How the environmental complexity affects forecasting in retail? Actual research trends

Abstract

Purpose: The aim of this work is to highlight the impact of complex environments on forecasting activities in the retail sector.
Design/Methodology/Approach: This work is based on a bibliometric analysis of the publications on complex environments and forecasting in retail, examined through the adoption of a web-based social network analysis (SNA) on the citation data.
Findings: The paper shows the last research trends in multi-factors forecasting in retailing, from which it emerges that when market complexity increases, new forecasting tools should be developed with the aim to make linear the relationship between complexity and optimization of forecasting models.
Research implications: The study highlights the inherent limits to forecasting, showing that an evolution of forecasting methods is necessary and the complexity science should be seen as opening up new paths to reveal important insights to assist decision-making.
Originality: The work provides an original interpretation of the research trends presenting the inverse relation between the complexity of the environment and optimization of forecasting plans.

Key words: Complex environments, forecasting, retail, bibliometric analysis, social network analysis.

> Andrea Moretta Tartaglione
Assistant Professor of Business Management; University of Cassino and Southern Lazio,Viale dell'Università, 03043 Cassino, Italy,
phone: +3907762994712,
email: a.moretta@unicas.it
Corresponding author

> Roberto Bruni
Assistant Professor of Business Management; University of Cassino and Southern Lazio, Viale dell'Università, 03043 Cassino, Italy,
phone: +3907762994793,
email: r.bruni@unicas.it

> Maja Bozic
PhD Student; University of Cassino and Southern Lazio, Viale dell'Università, 03043 Cassino,
email: m.bozic@unicas.it

> Ylenia Cavacece
PhD in Management and Information Technology;
University of Salerno, Via Giovanni Paolo II, 132, 84084 Fisciano, Italy,
phone: +39089 961111,
email: ycavacece@unisa.it

1. Introduction

The worldwide economy is characterized by high levels of complexity that affect how activities are managed to achieve competitive advantage.

In the systems theory, complexity derives from three dimensions: variety, which is the possible variations with which the phenomenon presents itself to the observer, or better, the number of variables; variability, each variable is not stable but changes over time creating additional variety; and indeterminacy, which is the impossibility for the observer to understand the phenomenon in its entirety. In management literature, authors often distinguish between internal complexity, which depends on the size of the company, the number of its components, the variety of social roles and personalities; and external complexity, which depends on the variety and variability of the environment in which a company operates. External complexity is the hardest to manage because it depends on variables that are not under the control of managers. Moreover, it continues to rise due to the continuous changes in consumption and communication, climate change, economic and political instability, transnational competition in the global marketplace, among many other factors. This creates dynamism in markets that are not simple to interpret, analyze or predict, making forecasting activities and marketing strategies difficult, particularly in the retail sector where complexity affects decision-making processes from store organization to supplier and customer relationships.

The ineffectiveness of traditional forecasting plans is partly due to the inability to predict in environments that are near the edge-of-chaos (Kurtyka 2000), because the system is continually and unpredictably changing, and managers have to continually obtain new information to understand the environment; any plan is therefore obsolete before it has been fully implemented (Mason 2007). Traditional forecasting techniques are often based on: (1) information that is obsolete by the end of the planning process (Loewen 1997; White 1998); (2) the assumption of a stable environment (Volberda 1997; Chakravarthy 1997); (3) the assumption that the firm can, to an extent, control its environment (Cravens 1991, White 1998). It is, therefore, necessary to develop new forecasting methods more suited to the current complex markets.

Focusing on the retail industry it becomes challenging forecasting its activities, especially considering that nonfinancial information on environmental changes is hardly provided (Harrauer and Schnedlitz 2015). At the individual level, Harrauer and Schnedlitz (2015) found that retail managers accept and regularly apply performance reports as information sources in each context. Especially, turbulence and unpredictable events drive store managers to demand more flexible performance-reporting procedures (Harrauer and Schnedlitz 2015). Based on these considerations, the aim of this work

is to analyze actual research trends in retailing multi-factor forecasting, particularly analyzing the impact of environmental factors on prediction in retail. This paper, by using the bibliometric analysis, collects, summarizes and synthesizes various theoretical approaches, through co-citation techniques, with a view to answering to two main research questions:

RQ1: What are the general research streams regarding environmental impact on forecasting?

RQ2: What are the research trends in environmental impact on forecasting plans in retailing?

The results represent a useful base for a more detailed future research on the forecasting in retail.

