The impact of product variety on fill rate, inventory and sales performance in the consumer goods industry

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Abstract

Purpose – The impact of product variety decisions on fill rate, inventory and sales performance in a consumer goods company has been examined. From a marketing perspective, it is possible to leverage sales, reach new segments and consequently increase competitiveness when there is a greater product variety on the market. However, operations and logistics professionals indicate potential impacts on the supply chain, such as production, storage and distribution complexity. The nature of the product variety-cost-sales performance relationship is not clear, and empirical evidence about whether and how operations cost and sales performance increases with variety is inconclusive.

Design/methodology/approach – The multiple linear regression and the Tobit regression techniques were applied over a seven-year horizon of data from a business intelligence platform of a consumer goods company.

Findings – Our results show that sales performance is negatively associated with product variety. The total effect of product variety on sales performance has been examined, including both the direct effect and the indirect effect through inventory and fill rate. Therefore, the findings provide a comprehensive understanding of the impact of product variety on operations and sales performance.

Originality/value – Several studies have researched the impact of product variety on fill rate, inventory and sales performance separately; however, the research of the impact and the relationship of these factors is scarce and limited.

Keywords Product variety, Inventory, Sales, Fill rate

Paper type Research paper

1. Introduction

In times of broad competitiveness, the search for market expansion strategies, diversification and even survival means that companies seek different alternatives not only to react to competition, but also to reach new customers, meet consumer demands, consolidate their position in the market and thrive in business. In this context, the full comprehension of the impact of product variety on company operations and results is fundamental to corroborate with company strategic plans and objectives.

Product variety is defined by the number of different products a company offers to the consumer (Brun and Pero, 2012). These products may be different regarding packaging characteristics, such as sizes of bottles or packaging (70 g, 90 g, 180 g, 250 mℓ, 500 mℓ, etc.) or manufacturing characteristics, such as the variation of formula composition, taste, fragrance and even the brand (Wan *et al.*, 2014). This variety emerges as an option to generate greater competitiveness and is directly linked to the strategies of companies in meeting customer preferences, as well as increasing sales performance (Yu, 2012). However, strategic effects of product variety can lead to relevant inefficiencies in quality or prices (Granero, 2019).

Marketing professionals have emphasized significant advantages with the introduction of new products. On the other hand, operations managers have focused on reducing operations cycles and shortening the time to respond to consumer needs (Lindsley *et al.*, 1991), as well as manufacturing alternatives to provide greater assortment of products and reduced costs. Despite the possible gains, the modern supply chain is set in challenging environments given

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the short product life cycles, high levels of customization and product variety (Bozarth *et al.*, 2009) and may have its complexity expanded due to product proliferation impacting, for example, on inventory management and distribution centers (Scavarda *et al.*, 2010). Yet, demand forecasting becomes more difficult given the greater presence of innovative products compared to functional products (Fisher, 1997), added to the possibility of generating diseconomies of scale and higher costs in operations (Yu, 2012). Some authors raise the point that SKU rationalization might be an advantageous strategy for high variety businesses as it drives lower production, transportation costs and inventory simplifications (Malinowski *et al.*, 2018).

1.1 Problem statement

The marketing literature indicates that increased product variety helps to increase sales performance (Nishino *et al.*, 2014; Berger *et al.*, 2007; Lancaster, 1990), while the operation management literature suggests that product variety may negatively affect inventory turnover (Wan *et al.*, 2019, Wan and Sanders, 2017). The nature of the product variety-cost-sales performance relationship is not clear, and empirical evidence about whether and how operations cost and sales performance increases with variety is inconclusive. Despite the vast product variety literature, it was possible to observe that researchers have not simultaneously examined the impact of variety on downstream processes in an empirical way, such as distribution, inventory management, fill rate and sales. These areas could be very important in practice, depending on the relative proportion of costs attributable to each stage of the supply chain. Simply increasing variety does not guarantee an increase in long run profits and can in fact worsen competitiveness. So far little research is available with regards to evaluating the impact of increasing product variety on fill rate, inventory and sales performance over a long period of time, as proposed by this study.

1.2 Research questions

What are the direct and indirect effects of product variety on inventory, fill rate and sales? Are there differences in the results of developed and emerging markets? When compared to previous researches, does the current study about a consumer goods company show differences in results?

1.3 Objective

The objective of this research is to evaluate the impact of product variety on fill rate, inventory and sales performance using a balanced panel data set from a consumer goods distribution center operation. Summing up, the following aspects have been evaluated and educidates: (1) the impact on the fill rate when there is an increase in product variety, (2) the impact on sales performance when there is a high fill rate, (3) the impact on sales performance when there is a greater product variety and (4) the impact of the variety on the inventory, (5) as well as the inventory on sales.

1.4 Method

To study these impacts associated with product variety empirically, archival data have been collected from a major consumer goods company in the toothpastes industry. The final dataset contains 2,242 observations during seven years at three distribution centers. The dataset includes product variety, sales, average inventory, fill rate and other operational variables at the distribution center-period level. Statistical analyses, such as multiple linear regression and the Tobit regression, were conducted to evaluate the impacts of product variety on the given variables.

This paper is structured as follows. The next section provides a review of the product variety literature and presents five hypotheses based on the literature. The research

methodology is developed in the third section. The fourth section reports the main statistical results. A discussion of the contributions and implications is in the fifth section, while conclusions, implications and research limitations are discussed in the last section.

2. Literature review

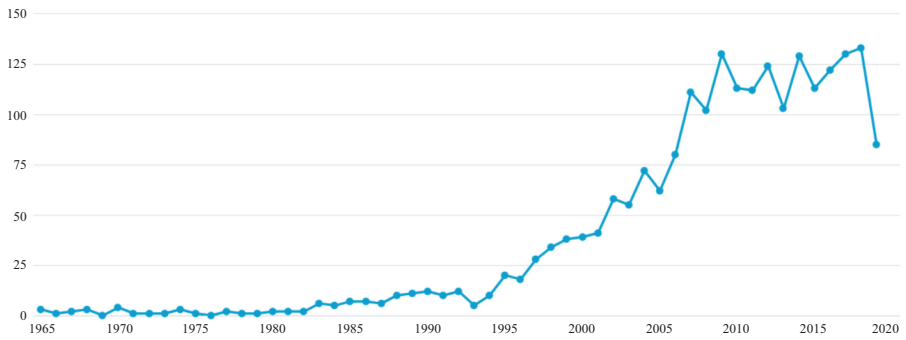
In the late 1990s, the product variety began to draw the attention of the academy to the need to expand knowledge about the subject. The expressiveness and importance of the subject became more and more evident as the years went by, making researchers, mainly engineers, publish more studies in the last 10 years.

Figure 1 shows the evolution of the subject to the research considering the research database Scopus as a source. The searches had as keywords the expressions 'Product Variety', 'SKU Proliferation', 'SKU Rationalization' and 'Product Assortment' with the intention of checking the literature on the visions related to operations and marketing theories.

A total of 2,184 documents were found with the determined filters, and among them, researches published in the *International Journal of Production Research*, *International Journal of Production Economics*, *Management Science*, *International Journal of Advanced Manufacturing Technology*, *Journal of Operations Management*, *IEEE Transactions on Engineering Management*, *Production and Operations Management*, *Journal of Manufacturing Technology Management*, *Supply Chain Management: An International Journal*, *International Journal of Operations Management*, *European Journal of Operational Research*, *Marketing Science*, as well as other journals related to marketing, economics and retail.

