings have relevant practical guidelines to the Brazilian firms and researchers in the analysis of the performance related to the net trade cycle, which it can be suggested that the Brazilian shareholders are not concerned about internal factors, as the inventory management, but if the firm is being managed profitable.*

**Palavras-chave:** *Inventory Management. Performance. Turning Point.*

**Área temática:** *Custos como ferramenta para o planejamento, controle e apoio a decisões*

## **Inventory management and performance of Brazilian firms (2010-2016)**

### **Abstract**

The inventory management faces a trade-off which affects firms in the relationship between maintaining high inventories and decreasing the probability of stock-outs or keeping inventory levels lower and applying the excess cash to other investments. Thus, this paper will investigate the relationship that exists between inventory management and performance between-financial Brazilian firms listed in the BM&FBovespa from 2010 to 2016. Inventory is not a relevant factor in the revenues of all the firms of the initial sample. The sample is refined through a simple linear regression to only comprise firms with a significant relationship between inventory and revenue. The results indicate that the model which considers Tobin's Q measurement of performance shows that there is no relationship between inventory and performance. However, a robustness check was done using the ROA to measure the performance and in this scenario, there is a statistically inverted U-shaped relation between the profitability, the net trade cycle and its square. This means that H1 and H2 would be confirmed and from these results the study found an optimal level of 244.87 days. These findings have relevant practical guidelines to the Brazilian firms and researchers in the analysis of the performance related to the net trade cycle, which it can be suggested that the Brazilian shareholders are not concerned about internal factors, as the inventory management, but if the firm is being managed profitable.

Keywords: Inventory Management. Performance. Turning Point.

Área temática: Custos como ferramenta para o planejamento, controle e apoio a decisões

### **1 Introduction**

Inventories are the assets that make up, especially in industry and retail, the greater volume of short-term investment of companies. Inventory management decisions are complex where excess cash invested in inventory overwhelms the firm with high inventory maintenance and opportunity costs. High inventory levels, on the other hand, help to increase sales revenue as customers have more flexibility in making purchasing decisions and the company reduces the risk of stock-outs, which is the lack of products on the 'shelf' (Deloof, 2003). Thus, efficient inventory management is a reflection on the firm's operating efficiency, in the seeking of lower storage costs and greater customer loyalty.

Taking into consideration the dynamics of investment decisions of a firm, much is discussed about the trade-off between investing in an asset and its impact on the performance of the organization. The firms expect to maximize its results through management frameworks which provide profitable choices between different classes of assets. When dealing with inventory management one must take into account the costs and variables that can influence this investment from acquisition, manipulation and sale.

Based on these assumptions, the study of Baños-Caballero, García-Teruel and Martínez-Solano (2014) indicate the existence of an inflection point of the inventories in relation to the performance, which implies the existence of an optimal level of investment in working capital that balances costs and benefits and maximizes a firm's value.

According to Kieschnick, Laplante and Moussawi (2013), working capital management is significantly influenced by expectations of future sales, and as a result of this, firms are concerned about the possibility of stock-outs. As evidenced by Corsten and Gruen

(2004), there is a probability that up to 43% of customers will move to another store when they face a lack of product.

As discussed by Baños-Caballero et al. (2014), the valuation of inventories should not be understood only through the indicators that measure their turnover and should take into account the policies of credit to customers and suppliers as well. Thus, this study will address inventory management from the net trade cycle (NTC).

In this context, it seeks to verify how the inventory management trade-off affects firms in the relationship between maintaining high inventories and decreasing the probability of stock-outs or keeping inventory levels lower and applying the excess cash to other investments. This paper aims to evaluate the effects of inventory management on performance and to identify the inflection point of the net trade cycle of the Brazilian companies listed on the BM&FBovespa from 2010 to 2016.

Inventories are an asset that represent a relevant amount of short-term investments for the firms, the study of the existence of an optimal level of inventory investments in relation to the firm's performance and value creation is justified as a collaboration to the understanding of the whether there is an optimal level of inventory or not.