The work is organized as follows: at first, the conceptual framework regarding to complexity of the environment and causal relationships between complex environments and forecasting activities is presented; at second, the methodology and data collection are described; then, a social network/citation analysis identifies the main literature aspects on the topic; last, the paper provides the discussion of results, the systematic framework of actual theoretical perspectives and the related conclusions.

2. Conceptual framework

The retail environment is changing faster than ever before (Hamel and Prahalad 1994; Kotter, 1996; Loewen1997; Conner 1998) thus increasing complexity (Achrol 1991). Complexity is defined as the measure of heterogeneity and variability in environmental factors (Lane and Maxfield 1996; Chae and Hill 1997; Chakravarthy 1997). When complexity increases, the ability to understand and use information to plan and predict becomes more difficult (Black and Farias 1997), the decision windows shorter, the risk of obsolescence greater and the long-term control becomes impossible (Mason 2007).

Literature highlights difficulties in outline a causative link between environmental variables and forecasting plans because of the complexity of variables and the chaotic nature of environments (Windsor 1995). However, research trends in forecasting continue to stress the analysis and prediction of the inter-relationship between an organization and its environment (Polonsky et al. 1999).

The business environment in general, as the more specific retail environment, presents several complexity constructs:

- Co-determination or co-evolution taking place between firms and their environments (Achrol 1991; Polonsky et al. 1999).
- Self-organisation and emergence occurring through participants in the environment (Mason 2007; Peters 1999; Mason 2007).
- Environmental changes starting small and developing slowly and unpredictably (Mason 2007).
- Non-linear relationships (Black and Farias 1997; Mason 2007).

Many authors clearly see environments as Complex Adaptive Systems (CASs) (Black and Farias 1997; Mason 2007; Peters 1999; Prendergast and Berthon 2000).

CASs are systems made up of many individuals, self-organizing elements able to analyse the changes in the external environment (Begun et al. 2003) and to adapt to them. Bruni et al. (2016) show how the CAS framework could be useful for gaining a better understanding of the evolution of market dynamics, focusing on topics such as the market complexity, adaptability, system features and purpose.

Essentially, CASs are networks of relationships and interactions (Moretta and Bruni 2015), in which the whole is more important than the sum of the parts; when a single element of the system changes, produces reactions and changes in associated elements and in the environment. The environment is always responding and adapting to these changes and the effects cannot be predicted with complete accuracy (Axelrod and Cohen 2001).

Complex systems face inherent bounds on their mathematical describability, computability, and predictability because they are nonlinear, dynamic, adaptive, and emergent (Linstone 1999).

In making a distinction between non-adaptive and adaptive complex systems, Casti (1997) specifies that the available predictive mathematical models could describe the firsts effectively because it is possible to see the whole picture and no rule changes are permitted inside them; while CASs permit rule creation or change and are not amenable to statistical approaches (Linstone 1999).

Since environments do appear to be CASs, a complexity or chaos perspective should be used to understand the dynamics of these systems and to guide forecasting activities for the benefit of the planner and decision maker (Mason 2007; Prendergast and Berthon 2000).

The principal characteristic of complex systems is self-organization, hence they cannot be controlled by an outside party or “manager” making plan longer-term outcomes unpredictable (Wilkinson and Young 1998; Frederick 1998; Kelly 1999).

While in a stable system small changes have small effects, in a CAS small changes or errors can grow exponentially with each iteration (Diamond 1993) and an infinite amount of precise data would be required to produce accurate long-term predictions (Mix 1993). However, many authors note that in the chaotic state CASs appear to exhibit a deterministic behaviour fixed by equations and yet incorporating randomness (Thietart and Forgues 1995). It may be orderly and suddenly become chaotic or vice versa but in every case the system is remarkably sensitive to initial conditions, making the use of historical data as a basis for forecasting dubious at best (Gordon and Greenspan 1988). This transition between order and chaos is the point at which sensitive dependence on initial conditions causes small inputs to

cause big changes (Mason 2007). Nilson (1995) refers to this as non-repetitive repetitiveness. Exactly where the system will go next cannot be predicted, but it will not go outside certain limits (Mason 2007).

Tables:

Table 1: Implication of complexity theory on forecasting techniques

Elements of complex systems	Implications on forecasting techniques
The system needs to be considered as a whole. Complex systems exhibit emergence – (self-organised) behaviour that results from the interactions.	Forecasting techniques need to enable practitioners to develop a vision of a system's emergent properties – the self-organised behaviour that could result from interactions between the parts.
The interactions between the component parts of a complex system lead to non-linear relationships between ''causes'' and ''effects''. A ''small'' cause can have ''large'' effect, and a ''large'' cause a ''small'' (or no) effect.	Forecasting techniques need to enable visions of phase-changed worlds. Foresight techniques must also accept the likely absence of any early warning signals.
The starting slate is never clean – extremely tiny errors in understanding where the system starts from can send any ''forecast'' off in totally the wrong direction.	Forecasting techniques need to recognise that everything is part of a system, that there is no ''new'' starting point, and that tiny, often trivial actions can have huge, irreversible, impacts.
Complex systems are not at equilibrium (if they are they are dead) and are always changing.	Forecasting techniques must be able to provide both optimisation and exploration processes to help identify a range of potential future situations and options.