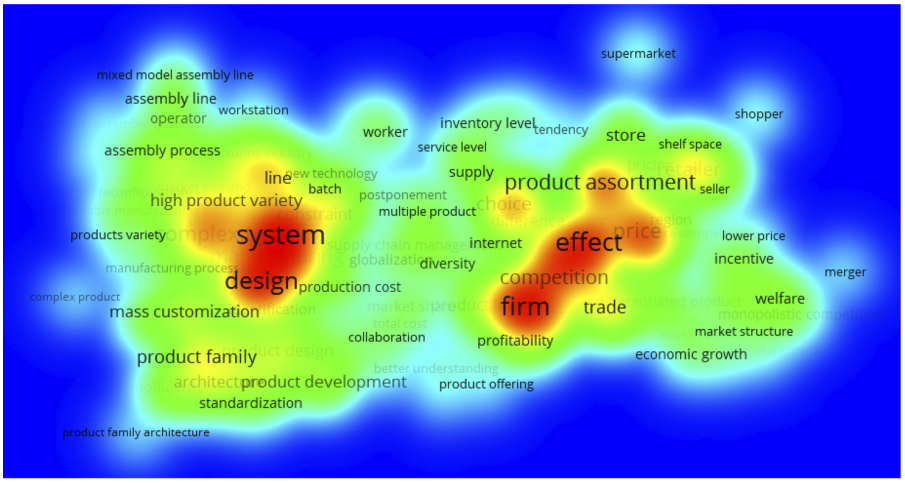
By verifying the density of documents about product variety generated through the Scopus database and with the help of the VOSviewer software, polarization is perceived in terms such as (1) manufacturing design, production system, mass customization, high product variety, product development, production cost, standardization, other manufacturing topics and (2) price, profitability, trade, effect, competition, product assortment, choice, other financial factors and activities related to marketing (Figure 2).

The existing literature can be basically divided between marketing and operations management. The marketing area shows the idea that a high product variety allows a company to satisfy heterogeneous customers and increase the probability of sale (Yu, 2012), which is also valid for the service industry, which has points of customer contact, thus product/service variety management is crucial for daily business (Nishino *et al.*, 2014). On the other hand, the operations area is concerned with operating costs, product quality,



Source(s): Scopus.com (2019)

Figure 1.
Documents published per year on product variety



Source(s): VOSviewer (2019)

Figure 2.
Density of literature papers by theme

manufacturing flexibility (Boer and Boer, 2019), SKU rationalization (Malinowski *et al.*, 2018), inventory management and on-time delivery (Patel and Jayaram, 2014).

2.1 Researches related to influence of product variety on sales

The effects of product variety on other dimensions are relevant points for research around the world. As early as the 1990s, the book industry provided evidence that product variety and time have emerged as prominent dimensions in global competition. The conclusion of Lindsley *et al.* (1991) was that the very existence of the industry depends on the ability of these firms to offer a greater variety of titles shipped in smaller quantities in a relatively rapid fashion. An extensive body of literature has examined the influence of product variety on sales. The literature can be divided into three main streams: marketing, operations management and supply chain management. The marketing literature indicates that increased product variety helps to increase sales performance (Nishino *et al.*, 2014; Berger *et al.*, 2007; Lancaster, 1990); the operation management literature suggests that product variety may negatively affect inventory turnover (Wan *et al.*, 2019; Wan and Sanders, 2017) and the supply chain management literature is concerned with maximizing business profitability by looking at both marketing and operations aspects. Our literature review divides major papers into these three dimensions (see Table 1).

2.2 Variables investigated in the literature

The main variables of the selected studies related to product variety are presented in Table 2 and, although some studies present more possibilities, the most relevant ones were considered in this table. Analyzing the literature, it is possible to highlight the variables of product variety, price/cost, demand, inventory, fill rate and sales, which are present in the largest number of studies on the product variety issues.

2.3 Product variety and general framework of the conceptual model

A conceptual framework represents the researcher's synthesis of literature on how to explain a phenomenon. Our literature review revealed that only two studies tested models to evaluate

Approach	Authors
Marketing	Lancaster (1990); Hui (2004); Scavarda *et al.* (2009); Stäblein *et al.* (2011); Nishino *et al.* (2014)
Operations management	Thonemann and Bradley (2002); Salvador *et al.* (2002); Alfaro and Corbett (2003); Appelqvist and Gubi (2005); Er and MacCarthy (2006); Bozarth *et al.* (2009); Ton and Raman (2010); Closs *et al.* (2010); Pero *et al.* (2010), Rajagopalan and Xia (2012); Yu (2012); ElMaraghy *et al.* (2013); Patel and Jayaram (2014); Zhou and Wan (2017); Wan and Sanders (2017); Malinowski *et al.* (2018); Xiong *et al.* (2018); Boer and Boer (2019); Granero (2019); Alptekinoğlu and Ramachandran (2019); Falkenhausen *et al.* (2019); Lyons *et al.* (2019). Wan *et al.* (2012); Wan *et al.* (2014)
Supply chain management	Lindsley *et al.* (1991); Randall and Ulrich (2001); Brun and Pero (2012); Wan *et al.* (2014); Syam and Bhatnagar (2015); Kautish and Sharma (2019). Wan *et al.* (2019)

Source(s): Prepared by the authors

Table 1. Academic papers related to product variety

the influence of product variety on marketing and operations variables simultaneously in a longitudinal study. Ton and Raman's model (2010) examined the effects of product variety and inventory levels on store sales. They showed that increases in product variety and inventory levels are both associated with higher sales, as Figure 3 shows. This product variety study focused on retail, while the effects of product variety on distributors were not performed.

Wan *et al.* (2012) examine the impact of product variety decisions on an operational outcome (unit fill rate) and on sales performance in distribution centers of a soft drink company. The authors provide the general framework for their research, as shown in Figure 4. The authors found that the total impact of product variety on sales performance initially is positive, although at a diminishing rate, beyond a certain level, increased product variety results in lower sales, i.e. "too much of a good thing."

These two studies motivated us to investigate a combined model of these authors, as shown in Figure 5. The variables investigated were (1) product variety, (2) fill rate, (3) sales performance and (4) inventory. Product variety was hypothesized to have a direct impact on three operational performances, as measured by the fill rate, inventory and on sales. In addition, operational performance was hypothesized to impact sales. Finally, the overall (combined direct and indirect) impact of product variety on sales performance was determined.

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This research examines the impact of product variety on both operations and marketing variables using data from a distributor, a key component in many supply chains often overlooked in previous research (Wan *et al.*, 2012).