The remainder of this paper is organized as follows. The second section presents the theoretical framework. The third describes the methodology and sample, the fourth discusses the results, and in the last section, we will present concluding remarks, as well as this study's limitations and some suggestions for future studies.

## **2 Theoretical framework**

This section brings up theories on short term assets and performance. It is also about the benefits and costs related to working capital and how inventory management affects the capital structures decisions toward maximizing performance as well as how these resources operate in firms.

### **2.1 Working capital management**

Companies are embedded in an uncertain scenario where working capital management plays a key role in maintaining the financial health of companies during the normal course of business (Scherr, 1989). According to Assaf Neto and Lima (2014), the current assets of an organization support the financial decisions made and enable the growth of the business, due to demand and care.

Therefore, it can say that efficient working capital management is a fundamental part of any firm's overall strategy to create shareholder value (de Almeida & Eid Júnior, 2014). As stated by Schiff and Lieber (1974), both production and credit terms can change over time with the seasonal change in the demand curve and the establishment of rules to react to demand. Recognizing the credit interface and inventory management results in better decision-making.

Firms who are subject to seasonal demand must be able to react to deviations from expected demand. Available operational responses include price changes, installation of extra capacity to allow changes in the rate of production, and the use of customer or product queues (Emery, 1987). Managers faced with the process of seeking resources for investment may adopt an aggressive working capital policy, pressing for lower inventory levels and reducing customer credit policies (Palombini & Nakamura, 2011).

Investment in accounts receivable and inventories represents a significant part of corporate assets, while commercial credit is a key source of funds for many companies (Baños-Caballero et al., 2014). According to Deloof (2003), it shows that most firms have a large amount of money invested in working capital and for this, it is expected that the way in

which these resources are managed will have a significant impact on the firm's performance.

With large amounts invested in working capital, one can expect that the management of these assets will significantly affect a firm's performance and as a result the firm will strive to achieve optimal working capital levels by paying the bills as late as possible, quickly delivering inventories, and charging the accounts receivable. However, this inflection point may vary according to the conditions (Enqvist, Graham & Nikkinen, 2014).

The net trade cycle should be evaluated in relation to the maintenance of liquidity reserve investments, the availability of unused borrowing capacity and the potential volatility in the firm's cash flow (Richards & Laughlin, 1980). In a complementary way Kieschnick et al. (2013) address that the net trade cycle is not about cash management, but it is about the company's management of its net operating working capital and as such, it is management receivables, inventory management and use of commercial credit.

## 2.2 Inventory management and performance

According to Silva and Madeira (2004), inventories are all goods and materials maintained by an organization to meet future demands. Extending this definition, Assaf Neto and Lima (2014) classify them as finished goods, products in process, final products and raw materials that are physically available to the company and used by them in the expectation of starting and finishing the production process or be marketed.

Inventory management is one of the oldest concerns of management-related studies. Firms should adjust market seasonal to the price and production process and have to dispose of products for sale (Scherr, 1989). In inventory management, another key point is how the materials are stored and moved. If this does not happen in a proper way it will cause damages to the materials and, consequently, impose additional costs to the firm (Dandaro & Martello, 2015).

Borges, Campos and Borges (2010), consider that adequate inventory management seeks to reduce the costs involved in the production process and to meet the demand with the lowest possible levels of inventories. According to Deloof (2003), the managers can create value for their shareholders by reducing the number of days of accounts receivable and inventories to a reasonable minimum while the negative relationship between accounts payable and performance is consistent with the view that less profitable companies expect more time to pay their bills.

Regarding da Costa, de Macedo, Câmara and de Sousa Batista (2013), the net trade cycle represents the period which the company will effectively require financing for its activities. This cycle still measures the cash flows, covering all payments and receipts of the company. The days sales outstanding, sales of inventory and payable outstanding represent, respectively, the amount of accounts receivable to sales ratio in days, the inventories to sales in days and the amounts payable to sales in days. The formula for calculating this index is represented as follows:

$$NTC = DSO + DSI - DPO \quad (1)$$

where:

NTC = Net trade cycle

DSO = Days sales outstanding

DSI = Days sales of inventory

DPO = Days payable outstanding

Kieschnick et al. (2013) show that the invested value of short-term capital and the net

trade cycle will decline as the levels of such investment increase. Banos-Caballero et al. (2014), demonstrate the existence of an inverted U-relation between working capital and corporate performance. They imply that there is an optimal level of investment in inventories and credit that balances costs and benefits and maximizes a company's performance. Therefore, managers of companies should seek to maintain the level of inventories as close as possible to this point to avoid the likelihood of stock-outs and loss of performance.