Source: Author's elaboration from Horton (2012)

3. Methodology and data collection

This work is based on a bibliometric analysis of the publications about environment and forecasting activities. Bibliographical data has been gathered from ISI Web Of Science by searching in the topic firstly for the keywords "external complexity", "environmental variables", "heterogeneous market" and "multi-factor" combined with the keyword "forecasting", secondly, for the keywords "trends in forecasting sales" and "retail", in the time period from 2013 to 2016. From the first search, 41 publications were selected, from the second search, 49. The works collected have been examined through the adoption of a web-based social network analysis (SNA) on the citation data (see Knutas et al. 2015). There are developed bibliometric tools providing literature review based on the network analysis. Analyses based

on co-citation techniques are widespread in science studies. They are among the major quantitative methods used with the aim of mapping the structure and dynamics of scientific research (Riviera 2012).

The analysis identifies the important authors, journals and keywords in the dataset, based on the number of occurrences and citation counts. A citation network of the provided records has been created and used to identify the important papers according to their in-degree, total citation count, and PageRank scores.

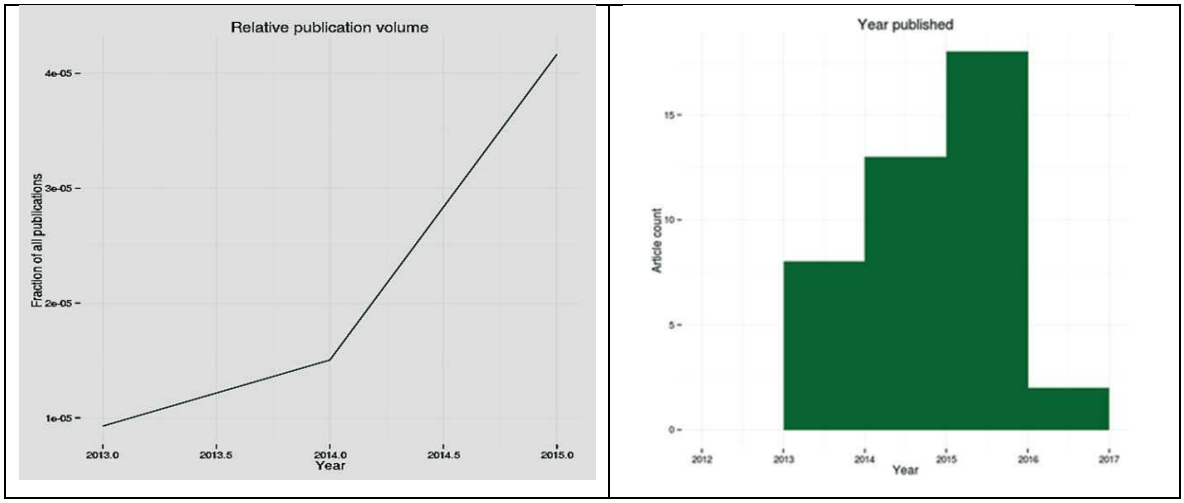
For greater completeness of the results, the analysis has been expanded to the most specialized journals on this matter (International Journal and Retail Distribution and Journal of Personal Selling and Sales Management), which were not indexed in Web Of Science, and to Google Scholar database.

The results of the analysis have been discussed in order to identify the most recent trends in retailing multi-factor forecasting.

4. Findings

As Figure 1 shows, the interest of scholars for the environmental impact on the forecasting has increased significantly since 2014. Besides the positive trend, there are not many studies about it. During this period, the main topics discussed are: how to measure environmental complexity, how to include hardly controlled factors in forecasting and how to well define the environment and predict its impact on business activities.