2.4 Hypotheses development

2.4.1 Product variety and fill rate. The increase in the product variety tends to produce a negative impact on the level of services (Closs *et al.*, 2010; Falkenhausen *et al.*, 2019), setup times (Er and MacCarthy, 2006) and operational costs (Thonemann and Bradley, 2002), as the internal, organizational and structural complexities of the supply chain increase and thereby decrease operational performance (Bozarth *et al.*, 2009). On the other hand, some authors claim that it is possible to increase variety without affecting the fill rate. Alternatives such as modularity (Pero *et al.*, 2010), process standardization (Salvador *et al.*, 2002), manufacturing flexibility (Rajagopalan and Xia, 2012), mass customization (ElMaraghy *et al.*, 2013) and postponement (Er and MacCarthy, 2006; Xiong *et al.*, 2018) are widely used to provide greater

Table 2.
Research and variables present in the product variety studies

Research/ VariablesProduct	Product variety	Price/ Cost	Demand	Inventory	Service level	Sales	Manufacturing flexibility	Lead time	Quality	Batch/ Prod. volume	Competitiveness	Loyalty/ Brand
Lancaster (1990)	✓	✓		✓		✓						✓
Lindsley *et al.* (1991)	✓	✓		✓	✓			✓	✓			✓
Randall and Ulrich (2001)	✓	✓	✓	✓	✓	✓						
Thonemann and Bradley (2002)	✓	✓	✓	✓			✓	✓		✓		
Salvador *et al.* (2002)	✓				✓		✓			✓		
Alfaro and Corbett (2003)	✓	✓	✓	✓	✓							
Hui (2004)	✓	✓				✓			✓			✓
Appelqvist and Gubi (2005)	✓	✓				✓		✓				
Er and MacCarthy (2006)	✓		✓	✓	✓			✓		✓		
Zhang *et al.* (2007)	✓			✓	✓	✓	✓	✓				
Scavarda *et al.* (2009)	✓	✓				✓	✓	✓				✓
Bozarth *et al.* (2009)	✓	✓	✓		✓		✓	✓		✓	✓	
Ton and Raman (2010)	✓		✓	✓		✓					✓	
Pero *et al.* (2010)	✓				✓		✓	✓		✓		
Closs *et al.* (2010)	✓		✓	✓	✓		✓					
Stäblein *et al.* (2011)	✓		✓			✓	✓					
Rajagopalan and Xia (2012)	✓	✓	✓			✓		✓				
Yu (2012)	✓	✓		✓	✓				✓	✓		

(*continued*)

Table 2.

Research/ VariablesProduct	Product variety	Price/ Cost	Demand	Inventory	Service level	Sales	Manufacturing flexibility	Lead time	Quality	Batch/ Prod. volume	Competitiveness	Loyalty/ Brand
Wan *et al.* (2012)	✓	✓	✓	✓	✓	✓						
Brun and Pero (2012)	✓	✓					✓		✓		✓	
ElMaraghy *et al.* (2013)	✓	✓	✓	✓	✓		✓				✓	
Nishino *et al.* (2014)	✓					✓						✓
Patel and Jayaram (2014)	✓	✓		✓	✓		✓	✓	✓			
Wan *et al.* (2014)	✓	✓	✓	✓	✓	✓					✓	
Syam and Bhatnagar (2015)	✓	✓	✓	✓								
Zhou and Wan (2017)	✓		✓	✓		✓						
Wan and Sanders (2017)	✓		✓	✓		✓						
Malinowski *et al.* (2018)	✓	✓	✓							✓		
Xiong *et al.* (2018)	✓	✓	✓				✓					
Boer and Boer (2019)	✓	✓			✓		✓	✓	✓			
Kautish and Sharma (2019)	✓		✓	✓	✓							
Granero (2019)	✓	✓				✓			✓			
Alptekinoğlu and Ramachandran (2019)	✓	✓			✓		✓					
Falkenhausen *et al.* (2019)	✓		✓		✓			✓				
Lyons *et al.* (2019)	✓		✓	✓	✓	✓	✓	✓	✓			
Total	*35*	*22*	*20*	*19*	*19*	*16*	*15*	*13*	*8*	*7*	*6*	*5*

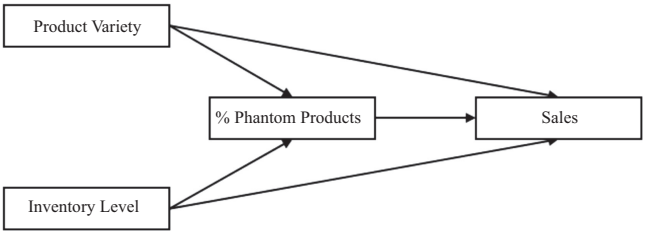
Source(s): Prepared by the authors

product variety and good fill rate at the same time (Appelqvist and Gubi, 2005). Considering that alignment of new products and supply chains is key for success (Pero *et al.*, 2010), practices related to the design-for-variety (DFV) may also provide some positive impact on service performance (Boer and Boer, 2019).

Considering the existing literature, it is expected that in this case:

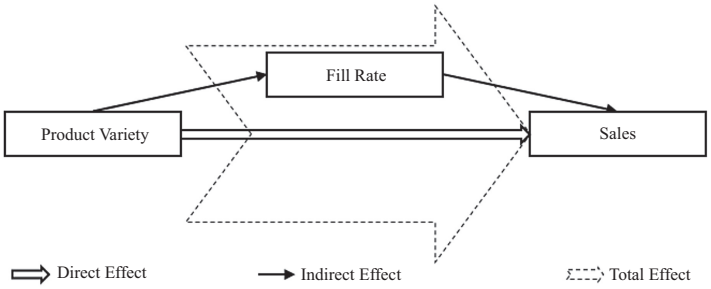
H1. A distribution center's overall fill rate decrease with increased product variety at a diminishing marginal rate.

2.4.2 Fill rate and sales performance. The fill rate is the fraction of customer demand that is met through immediate stock availability, without backorders or lost sales. High fill rate implies low levels of unmet demand, reducing the possibility of product replacement and



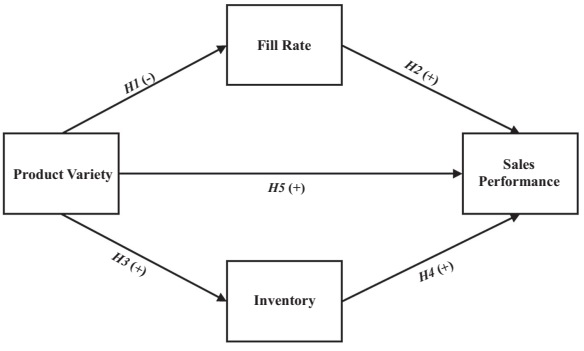
Source(s): Ton and Raman, 2010

Figure 3.
Relationship among product variety, inventory level, phantom products and sales



Source(s): Wan *et al.*, 2012

Figure 4.
The impact of product variety on operational performance and sales



Source(s): Prepared by authors

Figure 5.
Proposed framework of the conceptual model

increasing sales. Increasing distributors' fill rate consequently satisfies retailers' demand and boosts sales performance (Wan *et al.*, 2012). In addition, operational performance – such as fill rate – is indicated as a positive influence for sales performance when associated with the appropriate supply chain strategies (Randall and Ulrich, 2001).

Therefore, it is expected that in this case:

H2. A distribution center's overall sales performance increase with increased fill rate.

2.4.3 Product variety and inventory. Product variety carries significant implications for managing a company's inventory (Yu, 2012). This impact may not only be on finished products, but it may similarly affect the entire supply chain, such as raw materials because of the greater complexity generated for products' formulas (Er and MacCarthy, 2006). One way of meeting sales performance volume and the uncertainties generated by the market volatility stimulated by diversification of product portfolio is the increase in inventory. However, this strategy may jeopardize the capital invested in inventories (Jacobs and Swink, 2011), given that the products may become obsolete (Patel and Jayaram, 2014), damaged or expire as it is usual in fresh food supply chains (Nakandala and Lau, 2018). At the same time, in spite of the well-known growth trend of the inventory level derived from the increase in products, parameters such as process and demand variability, set-up times and production capacity should be considered in the analysis of product variety and inventory (Benjaafar *et al.*, 2004). Additionally, some authors mention that reducing SKUs may be more cost effective than inventory optimization, highlighting the villainous role of product proliferation on inventory levels (Alfaro and Corbett, 2003).

Therefore, it is expected that in this case:

H3. A distribution center's overall inventory level increase with increased product variety at a diminishing marginal rate.