Based on these assumptions, and with the purpose of checking the trade-off between the investment of short term assets and the performance of Brazilian firms, which means the existence of an inflection point between inventories and performance, the following hypotheses were defined for this study:

H0: There is no relationship between the inventory and performance.

H1: There is a positive relationship between lower inventory and performance.

H2: There is a negative relationship between higher inventory and performance.

### **3 Methodology**

This section will discuss the sample and data collection and treatment. It will define the analyzed variables and the expected signs according to the literature, and lastly, it will show the regressive models of analysis for this study.

#### **3.1 Sample and data**

The sample of this study comprised of Brazilian firms listed in the BM&FBovespa from 2010 to 2016 and the data was imported from the Económica database. This period was defined because 2010 was the beginning of the adoption of International Financial Reporting Standards (IFRS) for the Brazilian firms (CVM, 2017). This study only took into consideration the non-financial firms due to accounting and financial characteristics in relation to the financial firms. In addition, the accounting values were deflated by the Brazilian official inflation index (IPCA).

Inventory is not a significant factor from the revenues of all the non-financial firms of the initial sample. Therefore, this study refined the sample to only comprise firms with a significant relationship between inventory and revenue. This approach is going to bring more accurate results about how the performance of a company can be affected by the inventory. This is because there are companies, or even sectors such as Software and Programming, where inventories are non-significant for the revenues of the firms.

Thus, this study used a statistical way to maintain separation. It used a simple linear regression between total sales and inventory to determine which firms had significant levels of inventory for their sales. The initial sample comprised of 337 firms and after this technique was applied, the sample was reduced to 92 firms where 557 firm-year observations were performed.

#### **3.3 Variables definition**

This paper is based on the study of Baños-Caballero et al. (2014), in which the relationship between inventory management and performance in Brazilian non-financial firms is sought. The net trade cycle (NTC) is assigned as the explanatory variable of the study. It corresponds to the amount of the days sales outstanding, plus the days sales of inventory and minus the days payable outstanding.

The model-dependent variable is the performance (PERF). It will be the ratio of the sum of the market value of equity and the book value of debt to the book value of assets, as

well as the one used in previous studies on the relation between net trade cycles and performance (Baños-Caballero et al., 2014; Kieschnick et al., 2013).

Four additional control variables were added to ensure a better fit of the model, namely:

(a) Firm size (SIZE): size can influence firm's working capital management. Larger firms may demand larger investments in working capital due to their higher level of sales and may also be able to use their size to create relationships with suppliers that are necessary for reductions in working capital investments (Kieschnick, Laplante & Moussawi, 2006). For this study, the firm size was calculated by the logarithm of the total assets.

(b) Leverage (LEV): the degree of debt influences decisions related to inventory management. According to Gill, Biger and Mathur (2010), they show a significant negative relationship with performance, which means that the higher the firm's leverage the lower its performance. For this study, leverage was calculated by the ratio total debt to total assets.

(c) Profitability (PROF): profitability is measured by gross operating profit, which is defined as sales minus cash costs of goods sold and is divided by total assets minus financial assets. For some sample companies, financial assets, which are primarily shares of other companies, are a significant part of its total assets (Deloof, 2003). For this study, the calculation of the PROF will be the operating profit on the total assets.

(d) Growth opportunity (GROW): for this study, the growth opportunity is the measured by the ratio of the book value of intangibles, assets, and the total assets as reported in the study of Baños-Caballero et al. (2014), this variable demonstrates the investment in assets who provide new sources of growth.