Figure 1: Trend in research of the environmental impact on the forecasting (2013-2016)

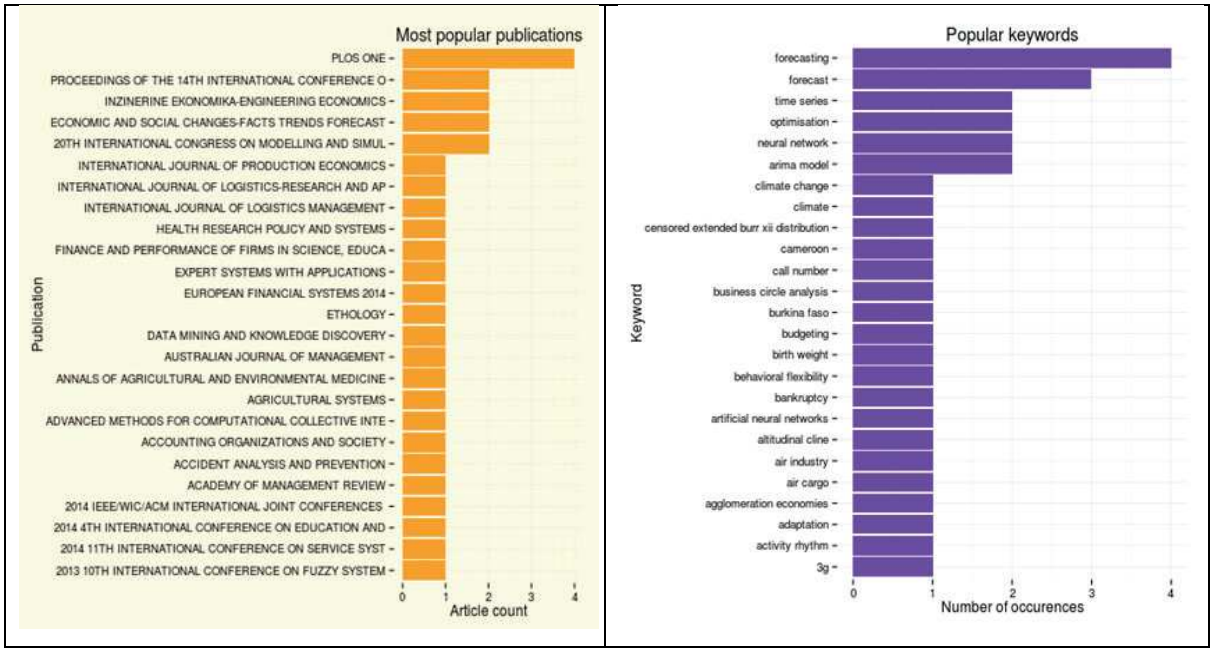


Source: Authors' elaboration on WOS data

4.1. Results from Social Network analysis - the macro aspect

The first, general research including keywords: “external complexity”, “environmental variables”, “heterogeneous market”, “multi-factor” and “forecasting”, gives the wide spectrum of articles (41) from the different research streams. These keywords were selected to export the important research streams related to the first research question. Co-citation analysis gives the rank by the most popular and cited keywords mentioned in the selected articles, which are, besides forecasting, forecast and its techniques, *optimization*, *climate change*, as well, *business circle analysis, budgeting* and *bankruptcy* (Figure 2).

Figure 2: Social network analysis of the general literature research of environmental impact on the forecasting plans by the most occurred publications and the cited keywords.



Source: Authors’ elaboration on WOS data

Expanding the social network analysis with the detailed analysis of the high-scored papers, it emerges that the first problem for the authors is the choice of the environmental factors to include in the forecasting methods.

We have classified the significant environmental factors that the authors of the papers detected identify at a macro-level, i.e. that affect the companies’ activities in general, irrespective to the related sector. The most common macro-environmental factors emerging from the analysis are *Climate change, Financial economic crisis, Affected transport capacity, Consumer Price Index (CPI), Fuel price.*

Sometimes climate change is set apart as an influential factor, thus climate change affects and make changes worldwide. It affects production plants, farms, water resources, translating influence via marketing channels until the final consumers. Climate change is a hardly controlled factor, but involving it in the future strategies and plans, companies could better prepare for a weather surprises; hence, it is considered within the relevant forecasting factors. On the other hand, along with it, there are the financial crisis, bankruptcy and high volatility in financial markets that represent the second macro-level influence. For example, reflecting the retail industry, the bankruptcy of a company can direct affect unemployment, Consumer Price Index (CPI) and fuel price leading to decrease the consumption and change shopping behavior.