2.4.4 Inventory and sales performance. Higher inventory levels in distribution centers imply greater product availability in several segments, which can potentially increase sales performance chances. The effect of high unplanned sales performance due to product demand volatility can be significant and even consume safety inventories (Jacobs and Swink, 2011). Low sales performance leads to an inventory level being affected (Wan and Sanders, 2017). Nonetheless, there are indications of an indirect negative retail effect between high product variety and high inventory levels. Due to the complexity generated by high variety and inventory, operators can make mistakes in internal logistics and consequently lose sales performance given the lack of supply or product replenishment (Ton and Raman, 2010).

Therefore, it is expected that in this case:

H4. Since the company expects more sales, it keeps more inventory.

2.4.5 Product variety and sales performance. Product variety can be used as an important lever for sales performance because of the greater possibility of the consumers finding a variant that matches their preferences (Syam and Bhatnagar, 2015). The classic Lancaster (1990) study takes an approach to marketing strategies and demonstrates that product choice happens based on its attributes and characteristics. It also shows that increasing the product variety reduces the distance between what the consumer expects and finds in the market, which can boost sales. Nishino *et al.* (2014) correlated the choice of stores in Japan with sales, showing that product variety, which stimulates freedom of choice and carries the impression of optimum product availability (Broniarczyk, 2008), is an important driver to meet the demands of diversified consumers, depending on how the strategy is employed and tends to move from retailers to distributors (Wan *et al.*, 2014), thus enabling increased sales performance (Zhang *et al.*, 2007), not only in physical stores but in the online segment, where product assortment plays a role of a value-added feature to the segment, improving e-tailing

performance (Kautish and Sharma, 2019). However, studies indicate that consumers can move their purchases to other brands or variants, indicating a decline in brand loyalty, as product variety generates more purchasing opportunities (Dawes *et al.*, 2015). More products do not always lead to higher profits when consumer preferences are more uncertain (Alptekinoğlu and Ramachandran, 2019). It is still necessary to consider that in some product categories, the most reliable manufacturers have a competitive advantage over retailers' brands (Cho *et al.*, 2015) and are leading the way in the sales performance race. While the advantages of product variety are presented, it is necessary to consider the direct substitutes, which by their similarity can generate cannibalization of existing products and negative growth rates (Hui, 2004).

Therefore, it is expected that in our case:

H5. A distribution center's overall sales performance increase directly with increased product variety at a diminishing marginal rate.

All hypotheses are shown in Figure 5. H1/H2 and H3/H4 represent the indirect path from product variety to sales performance via the fill rate and inventory level. The direct impact on sales performance from product variety is identified by H5. The total effect of product variety on sales performance includes both direct and indirect effects and is assessed by the combination of the impacts proposed in the three paths.

3. Methodology

3.1 The toothpaste industry

Toothpastes are usually marketed as paste, gel or powder and are used for dental hygiene, removing food debris and staining of tooth surfaces. The simplified production process of toothpaste consists of the combination of selected raw materials for the desired formula in a mixer with parameters, such as controlled temperature and humidity. The filling sector operates machines that will allow the filling and sealing of tubes with the toothpaste previously manufactured. After these processes, the tubes are packed into individual cartons and will later be unitized in the form of plastic film packages, e.g. a dozen. The packages are placed in shipper cases, which will finally compose the product pallets, allowing the products to be sent to distribution centers. Raw materials, packaging materials, packaging and final product sizes, palletizing and batch size vary according to each product, based on branding strategies, product application, manufacturing and distribution. Having a product with stripes, as a case in point, may involve different processes. For this case, it is necessary to work in separate manufacturing tanks with creams and gels and filling machines with nozzles specially designed for filling the tube (Crest.com, n.d.).

Brazil's toothpaste market is huge with potential growth opportunities. Brazil is among the fastest growing beauty industries in the world, with the toothpaste market as one of the leading markets. It is also one of the leading markets among toothpaste markets of BRICS countries. Products like toothpaste have high penetration in Brazil's society; however, companies have opportunities to develop products with specific features under secondary oral care products. Brazil is the world's fifth largest market for toothpaste and the largest market in Latin America. The market is also marked by the presence of global companies offering products from their international portfolio to provide for a wider range of options to the local consumers.

The toothpaste industry has a multi-tiered distribution structure. End customers purchase toothpaste products at retail stores such as supermarkets and convenience stores such as pharmacies. Retail stores are supplied by specific distribution centers assigned based on geography. There are generally no overlapping delivery areas among distribution centers, allowing each distribution center to have a stable and mutually exclusive set of retail stores as their customers. Stock-outs occur when a distribution center cannot satisfy an order from a given retail outlet, since orders are frequently placed by retailers.

3.2 Sample

Seven years of data – from 2010 to 2016 – were collected directly from the business intelligence platform of a consumer goods company that operates with distribution centers in Brazil. The family of products investigated is the toothpaste, considering 31 subfamilies, responsible for approximately 48% of this company revenue in the studied period. This family of products reached a total of 327 stock-keeping units (SKUs) sold over the seven years and directly served more than 3,200 customers, including wholesalers, large retailers, small stores and pharmacies spread throughout the 26 states and federal district of the country. Data were collected on a monthly basis from each distribution center, totaling 2,242 observations after disregarding invalid and inconsistent data. Satisfactory results were found. The distribution centers have unique codes for each product. An SKU is differentiated by having a unique combination of size, packaging, composition (toothpaste formula) and brand. Many of the classic statistical quality control techniques, such as pareto charts and control charts, were used to track and evaluate the quality of the company's data. The distribution center-level data collected consist of the number of products sold, fill rate, inventory and sales performance per month for all toothpaste products carried by the distribution center. Product variety was calculated as the number of SKUs carried by a distribution center in a given month.

3.3 Measurements

These research variables can be verified in Table 3. They were defined based on theory to support the analysis of sales, fill rate, inventory and product variety, providing an approach not only to supply chain but also to marketing.

3.3.1 Product variety. Product variety is defined by the quantity of SKUs sold at a distribution center in a given month, which is a measure well accepted by several authors, such as Randall and Ulrich (2001), Alfaro and Corbett (2003), Stäblein *et al.* (2011) and Wan *et al.* (2012). Although the literature deals with product variety in three dimensions – internal, external and dynamic (Stäblein *et al.*, 2011) –, external variety will be considered, defined as the number of different versions of a product offered by a company (Randall and Ulrich, 2001), which can also be referenced as SKU variety.

Hypothesized to impact three dependent variables, fill rate, inventory and sales, product variety measured by the number of SKUs is our key independent variable.

3.3.2 Fill rate. The fill rate ($Fill\ rate_{ij}$), considered as a measure of operational performance, is an important parameter especially for the type of industry studied. This variable represents the ratio between the quantity of products delivered and the quantity of goods ordered by customers in a given month. This measure is relevant as it shows the fill rate provided in relation to the combination of SKUs in an order (Closs *et al.*, 2010). Data on the number of cases returned at distribution center in a given month were also collected as another indicator related to the fill rate.

3.3.3 Inventory. The inventory is denoted by the number of available-for-sale cases at the beginning of the month ($Inventory_{ij}$), i.e. the amount of stock in a distribution center and ready to be distributed to interested consumers. The quantity of inventory can be computed by taking the amount of stock previously observed and then including any subsequent stock addition and subtracting sales performance or other stock disposals.

3.3.2 Sales performance. The sales performance is presented in this work as the number of cases – the standard unit of measure of the company studied – sold to customers in each month ($Sales\ performance_{ij}$). Sales performance is vastly studied and can demonstrate important managerial implications.