The variables used in this study are represented in Figure 1:

Figure 1 - Summary of variables

Variables	Acronym	Definition	Signal Expected	Base Study <sup>a</sup>
<b><u>Explanatory Variable</u></b>				
Net trade cycle	NTC	Sum of days sales outstanding, days sales of inventory and days payable outstanding	(+) (-)	(1) (6)
<b><u>Dependent Variable</u></b>				
Performance	PERF	Ratio of the sum of the market value of equity and the book value of debt to the book value of assets.		(1) (2) (7)
<b><u>Control Variables</u></b>				
Firm Size	SIZE	Natural logarithm of sales	(+)	(1) (2) (3) (4)
Leverage	LEV	Ratio of total debt to total assets	(-)	(1) (3)
Profitability	PROF	Return on assets	(+)	(1) (4)
Growth Opportunities	GROW	Book value of intangibles assets to total assets	(+)	(1)
(a) Based researches: (1) Baños-Caballero et al. (2014); (2) Kieschnick et al. (2013); (3) Palombini and Nakamura (2011); (4) Deloof, (2003); (5) Afza and Nazir (2008); (6) Shin and Soenen (1998); de Almeida and Eid Júnior (2014).				

Source: Elaborated by the authors

### 3.3 Technical analysis model

The data of this study will be treated with the software Stata and the Multiple Regression technique and will be used with panel data that, according to Andrade and Galina (2013), analyzes the variations of the transversal units simultaneously with the variations of the individual units over time.

In order to identify the relation of significance of the net trade cycle to the performance of Brazilian companies, the following multiple regression model was developed:

$$PERF = \beta_0 + \beta_1 NTC_{i,t} + \beta_2 NTC_{i,t}^2 + \beta_3 SIZE_{i,t} + \beta_4 LEV_{i,t} + \beta_5 ROA_{i,t} + \beta_6 GROW_{i,t} + \sum_j^{j-1} \beta_j YEAR + \varepsilon \quad (2)$$

For this regression model, tests will be carried out to verify the best model to be used, and tests will be made to detect and treat the presence of outliers, multicollinearity, heteroscedasticity and autocorrelation as well.

From the coefficients of the net trade cycle it is possible to determine the turning point for performance and this point is calculated according to the following formula:

$$Turning\ point = -\beta_1 / 2\beta_2 \quad (3)$$

In this step, it is expected that there is a distinct relationship of signals between the first and second angular coefficients of the model.

## 4 Results

This section discusses the results of this study. It seeks to show the relationship between inventory management and performance in order to verify the existence of a nonlinear relation between the variables due to the existence of a turning point in this relation. Finally, we verify the results found from the robustness check. The data from this study were taken from the Economática database and the sample corresponds to the Brazilian non-financial companies from 2010 to 2016 listed in BM&FBovespa. For the analysis of the data of this study, possible extreme data (outliers) were treated with the use of the winsorization technique at 0.025.

### 4.1 Descriptive statistics

Before analyzing the results, the descriptive data of the study is presented, showing the composition of the data of the proposed model. The table below reports the number of observations, mean, standard deviation, maximum and minimum. Table 1 presents some descriptive statistics of the regressive model of analysis in which it shows that the average performance is of 0.85% and the average net trade cycle is 103.41 days.

Table 1 - Descriptive statistics

Variables	Observations	Mean	Standard Deviation	Minimum	Maximum
PERF	690	.8538916	.6247626	.1240088	3.097835
NTC	806	103.4134	161.5574	-229.2126	660.1008
SIZE	805	21.14352	2.028813	16.96877	25.01314
LEV	818	.3338608	.2058632	0	.9099082
PROF	818	.039557	.1075081	-.3417852	.2393675
GROW	657	.087861	.1416442	0	.5602142

*Note.* Variables: PERF – Performance; NTC – Net trade cycle; SIZE – Logarithm of sales; LEV- Leverage; PROF – Profitability; GROW – Growth Opportunities.