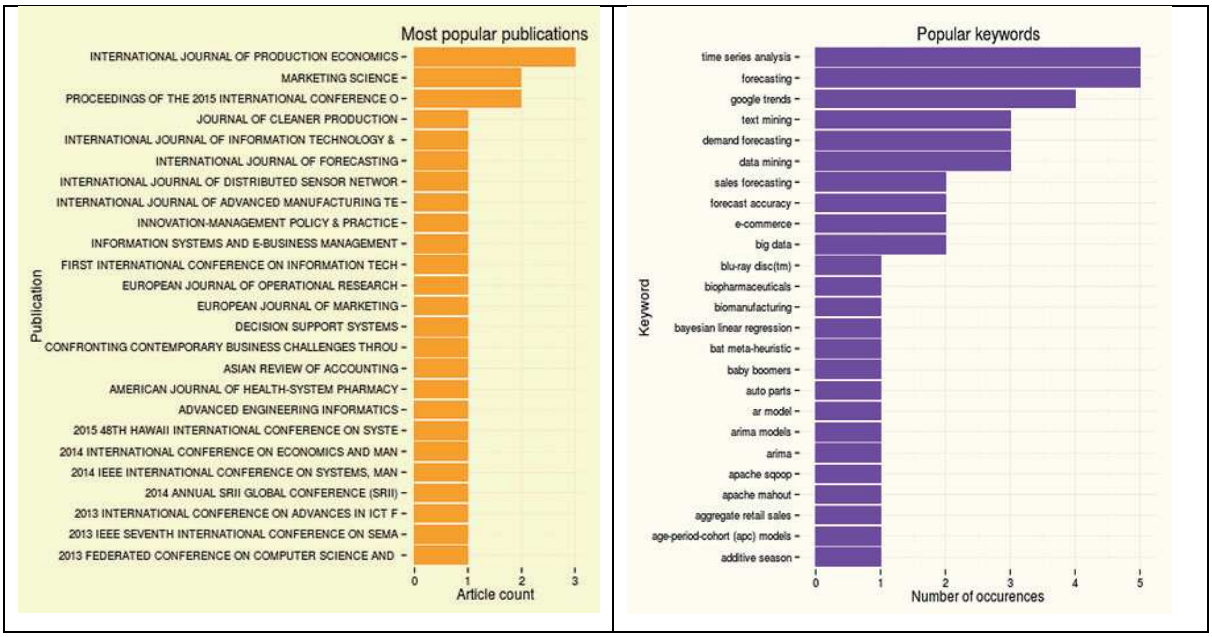
Harrauer and Schnedlitz (2016) address to the recent financial economic crisis as the explicit cause of the turbulent market. The authors highlight that since 2008, neither long-term forecasts nor schedules are possible. Before the crisis, it was possible to plan every two or three weeks, but now companies have gone to weekly planning only because they cannot forecast that fast anymore. As a consequence, in several companies the top management has undertaken profound restructuring activities, which have led to significant changes in in-store activities and performance measurement (Harrauer, Schnedlitz, 2016). Reports even provide store managers with information on goal completion on a daily or even hourly basis in some cases. Moreover, they show deviations from past results and forecasts for the future to facilitate decision-making. All in all, store managers need to react immediately to reports if store performance is weak. However, they acknowledged that business success could only be reached if store managers and their employees jointly deal with turbulent developments (Harrauer and Schnedlitz 2016).

Capello and Caragliu, (2015) point that cities hosting financial activities have been severely hit by the crisis; however, they also host hard and soft territorial capital elements, high physical accessibility, access to information and knowledge, advanced functions, agglomeration economies, generating inter-sectoral productivity growth and the ability to adjust to the crisis. The authors apply the new version of a macroeconomics "regional growth forecasting model" taking account of the crisis and capturing scenarios of long-term costs. In *industrial transportation*, the forecast demand at each destination may be affected by a number of factors. Consequently, a conventional transport plan often fails to match the reality, so the planned transport capacity is either insufficient to meet the demand or wastefully excessive (Corso 2015).

4.2. *Results from Social Network analysis - the retail aspect*

In the second analysis are outlined the trends about the environmental impact on forecasting plans in the retail industry, using the keywords in the search engine: trends in forecasting sales, retail. The most popular cited keywords (49 articles) are: google trends, demand forecasting, data mining, sales forecasting, e-commerce, big data, biopharmaceuticals and bio-manufacturing (Figure 3).

Figure 3: Social network analysis of the research trends in influence of external factors on retailing by the most occurred publications and the cited keywords.



Source: Authors' elaboration on WOS data

In this analysis, the influence of online activity on the retail industry emerges, nevertheless, data mining, particularly big data that every company is streaming to handle in the more efficient way, take an important role in forecasting plans. At the retail level, the environmental factors emerging from the analysis are: *Internet data, Competition, Industry concentration, Shared information in a supply chain, Limited data, Seasonality, Weather, Location of the decoupling point, Relations inside a supply chain.*

According to Carriere-Swallow (2013), the majority of economic variables are released with a lag, making it difficult for policy-makers to make an accurate assessment of current conditions. The author explores whether observing *Internet browsing habits* can inform practitioners about aggregate consumer behavior in an emerging market.