Observable variables	Description
$Product\ variety_{ij}$	Quantity of products (SKUs) sold at distribution center i in month j
$Fill\ rate_{ij\text{-}1}$	Ratio between the quantity of goods effectively delivered and the quantity of goods ordered by the customer to the distribution center i in month j
$Fill\ rate_{ij}$	Ratio between the quantity of goods effectively delivered and the quantity of goods ordered by the customer to the distribution center i in month j-1
$Returns_{ij}$	Number of cases returned to distribution center i in month j
$Sales\ performance_{ij}$	Number of sold cases at distribution center i in month j
$Orders_{ij}$	Number of cases requested at distribution center i in month j
$Unit\ price_{ij}$	Average price per box sold at distribution center i in month j
$Inventory_{ij}$	Quantity of cases on hand at distribution center i at the beginning of month j

Source(s): Prepared by authors

Table 3.
Variables description

3.4 Descriptive statistics

Table 4 provides descriptive statistics for the variables used in the analysis.

Table 5 summarizes the correlations among these variables across all observations.

Multicollinearity occurs when independent variables in a regression model are correlated. This problem occurs between orders/sales performance (0.999) measures of the same construct as shown in Table 5. To deal with this problem, the "orders" variable was removed from the database and only the "Sales Performance" variable was used to address the sales. Variance inflation factors (VIF) were also calculated for each of the variables in order to determine if multicollinearity may be present. The VIFs are all found to be less than 5, thus implying that multicollinearity is not a concern in this analysis.

3.5 Model

In order to better understand the relationships among product variety, fill rate, inventory and sales, a model consisting of a three-equation system was applied.

In Equation (1), $Fill\ rate_{ij}$ was estimated from $Product\ variety_{ij}$, its square, and several control variables,

$$Fill\ rate_{ij} = \beta_0 + \beta_1 Product\ variety_{ij} + \beta_2 (Product\ variety_{ij})^2 + \beta_3 Orders_{ij} + \beta_4 Fill\ rate_{ij} - 1 + \sum_{j=1}^{3} \beta_5 \mathrm{DC}\ Dummy_{ij} + \sum_{k=1}^{11} \beta_6 Month\ Dummy_{kt} + e_{ij} \quad (1)$$

In Equation (2), $Inventory_{it}$ was estimated from $Product\ variety_{ij}$, its square, and several control variables

Variables	Minimum	Maximum	Mean	Std. deviation
$Product\ variety_{ij}$	1.00	29.00	6.69	5.04
$Fill\ rate_{ij}$	0.13	100.00	97.36	7.97
$Sales\ performance_{ij}$	1.00	501781.00	39565.89	80480.38
$Orders_{ij}$	2.00	504430.00	40640.10	82282.01
$Inventory_{ij}$	0.00	439512.00	33942.52	60335.29
$Unit\ price_{ij}$	28.52	271.09	117.21	44.36
$Returns_{ij}$	0.00	502092.00	3451.21	24039.93

Source(s): Prepared by authors

Table 4.
Descriptive statistics of variables

Variables	1	2	3	4	5	6	7
1. *Product variety* $_{ij}$	1.000						
2. *Fill rate* $_{ij}$	0.072**	1.000					
3. *Sales performance* $_{ij}$	0.555**	0.049*	1.000				
4. *Orders* $_{ij}$	0.556**	0.039	0.999**	1.000			
5. *Inventory* $_{ij}$	0.569**	0.066**	0.939**	0.936**	1.000		
6. *Unit price* $_{ij}$	0.101**	0.028	0.094**	0.093**	0.082**	1.000	
7. *Returns* $_{ij}$	−0.055**	−0.143**	−0.059**	−0.059**	−0.061**	0.031	1.000

Note(s): ** The correlation is significant at the 0.01 level (bilateral)
Source(s): Prepared by authors
* The correlation is significant at the 0.05 level (bilateral)

Table 5.
Pearson correlation matrix

$$Inventory_{ij} = \delta_0 + \delta_1 Product\ variety_{ij} + \delta_2 (Product\ variety_{ij})^2 + \delta_3 Orders_{ij} + \delta_4\, Inventory_{ij-1} + \sum_{j=1}^{3} \delta_5\, DC\ Dummy_{ij} + \sum_{k=1}^{11} \delta_6\, Month\ Dummy_{kj} + \xi_{ij} \quad (2)$$

While in Equation (3), *Sales performance*$_{ij}$ was estimated from *Product variety*$_{ij}$, its squared and control variables.

$$Sales\ performance_{ij} = \phi_0 + \phi_1 Product\ variety_{ij} + \phi_2 (Product\ variety_{ij})^2 + \phi_3 Fill\ rate_{ij} + \phi_4 Orders_{ij} + \phi_5 Inventory_{ij} + \phi_6 Unit\ price_{ij} + \phi_7 Returns_{ij} + \sum_{z=1}^{3} \phi 7\mathrm{DC}\ Dummy_{ij} + \sum_{k=1}^{11} \phi 8 Month\ Dummy_{kj} + E_{ij} \quad (3)$$

Equation (1) models the first dependent variable (*Fill rate*$_{ij}$) in relation to the independent variable (*Product variety*$_{ij}$) and its square to assess the potential nonlinear relationship between product variety and fill rate (H1). Since fill rate is calculated as a percentage, the dependent variable in Equation (1) can range from 0 to 100, with the data containing a great many 100 values (i.e. no stockouts in a given month at a particular distribution center). The log transformation was used to make highly skewed distributions of *Fill rate*$_{ij}$ less skewed. In order to handle truncated and other non-randomly selected samples, a Tobit model was used to estimate Equation (1) (Tobin, 1958 and Wan *et al.*, 2012). Other control variables were identified as potential influencers on the *Fill rate*$_{ij}$; *Orders*$_{ij}$ represents the number of cases requested at distribution center *i* in month *j*, which is an indicator of the distribution center's capacity, while higher retail orders placed at the distribution center may be associated with lower fill rates; and *Fill rate*$_{ij\text{-}1}$ represents the ratio between the quantity of goods effectively delivered and the quantity of goods ordered by the customer to the distribution center *i* in month j-1. The fill rate in the previous months is also expected to be associated with the fill rate in the current week. Dummy variables were included in Equation (1) to control differences among distribution centers over time.

Equation (2) models the second dependent variable ($Inventory_{ij}$) in relation to the independent variable ($Product\ variety_{ij}$), its square term, to assess the potential nonlinear relationship between product variety and inventory (H3) along with control variables. The log transformation was used to make highly skewed distributions of $Inventory_{ij}$ less skewed. In order to handle truncated and other non-randomly selected samples, a Tobit model was used to estimate Equation (2). Control variables in Equation (2) include: $Order_{ij}$ represents the number of cases requested at distribution center i in month j, which is an indicator of the distribution center's capacity, while higher retail orders placed at the distribution center may be associated with lower inventory level; and $Inventory_{ij\text{-}1}$ represents the quantity of cases on hand at distribution center i at the beginning of month j-1. The inventory in the previous months is also expected to be associated with inventory in the current month; and dummy variables were included to control differences among distribution centers over time.