Source: Elaborated by the authors

Table 2 presents the correlation matrix of the model proposed. The data demonstrates that the variables have low correlations between them, which corresponds to a good index of low endogeneity and autocorrelation of the regressors. In addition, we used the VIF test to verify the presence of multicollinearity among the variables, and the mean VIF of the model was 2.20, which demonstrates the nonexistence of multicollinearity problem.

Table 2 - Correlation Matrix

	PERF	NTC	SIZE	LEV	PROF	GROW
PERF	1.0000					
NTC	-0.1140	1.0000				
SIZE	0.1473	-0.1623	1.0000			
LEV	0.0047	0.0103	0.0759	1.0000		
PROF	-0.0067	-0.2416	0.3719	-0.0615	1.0000	
GROW	0.4175	-0.1030	0.3133	-0.0600	0.0474	1.0000

*Note.* Variables: PERF – Performance; NTC – Net trade cycle; SIZE – Logarithm of sales; LEV- Leverage; PROF – Profitability; GROW – Growth Opportunities.

Source: Elaborated by the authors

#### 4.2 Effects of net trade cycle on performance by Tobin's Q

In order to ascertain the relationship between the performance and the net trade cycle, a nonlinear regression was used with fixed effects. It was determined by the performance of tests proposed in the methodology and the results are represented in Table 3. It is important to highlight that the net trade cycle represent lower levels inventories and the its square represent the higher levels of inventories.

The results obtained from the proposed model confirm the null hypothesis (H0) of the study wherein there is no relation between the net trade cycle and the performance in Brazilian non-financial firms. This implies the nonexistence of an inflection point between the performance and net trade cycle of Brazilian non-financial firms in the analyzed period

due to the absence of significance in both coefficients of the net trade cycle (NTC and NTCSQ). This finding can be analyzed from the standpoint of stock-outs in which inventory levels affect the performance due to a lack of products and the probability of customer evasion and, thus, loss of sales, as shown by Corsten and Gruen (2004).

As evidenced in the results, the additional variables of this study, introduced to control for other potential influences on the performance of the firm, presented its level of significance. Wherein in the model proposed there are three significant variables, the size negatively and debt level and profitability are positively significant for the performance of the firms. In addition, it is noted that size and growth opportunity have a weak significance at 10%, while the leverage has a strong relationship with the profitability measured by the value of the firms.

Table 3 - Estimated Results

Model Variables	PERF – Performance (Tobin's Q)	
	Expected signal	Fixed effects model
Constante		2.2378***
NTC	(+)	-0.0283
NTCSQ	(-)	0.0066
SIZE	(+)	-0.0679*
LEV	(-)	0.8742***
PROF	(+)	0.6222*
GROW	(+)	-0.4335*
<b>Observations</b>		557
<i>Year Dummy</i>		Yes
<b>Adjusted R-Squared</b>		0.187

*Note.* Variables: PERF – Performance; NTC – Net trade cycle; NTCSQ – Net trade cycle squared; SIZE – Logarithm of sales; LEV- Leverage; PROF – Profitability; GROW – Growth Opportunities.  
 \* Means that the variable is significant at the 0.1 level.  
 \*\* Means that the variable is significant at the 0.05 level.  
 \*\*\* Means that the variable is significant at the 0.01 level.

Source: Elaborated by the authors

It can be seen that other factors related to inventory management and credit policies affect the performance of Brazilian non-financial firms in the period analyzed. Thus, it showed that the companies analyzed do not present an inflection point in relation to the net trade cycle and the performance that would indicate an optimum level of inventory, payment of suppliers and customers.

#### 4.3 Robustness check

In order to check out the empirical and theoretical robustness of the results found, the same analyses were performed using the return on assets (ROA) as the dependent variable. This approach was used by Baños-Caballero et al. (2014) in their robustness check and they

found the same results as when they analyzed the performance from the value and profitability outlook, and Deloof (2003), which found a significant negative relation between gross operating income and net trade cycle of Belgian firms.

Table 4 shows that when using a performance measured by the ROA, it is implied that there is an optimal point between inventory management and performance. It is because the results of the regression show the existence of a statistically inverted U-shaped relation between the profitability, the net trade cycle and its square. Therefore, these findings meet the results of Baños-Caballero et al. (2014). Thus, the coefficients for net trade cycle variables allow us to determine for our sample, the turning point in the relationship between performance of firms and net trade cycle. We found the turning point to be 244.87 days.