Choi (2014) discusses fast fashion as a commonly adopted strategy in fashion retailing. Under fast fashion, "operational decisions have to be made with a tight schedule" and the

corresponding forecasting method has to be completed with *very limited data* within a limited time duration. Motivated by fast fashion business practices, in the paper, an intelligent forecasting algorithm, which combines tools such as the extreme learning machine and the grey model, is developed. The work is focused on two important features in the fashion industry: (a) the demand trend slope is large, or (b) the seasonal cycle's variance is large.

The paper of Eksoz (2014) develops a conceptual framework for factors involved in collaborative forecasting in food supply chains. It is addressed to a scarcity of research examining how manufacturers and retailers conduct long-term and accurate collaborative forecasting for seasonal, perishable, promotional, and newly launched products. In the proposed framework, Eksoz (2014) focuses on the collaborative forecasts between manufacturers and retailers. The author identifies trends, gaps and areas for future research involving partners' integration, *information sharing* and forecasting processes in the supply chain. The review reveals that partners' integration is a key requirement for collaborative forecasting while the type and quality of information shared are critical for forecasts. Moreover, forecasting strategies of manufacturers and retailers play a pivotal role for consensus forecasts while the role of forecast horizon and frequency should not be neglected (Eksoz 2014).

The biggest issues of forecasting in the retail industry are the trend and *seasonality* in the sales, that can produce many uncontrolled patterns and several authors suggest to overcome these findings with advanced statistical tools as Support Vector Regressions, Hol-Winter, ARIMA models etc. Besides trends of using modern forecasting tools in retail, analyzing online platform data becomes popular in order to discover consumer behaviors and set the marketing strategies.

As online data flow, social media, e-commerce have a high impact on consumer behavior and it becomes the crucial environmental factor, not just internal, in the retail industry, it is worthy to analyze in the future literature regarding the forecasting consumers reactions related to the retail.

4.3. Research findings of literature review

According to Harrauer and Schnedlitz (2016) "*environment*" is an established construct in the contingency theory literature (Chenhall 2003). Combining internal (inner corporate) and external (outer corporate) elements (Waterhouse and Tiessen 1978), the construct summarizes all changes and market dynamics that are hardly predictable and generate uncertainty (*turbulence*) (Child 1975). At the retail store level, the environment is created by the level of performance given the variety of store's products and services (Kumar and Karande 2000). Moreover, it deals with changing customer needs (*diversity*).

Mintz and Currim (2013) discuss how often companies have to adapt their marketing and service technology to stay competitive in the market and cover the complexity of retailing business in their performance measurement design (*complexity*). High-stress level, suppression and restrictions also shape working environment (hostility) (Banker et al. 1996).

Several authors outline that retailers have to focus proactively on demand forecasting and managing supply requirements until the consumer enters the store, as all following processes are only reactive. For example, retailers can vary products or prices based on anticipated consumer behavior. This refers not only to demand forecasts but also to proper optimization methods to steer consumers' behavior. *The location of the decoupling point* has a misleading impact on planning separating the planning tasks into forecast-driven and order-driven processes (Hubner and Kuhn 2013).

Arunraj and Ahrens (2016) relate to weather as the risky factor for a retail industry that can cause the change in consumer demand and shopping decisions. However, only few research studies about weather and retail shopping are available in the literature. The study by Arunraj and Ahrens (2016) aims at developing a model to analyze *the relationship between weather and retail shopping behavior* (i.e., store traffic and sales).

As retail business is becoming a complex set of activities also its sales prediction is becoming a complex activity that does not lean on a one factor, as the history of sales, but many factors that are indirect or direct linked to the sales: orders, promotions, customer behaviors, logistic information, competition distance, the price of gas, etc.

The nature of the retail business is an important factor in provisional predictions. In the fashion industry, operational decisions have to be made with a tight schedule and corresponding forecasting method has to be completed with very limited data within limited time duration (Choi 2014), while in food supply chains it leans on collaborative forecasting between manufacturers and retailers.

Literature describes the complexity of forecasting activities in terms of many relations in the supply chains and their exchange of information. Forecasting could not stand the process by itself for a one business unit, but it has to integrate with others in the way of creating the value for all units. It allows the forecasting process owner, usually the director or manager of demand planning, to view departmental forecasts from various functions that have different perspectives on the state of the business based on their views of the marketplace (Chase Jr, C.W. 2013).