Equation (3) models the third dependent variable ($Sales\ performance_{ij}$) in relation to the independent variable ($Product\ variety_{ij}$), its square term, to assess the potential nonlinear relationship between product variety and sales performance (H3) and the fitted values of $Fill\ rate_{ij}$ and $Inventory_{ij}$ along with control variables. The independent variable $Sales\ Performance_{ij}$ did not require transformation because it has a normal probability distribution. The fitted value for $Fill\ rate_{ij}$ should have a positive effect on sales performance as stated in H3. The dependent variable $Inventory_{ij}$ should also have a positive effect on sales performance, as stated in H4. Control variables in Equation (3) include: $Order_{ij}$ represents the number of cases requested at distribution center i in month j, which is an indicator of the distribution center's capacity, while higher retail orders placed at the distribution center may be associated with high sales performance; $Unit\ price_{ij}$ represents the average price per box sold at distribution center i in month j and it is also expected to have a negative impact on sales performance; $Returns_{ij}$ represents the number of cases returned to distribution center i in month j. $Returns_{ij}$ is also expected to have a negative impact on sales performance. Dummy variables were included to control differences among distribution centers over time.

4. Analysis and results

The results for the impact of product variety on fill rate, inventory and sales performance are summarized in Table 6. The estimations for the fill rate as the dependent variable (Equation (1)) are reported in Models A, B and C. The estimations for inventory as the dependent variable (Equation (2)) are reported in Models D, E and F. The estimations for inventory as the dependent variable (Equation (3)) are reported in Models G, H and I. The dummy variables were included in all models, but they are not shown in Table 6 to facilitate data interpretation.

4.1 Results on the impact of product variety on fill rate

The base model for the fill rate, Model A, only includes the control variables in Equation 1. As expected, the fill rate of the previous month has a significant and positive coefficient. $Orders_{ij}$ had no influence on fill rate probably because the distribution centers did not have delivery capacity issues during the period studied.

Model B adds the linear term for product variety. The estimation confirms a negative relationship between product variety and the fill rate, while greater product variety contributes to a lower fill rate, as shown in Figure 6.

Model C includes both linear and quadratic terms for product variety. The increasing Pseudo R^2 from Model B to Model C suggests that Model C explains the variation in the dependent variable better than the model with only a linear term (Model B). Note that both the

Table 6.
Estimated results for the models

Technique		Tobit			Tobit			Multiple linear regression	
	Fill rate Model A	Fill rate Model B	Fill rate Model C	Inventory Model D	Inventory Model E	Inventory Model F	Sales performance Model G	Sales performance Model H	Sales performance Model I
Product Variety$_{ij}$		−0.017** (0.002)	−0.030** (0.005)		0.219** (0.005)	0.477** (0.010)		0.522** (0.004)	1.080** (0.009)
Product Variety$_{ij}^2$			0.001** (0.000)			−0.015** (0.000)			−0.620** (0.000)
Fill Rate $_{ij}$				0.013** (0.004)	0.013** (0.003)	0.011 (0.002)		0.070** (0.002)	0.058** (0.002)
Fill Rate $_{ij-1}$	0.008** (0.000)	0.009** (0.000)	0.009** (0.001)						
Orders$_{ij}$	−0.000** (0.000)	−0.000 (0.000)	−0.000 (0.000)	0.000** (0.000)	0.000** (0.000)	0.000** (0.000)	0.254** (0.000)	0.190** (0.000)	0.241** (0.000)
Inventory on hand$_{ij}$							0.281** (0.000)	−0.073** (0.000)	−0.075** (0.000)
Unit price$_{ij}$							−0.064** (0.001)	−0.100** (0.000)	−0.088** (0.000)
Returns$_{ij}$							−0.051** (0.000)	−0.039** (0.000)	−0.041** (0.000)
Constant	3.872** (0.087)	3.896** (0.087)	3.915** (0.088)	8.422** (0.382)	7.763** (0.273)	7.248** (0.235)	9.608** (0.084)	7.358** (0.235)	7.021** (0.203)
Pseudo R^2 or R^2	0.100	0.150	0.154	0.227	0.385	0.457	0.685	0.850	0.888
Observations	2,242	2,242	2,242	2,242	2,242	2,242	2,242	2,242	2,242

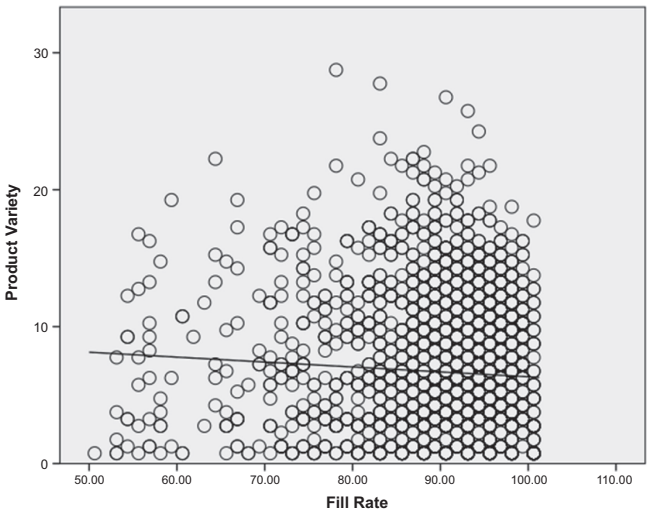


Figure 6.
Product variety vs. Fill rate

linear and quadratic terms for product variety are significant and that the coefficient is negative for the linear term and positive for the quadratic term. This means that the relationship between product variety and fill rate follows a U-shaped function, i.e. higher levels of product variety initially increase fill rate, but after a certain level of product variety is achieved additional product variety decreases fill rate.

To check the shape of the relationship between product variety and the fill rate, it is possible to identify the point of total effect of product variety that reaches the lowest fill rate, i.e. the number of SKUs that makes the model reach the lowest fill rate is equal to 21 SKUs of toothpaste in a given month and distribution center. A total of 99.3% of database observations is smaller than 21 SKUs. This result suggests that an increase in product variety reduces the fill rate at a diminishing marginal rate for many observations, thus Hypothesis 1 is supported.

4.2 Results on the impact of product variety on inventory

The base model for the inventory, Model D, includes only the control variables in Equation 2. As expected, the fill rate has a significant and positive coefficient. $Orders_{ij}$ had no influence on inventory probably because the distribution centers did not have delivery capacity problems during the period studied.

Model E adds the linear term for product variety. The estimation confirms a positive relationship between product variety and the fill rate. Greater product variety contributes to higher inventories, as shown in Figure 7.

Model F includes both linear and quadratic terms for product variety. The increasing Pseudo R^2 from Model E to Model F suggests that Model F explains the variation in the dependent variable inventory better than the model with only a linear term of product variety (Model E). Note that both the linear and quadratic terms for product variety are significant and that the coefficient is positive for the linear term and negative for the quadratic term. This means that the relationship between product variety and inventory follow an Inverted U-shaped function, i.e. higher levels of product variety initially decrease inventory, but after a certain level of product variety is achieved additional product variety increases inventory.

To check the shape of the relationship between product variety and the inventory, it is possible to identify the point of total effect of product variety that reaches the highest

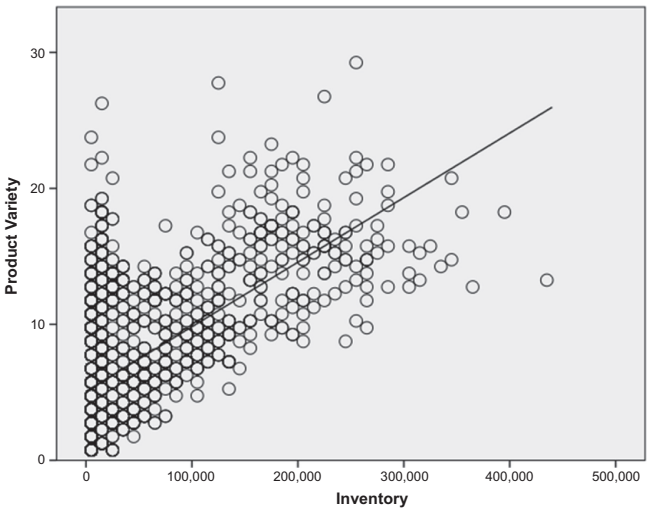


Figure 7.
Product variety vs. inventory

inventory, i.e. the number of SKUs that makes the model reach the highest inventory is equal to 16 SKUs in a given month and distribution center. A total of 94.1% of database observations is smaller than 16 SKUs. This result suggests that an increase in product variety increases the inventory at a diminishing marginal rate for many observations. Therefore, Hypothesis 3 is supported.