The results indicate that lower levels of inventories improve the performance due to the possibility that the firms have increased and improved their sales and credit policies, as evidenced by Baños-Caballero et al. (2014). The second moment where the increase in the level of inventories are related with a decrease of the performance, demonstrates that higher inventories result in low inventory turnover, too long credit policies and missing opportunity costs. These results meet the findings the Baños-Caballero et al. (2014), Deloof (2003) and Kieschnick et al. (2013). It means that when evaluating performance by profitability, the hypotheses of H1 and H2 would be confirmed; in which lower inventory levels have a positive relation with performance while higher inventory levels have a negative relation with performance.

Table 4 - Estimated results of the robustness check

Model Variables	Value Outlook	Profitability Outlook
	PERF - Tobin's Q	ROA – Return on assets
Constante	2.2378***	-0.6380***
NTC	-0.0283	0.0191**
NTCSQ	0.0066	-0.0039***
SIZE	-0.0679*	0.0373***
LEV	0.8742***	-0.1988***
PROF	0.6222*	
GROW	-0.4335	-0.3304***
<b>Observations</b>	557	647
<i>Year Dummy</i>	Yes	Yes
<b>Adjusted R-Squared</b>	0.187	0.227

*Note.* Variables: PERF – Performance; NTC – Net trade cycle; NTCSQ – Net trade cycle squared; SIZE – Logarithm of sales; LEV- Leverage; PROF – Profitability; GROW – Growth Opportunities.  
 \* Means that the variable is significant at the 0.1 level.  
 \*\* Means that the variable is significant at the 0.05 level.  
 \*\*\* Means that the variable is significant at the 0.01 level.

Source: Elaborated by the authors

Therefore, this study shows that the relation between the net trade cycle and the performance in the Brazilian firms is presented as non-significant when it is portrayed from

the value outlook, which means that the shareholders only bear in mind if the firm is being profitable. When the Brazilian firms are analyzed from the profitability outlook, it reflects the decision-making of the managers, which are based on the increase of performance for achieving their goals. They also take into account the net trade cycle as a significant variable which presents an optimal level in relation to performance.

## 5 Conclusions

This paper aimed to evaluate the effects of inventory management on performance and to identify the existence of the inflection point of the net trade cycle of the non-financial firms listed on the BM&FBovespa from 2010 to 2016. It used a multiple nonlinear regression and the data was extracted from the Economática database. The sample is comprised of non-financial quoted firms from Brazil, which are listed in the BM&FBovespa. It applied a simple linear regression for each firm and then it selected all the firms that have a significant relationship between their inventories and revenues. After this, the sample it was composed of 92 firms with 557 firm-year observations.

The results of the study in a first instance confirms the H0 hypotheses, no relation between net trade cycle and performance. It is because the model that uses Tobin's Q for measuring performance do not present a significant relationship among both coefficients of the net trade cycle (NTC and NTCSQ) and performance measured throughout the value of the firms. However, when the firms are evaluated by profitability (ROA), the results show a presence of an inverted U-shaped relation between net trade cycle and performance. These findings meet the results of Baños-Caballero et al. (2014), which represents an existence of an optimal level, which for this study is 244.87 days.

These findings have relevant practical guidelines to the Brazilian firms and researches in the analysis of the performance related with the net trade cycle. First, because the results demonstrate a presence of an inflection point of net trade cycle and profitability, managers can seek an optimal way of managing short term assets. Second, our findings indicate differences between the outlooks from value and profitability in the Brazilian firms, which can suggest that the Brazilian shareholders are not concerned about the inventory management, if the firm is being managed profitably

The limitations of this study are in not addressing external factors that influence the decision making of the managers related to performance. Consequently, it should be noted that the measured performance is influenced by macroeconomic factors and, therefore, is not limited to just the factors inherent to the management of the firm's working capital and inventory.

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