The study by Arunraj and Ahrens (2016) aims at developing a model to analyze the relationship between weather and retail shopping behavior (i.e., store traffic and sales). Nevertheless, limitation of such data makes a forecasting process more inaccurate. Sensing the environmental factors is the important phase in the

forecasting process and could not be ever done in the perfect way. The most difficult explanatory variables to simulate are those related to competitors and to items that people have little control over, such as weather, economy and local events. Taking uncontrollable factors such as weather or climate change into the model could give the more realistic predictions, or the model could fail because of their hardly control nature.

5. Discussion

The findings of the social network analysis allow identifying the most important environmental factors recognized by the literature at a macro and retail level (Table 2).

Table 2: the most important environmental factors in retailing

I. Macro level:	Climate change	**II. Retail level:**	Internet data/Internet browsing habits
	Consumer Price Index (CPI)		Competition
	Fuel price		Industry concentration
	Financial economic crisis		Shared information in a supply chain
	Affected transport capacity		Limited data
			Seasonality
			Location of the decoupling point
			Weather
			Relations inside a supply chain
			Unexpected external events

Source: Authors' elaboration

With this classification, it is possible to answer on both research questions. For the first (RQ1) the general streams of environmental impact on forecasting are trying to observe and measure recent financial crisis, climate change, volatility in Consumer Price Index and industrial transportation, creating models that will optimize their influence in the long term. Their hardly measurable nature is prevailing on the retail level (RQ2) influencing volatility of prices, industry concentration, unexpected events (hurricane, strikes etc.), limited data from weather, demography structures, missing information in supply chain, etc. These factors require a short-term forecasting; their uncontrollable effects result in no "perfect" forecasting models, but in many "optimal models" that work well, assuming them, in the specific situation for a specific purpose. A forecasting model consists in matching internal factors with the influence of the externals ones through statistical analysis based on the observation of data from the past or present. By integrating the findings of the research, analyzing the different theoretical approaches, organizing and systematizing them by the number and type of factors

included in the forecasting models, the level of complexity, the role of forecast horizon and the solutions proposed by the authors, it is possible to outline the last research trends in multi-factors forecasting in retailing (Table 3). The complexity of the model is a function of the number of variables, the method used, the relationships among the model elements, and relationships among models, forecasts, and decisions. Essentially, a complex forecasting is a process that is not very understandable to forecast users.

Table 3: Organizational framework of theoretical perspectives on the topic.

Authors	Number of external factors	[5]Type of factor	[6]Complexity	The role of forecast horizon	Solution
Mintz and Currim (2013)	Many	Competition/Industry concentration	High	Long-term	The inclusion of firm strategy, environmental characteristics and the use of financial metrics are positively associated with marketing-mix performance.
Chase Jr, C.W.(2013)	Many	Relations inside supply chain/Unexpected external events	High	Long-term	Unconstrained demand forecasting.
Carriere-Swallow Y(2013)	Many/Aggregate	Internet	High	Short-term	Improve the efficiency of nowcasting models.
Hubner and Kuhn (2013)	One	Location of the decoupling point	Medium	Short-term	Optimization methods to steer consumer behavior, demand to forecast order-driven processes.
Eksoz C (2014)	Many	Shared information in a supply chain	High	Long-term	Collaborative forecasts between retailers and manufacturers.
Choi T (2014)	Less	Limited data/Seasonal cycle	Low	Short-term	Efficient forecasting models that will help operational decisions with a tight schedule.
Arunraj and Ahrens (2016)	One	Weather	High	Long-term	Developed a model that analyze the relationships between a weather and retail shopping behavior.
Harrauer and Schnedlitz (2016)	Many	Financial crisis	High	Short term	More flexible performance–reporting procedures.