4.3 Results on the impact of inventory on sales performance

Model G includes the independent variable inventory and some control variables for sales performance in Equation 3. As expected, the coefficient for $Orders_{ij}$ is significant and positive, while $Returns_{ij}$ quantity has a significant and negative coefficient, and $Unit\ price_{ij}$ is negatively associated with sales. The estimation confirms a positive relationship between inventory and sales performance. Greater inventories contribute to larger sales performance, as shown in Figure 8. This fact can be explained by the company expecting more sales performance, so it keeps more inventories in its distribution center. Therefore, Hypothesis 4 is supported.

4.4 Results on the impact of fill rate on sales performance

Model H adds the fill rate and the linear term for product variety. The estimation confirms a significant and positive relationship between fill rate and sales performance. A greater fill rate contributes to a larger sales performance, as shown in Figure 9.

Model H adds the linear term for product variety. The fill rate has a significant and positive coefficient in this model, indicating that sales are gained when the fill rate increases at a distribution center. Hypothesis 2 is, therefore, supported.

4.5 Results on the impact of product variety on sales performance

Model I adds the quadratic term for product variety. The direct effect of product variety on sales is represented by the coefficient of the linear term for product variety in Model I. The increasing Pseudo R^2 from Model H to Model I suggests that Model I explains the variation in the dependent variable sales performance better than the model only with a linear term of

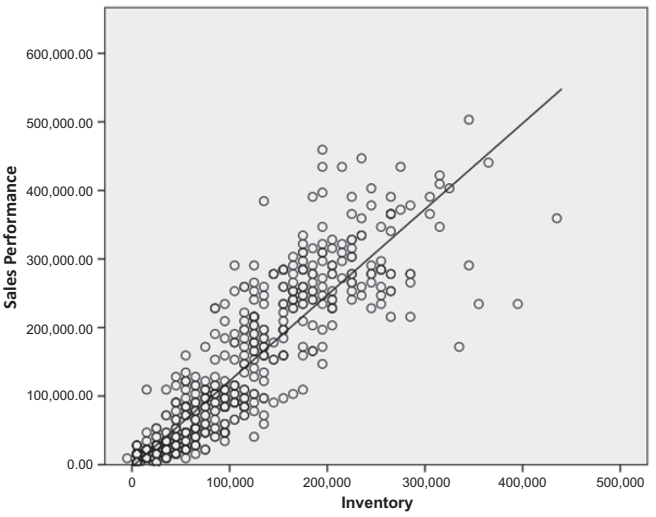


Figure 8.
Sales performance vs. inventory

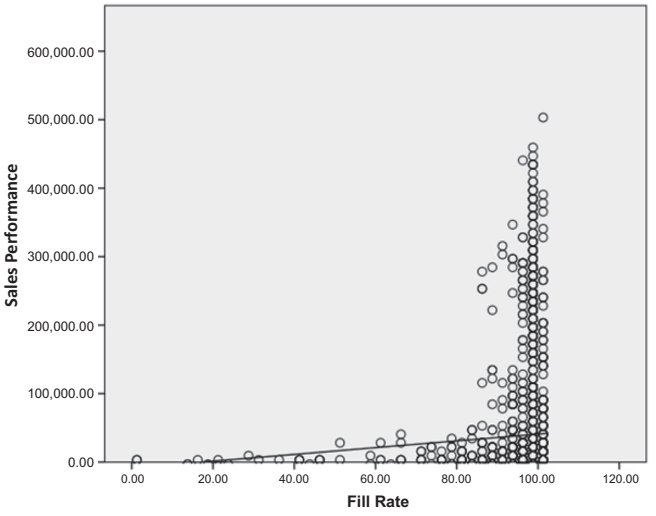


Figure 9.
Sales performance vs. fill rate

product variety (Model H). Note that both the linear and quadratic terms for product variety are significant and that the coefficient is positive for the linear term and negative for the quadratic term. This means that the relationship between product variety and sales performance follow a U-shaped function, i.e. higher levels of product variety initially increase sales performance, but after a certain level of product variety is achieved additional product variety decreases sales performance as shown in Figure 10.

To check the shape of the relationship between product variety and sales performance, it is possible to identify the point of total effect of product variety that reaches the highest sales, i.e. the number of SKUs that makes the model reach the maximum sales performance. A total of 81.1% of database observations is smaller compared to the number of SKUs of this

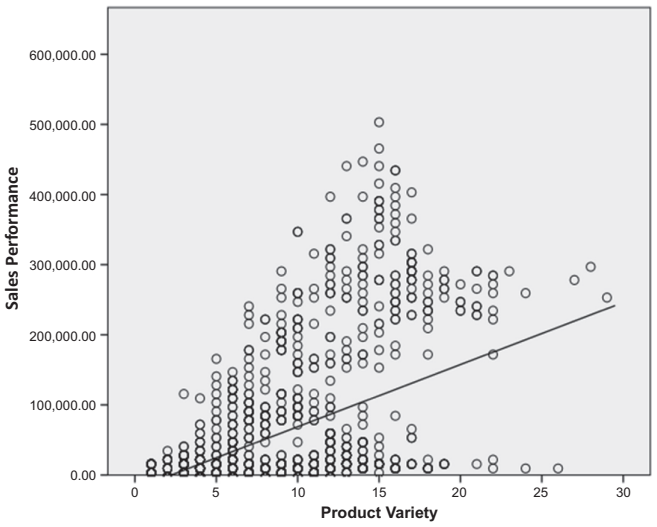


Figure 10.
Sales performance *vs.* product variety

maximum sale. This result suggests an increase in product variety directly raises performance at a decreasing rate when product variety is reduced at this minimal point; otherwise, an increase in product variety actually leads to reduced sales. Therefore, Hypothesis 5 is partially supported for the observations in the dataset.

The total effect of product variety on sales is the sum of the direct and indirect effects as shown by Equation (4).

$$\begin{aligned} Total\ effect = & \left(\frac{\partial\, Sales\ performance_{ij}}{\partial\, Product\ variety_{ij}}\right) \\ & + \left[\left(\frac{\partial\, Sales\ performance_{ij}}{\partial\, Fill\ rate_{ij}}\right)\left(\frac{\partial\, Fill\ rate_{ij}}{\partial\, Product\ variety_{ij}}\right)\right] \\ & + \left[\left(\frac{\partial\, Sales\ performance_{ij}}{\partial\, Inventory_{ij}}\right)\left(\frac{\partial\, Inventory_{ij}}{\partial Product\ variety_{ij}}\right)\right] \end{aligned} \tag{4}$$

By simplifying Equation 4 and assigning the parameters found in Table 6, it is possible to observe: Total Effect = 1,042–1,238 $Product\ variety_{ij}$. Therefore, the point of maximum sales performance is less than a single product. This indicates that the overall effect of the product variety on sales performance is negative, regardless of the number of SKUs of the company studied. Therefore, Hypothesis 5 is not supported for the observations in the dataset.

For this toothpaste company, sales performance does not increase when product variety increases. The indirect effect of product variety on sales performance through the $Fill\ rate_{ij}$ is negative. Despite the company's strong focus on fill rate, as the product variety increases, the portfolio complexity is increased. Therefore, the demand forecast is less accurate, which may generate a significant impact on inventory. The complexity of inventory management is greater when there is a greater product variety. This happens due the uncertainties generated by the introduction of new products, which induces the company to raise inventories rates to minimize sales performance disruptions. Other issues help to explain the negative total effect on sales performance, such as cannibalization and direct substitutes (Hui, 2004; Dawes *et al.*, 2015) which outweigh the possibility of consumers finding products that most satisfy their

needs (Lancaster, 1990; Nishino *et al.*, 2014; Syam and Bhatnagar, 2015). This result contrasts with the results obtained by Zhang *et al.* (2007) and Ton and Raman (2010) possibly due to market differences, products and impacts identified in the analyzed supply chains.

5. Contributions and implications

In this paper, the impact of product variety on inventory levels, fill rate and sales has been investigated. By doing so, it was possible to contribute to the literature of operation management (Bendig *et al.*, 2017; Hofer *et al.*, 2012) and marketing (Bendig *et al.*, 2017; Steinker and Hoberg, 2013). Unlike examining product variety from a functional or social perspective, product variety has been examined from the firm's perspective. This perspective has received little attention in the existing literature on product variety and distinguishes this paper from earlier research.

First, it was important to provide an empirical explanation of the mechanism by which operations outcomes (Inventory and Fill Rate) and marketing outcomes (Sales) respond to higher product variety. Then, marketing and operations outcomes were integrated by jointly studying these effects to explore the impact of product variety on the inventory level, fill rate and sales. Second, the impact of product variety on inventory level changes over a long period studied. Operations management researchers have generally used analytical models to investigate inventory decisions and it was possible to contribute to the inventory management literature by empirically investigating how inventory level and product variety change over seven years with data grouped on a monthly basis.

In addition to the theoretical contributions, it was possible to provide an in-depth understanding of how product variety affects inventory level: the uncertainties generated by the introduction of new products influence companies to raise inventory levels to minimize sales performance disruptions. In general, by increasing the inventory level, the chances of having the product available to meet a sale also increase. These results suggest that increases in product variety raise inventory level, and inventory level is positively related to sales performance.

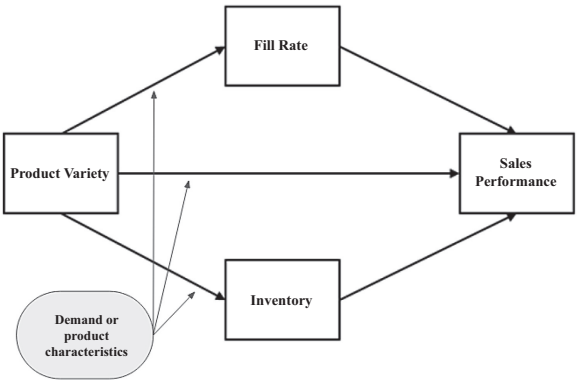
Product variety strategies commonly create more demand and improve sales performance (Lancaster, 1990; Nan and Rajagopalan, 2009). Our results indicate that increases in product variety did not help to boost sales performance in the Brazilian toothpaste company. A previous study presented a different result. As shown in Table 7, Ton and Raman (2010) point out that the more SKUs, the greater sales performance. Wan *et al.* (2012) suggest that when product variety increases too much, it may even reduce sales.

Most importantly, these findings indicate that the impact of product variety is a combined outcome of changes in fill rate, inventory levels and sales performance. This paper contributes to the development of the theory by extending the earlier models of Ton and Raman (2010), and Wan *et al.*, (2012), to assess the impact of product variety on an organization's performance. Building insights based on empirical research should advance the cumulative knowledge gained on variety. Figure 11 summarizes the theoretical model.

Therefore, the relationship between product variety and sales is affected by changes in some demand or product characteristics, such as demand variability and product profit margin. In other words, this leads to new theoretical insight that some moderator variable

Table 7. compares our study results with previous studies

Authors	Overall impact product variety on sale
Ton and Raman (2010)	Positive
Wan *et al.* (2012)	Sale increase at a diminishes marginal rate
Our study	Negative



Source(s): Prepared by authors

Figure 11.
Proposed framework of the conceptual model

affects the strength and direction of the overall relation between product variety and sales. The moderator variable is usually an interaction, as the relation between product variety and sales depends on a third variable. More studies are needed to identify these moderating variables.

This finding can help managers to implement product variety strategies based on empirical evidences. Companies can maintain high product variety only when the sales performance and profit of the business increase. In addition, companies may use some regions to test their new products. If market responses are good in these areas, then it is reasonable to expect that these varied products will generate better sales, as one strategy does not fit all regions.

6. Conclusions

This study is an attempt to better understand how product variety affects fill rate, inventory and sales performance in distribution centers of the consumer goods company. Previous research has examined the impact of product variety on fill rate and sales performance (Wan *et al.*, 2012) and the impact of product variety on sales and inventory on sales (Ton and Raman, 2010). This work is distinct from the previous research. The impacts of product variety on fill rate, inventory and sales performance were analyzed simultaneously.

The major findings show the following for the distribution centers in this sample: fill rate decreases with increased product variety at a diminishing marginal rate, inventory increases with increased product variety at a diminishing marginal rate, sales performance increases with an increase in fill rate, and since the company expects more sales, it keeps more inventories. These findings support the negative impact of product variety on operational performance proposed in previous studies. However, analyzing the impact of product variety on sales, this study shows a different result. Ton and Raman (2010) point out that the more the SKUs, the greater the sales performance. Wan *et al.* (2012) state that a distribution center's overall sales increase with increased product variety at a diminishing marginal rate. This study suggests that increasing product variety reduces sales performance. This result is different from Wan *et al.* (2012) and Ton and Raman (2010), possibly due to market, product and cultural differences. This means that the company under study has too many bad aspects on the operational side which are not enough to outweigh the direct benefits gained from the marketing side. This negative impact may not always be observable as studies do not evaluate more operational variables such as inventory as part of their models.

The divergences between this study and others suggest that the dynamics of emerging and developed markets, as well as the type of family studied, may present differences in results, suggesting that generalization may be myopic.

These findings provide several implications and questions for industrial practitioners, such as: does the world need so many toothpastes from each manufacturer? This same issue has been raised by Fisher (1997), but with current numbers of SKUs available (Jan/2020) in Brazilian supermarkets, whereas in 2007 there were only 27 in American supermarkets. The strategy of always increasing the mix could reduce profitability, since product variety could increase inventory, reduce fill rate and even reduce sales. The introduction of new products requires an in-depth analysis of the existing mix of products, while working on a simplified portfolio could bring more profitability.

Although the results of this research are robust, updated and based on quantitative analysis of seven years of data from a Brazilian toothpaste company, the focus on a single product category, company and country challenges the generalizability of the findings. The inclusion of more products, more companies and more countries is suggested for future studies. It is also highly recommended to use cost, price and profit as sales and inventory measures instead of sold cases, as it has been done in this study. Furthermore, it would also be relevant to expand the study to the entire supply chain – suppliers, manufacturers, distributors, retailers and consumers can bring great value to new research.

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