***based on the relevant publications

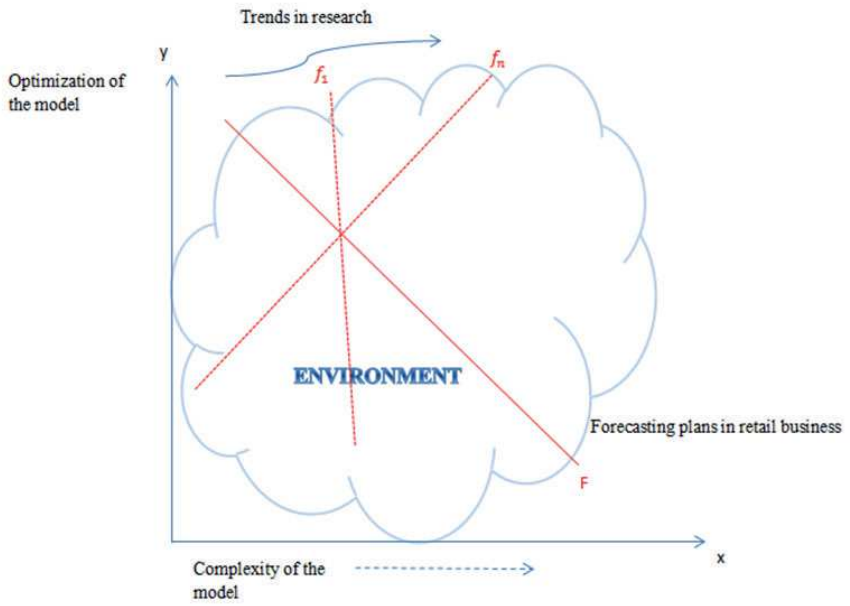
Source: Authors' elaboration

As the Table 3 shows, the trend in literature is to use complex forecasting models, although there is a heated debate about their capacity to provide more accurate forecasts because, even if complex models are preferred because they use more sophisticated analysis and include a greater number of variables, the probability of errors and the difficulties for forecast users to make plans appears to be greater.

Putting their different perspectives in a one framework and looking for the relations and

trends, authors explain the inverse relation (Figure 4) between two aspects –complexity and optimization-, in the turbulent environment, when complexity (x) increases it is difficult to optimize forecasting plans in retail considering many uncontrolled factors, then optimization (y) decreases and vice versa, optimization (y) increases when complexity (x) decreases; in other words, it is easy to maintain simple forecasting models (F), not considering the environmental impact. In the middle point, complexity and optimization are delivering "balanced" forecasting plans.

Figure 4: The environmental impact on forecasting plans in retail business through relation between complexity and optimization of the forecasting plans



Source: Authors' elaboration

The present and the near future are moving forward those perspectives (f1-fn): by increasing a market chaos, new forecasting tools will be developed to try to maintain complexity in an efficient way so that the most complex model is the most optimal model (fn). It is the matter of the time when the relationship between complexity and optimization will become linear, and the most complex model with numerous environmental factors will show the best results in forecasting plans.

6. Conclusion

The retail environment affects the retailers' sales and performance. Forecasting activities are necessary to predict external events and provide data to elaborate strategic plans to stay competitive. However, these activities are becoming increasingly difficult because of the increasing complexity of the environment, which implies an evolution of forecasting methods. Several authors see environments as Complex Systems and suggest applying the complexity theory to improve previsions and planning.

According to the complexity theory, as stated by Horton (2012), the new forecasting techniques should:

– Enable a vision of a system's emergent properties.
– Embrace emergence rather than planning and forecasting.
– Focus on interactions rather than constituent parts.
– Recognise that even the basic rules and essential profile of a system can change (where rules can be also values and perspectives).
– Enable visioning of phase change situations (with no early warning signals) and the resulting changed world.
– Recognise that everything is part of a system where tiny, trivial actions can have huge, irreversible impacts.
– Enable practitioners to visualise systems from very different perspectives, including ones not possible now.
– Enable the generation of a range of future options and alternative potential strategies through both optimisation and exploration, including some that sound negative, impossible or ludicrous now.

As stated by Linstone (1999), it is evident that the challenge for the forecaster is an awesome one. A better understanding of the internal dynamics of nonlinear systems is vital for more effective forecasting and it will require unprecedented insight and ingenuity. "Rather than merely confirm the inherent limits to forecasting, complexity science should be seen as opening up new paths to reveal important insights to assist decision-making" (Linstone 1999, p.88). The study of the evolution of complex dynamic systems shows that the conjunction of order and chaos, stability and instability, self-organization and chance, is decisive for progress (Linstone 1999).

However, the results of this paper show a different trend in literature. Through a bibliometric analysis, the work identifies the most recent trends on environmental impact in retail forecasting. The results show that the actual forecasting models are not focused on the environment as a whole but instead each model includes different environmental factors (Climate change, Fuel price, etc.) without considering the relationships between them or considering their relationships linear. These techniques provide a distorted and incomplete vision of the markets and make forecasting plans ineffective in a turbulent environment.

From literature it emerges that authors

recognize the importance of including a greater number of variables and more sophisticated analysis able to capture the causal relationships between them in the forecasting models; but, at the same time, they are aware that this could increase the probability of errors and the difficulties for forecast users to make plans. Hence, trends in literature are based on the idea that when market dynamism increases, new forecasting tools should be developed with the aim to make linear the relationship between complexity and optimization of the forecasting model, so that the most complex model will show the best results in forecasting plans.

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