

Longitudinal study of perceived environmental uncertainty. An application of Rasch methodology to SMES

Perceived environmental uncertainty with Rasch

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Abstract

Purpose – This work develops a longitudinal analysis of perceived environmental uncertainty applying the Rasch methodology (1960). The environmental uncertainty is defined as an individual's perceived inability to predict the environment accurately (Milliken, 1987). The study focuses on analysing the state uncertainty from the perspective of the information and under the cognitive approach to the business reality.

Design/methodology/approach – Rasch measurement theory (1960) is applied, specifically the differential item functioning analysis based on the responses to a survey of SMEs.

Findings – The main sources of uncertainty for all the SMEs in the sample are two sectors in their general environment: economic and political-legal ones. These segments are the only ones in the environment that generate uncertainty that in 2016 is significantly different from that in 2019, being lower in the latter year.

Originality/value – This is a pioneering analysis of uncertainty both for its longitudinal nature and the methodology applied.

Keywords SMES, Environment, Uncertainty, Rasch, Longitudinal

Paper type Research paper

1. Introduction

The relevance of the environmental analysis for the management of organisations is not new, but it is particularly topical after recent events around the world. Its importance was anticipated by Chester Barnard (1938) at the beginning of the past century. This author defined organisations as open systems in permanent contact with their environment. This idea is the beginning of a multiplicity of research lines on environmental characterisation (e.g. Castrogiovanni, 2002; Dess and Beard, 1984; Duncan, 1972; Jurkovich, 1974), its mode of analysis (e.g. Aguilar, 1967; Daft *et al.*, 1988; Du Toit, 2016; García-Carbonell *et al.*, 2021; Sawyerr, 1993) and particularly on its relationship with a wide variety of organisational and strategic aspects (e.g. Danneels and Sethi, 2011; Leifer and Huber, 1977; Pryor *et al.*, 2019; Shopa *et al.*, 2021; Srivastava and Frankwich, 2011) [1], among others. Thus, environmental analysis has not only become a “foundation topic” in Strategic Management but has also given rise to numerous other fields of study (Robinson *et al.*, 2021), while generating an excessive fragmentation of knowledge about the organisational environment (Meinhardt *et al.*, 2018).

In the analysis of the environment, its uncertainty has received special attention, both in the classic works of Aguilar (1967), Thompson (1967), Duncan (1972) or Lawrence and Lorsch (1967), and in the majority of the most recent research, for example, that of Abu-Rahma and Jaleel (2019), Robinson and Simmons (2018b) or Haarhaus and Liening (2020). Environmental uncertainty has become the most used environmental dimension to characterise the environment (Miles and Snow, 1978) and a central concept in the organisation theory literature (Milliken, 1987). However, its conceptualisation and measurement have not been without some problems (Buchko, 1994) [2] and debates (e.g. Dess and Rasheed, 1991;



Sharfman and Dean, 1991a, b). In a general way, the uncertainty of the environment can be defined as an individual's perceived inability to accurately predict the environment (Milliken, 1987). This may be due to the difference between the information available and that needed for decision-making (Zhang *et al.*, 2012). Uncertainty is the subject of our study.

In the case of small and medium sized enterprises (SMEs), the unit of analysis of this work, the uncertainty created by the environment is of vital importance for them (Gaur *et al.*, 2011). The greater vulnerability, the scarcity of resources and the limited ability of these firms to predict external changes can hinder their success or can cause their failure (Babakus *et al.*, 2006). Therefore, the SMEs generally face greater uncertainty than large firms when it comes to the external environment (Baporikar *et al.*, 2016).

On the other hand, in most SMEs, the manager is the only person involved in the process of analysing the environment and the one in charge of obtaining the information needed about the outside world (Aldehayyat, 2015; Smeltzer *et al.*, 1988). Thus, in these organisations, strategic choices by the decision-maker are more conditioned by their perceptions of the environment than by objective and formal analyses (Parnell *et al.*, 2000). Therefore, the role of managers and their perceptions are crucial in the environmental analysis of SMEs.

Thus, this work is framed within the cognitive approach to the business reality and considers the environment and its uncertainty based on managerial perceptions (e.g. Babakus *et al.*, 2006; Duncan, 1972; Lewis and Harvey, 2001; May *et al.*, 2000; Sund, 2013).

On the other hand, the range of techniques, methodologies and approaches used in the research on environmental analysis and the development of the research field are a reflection of the increased complexity of the object of study. However, although there is some consensus that the environment of firms is increasingly uncertain, currently "a longitudinal study investigating the perceived organizational uncertainty is missing" (Meinhardt *et al.*, 2018). Thus, given the scarcity of longitudinal analyses within this field (Meinhardt *et al.*, 2018; Sund, 2013), this work takes on the challenge of making a contribution in this regard by applying, in addition, a novel methodology: the methodology of Rasch (1960). Therefore, the aim of this work is to apply the Rasch (1960) measurement theory in order to analyse the environmental uncertainty perceived by managers of SMEs at two different times, 2016 and 2019.

The methodology of Rasch (1960) has long been widely applied in other scientific disciplines such as Medicine or Education. However, it has recently begun to be used in the area of Management (e.g. Drehmer *et al.*, 2000; Fischer *et al.*, 2006; Martin *et al.*, 2016; Salzberger and Sinkovics, 2006). This methodology is particularly suitable for the treatment of latent variables and for the measurement of non-directly observable constructs (Godfrey and Hill, 1995), which are the majority in Business Administration and Management.

In short, the main contribution of this work goes beyond a specific analysis of the environmental uncertainty perceived by some SMEs at a specific time and place. The true value of this work is the tool used and that a longitudinal analysis of the environmental uncertainty perceived by managers has been carried out.

This work is structured in five parts. After this introduction, its theoretical basis is commented: the perceived environmental uncertainty. Next, the research methodology is explained, including the data collection and management, as well as the design of the scales and especially the Rasch (1960) measurement theory. In the following section, the results are discussed to finally provide the conclusions and their main implications.

2. Perceived environmental uncertainty

2.1 Perceived environmental uncertainty: perspectives and definitions

Environmental analysis is the process of searching and collecting information about events, trends and changes external to the organisation that will guide its future course of action

(Aguilar, 1967). Thus, managers draw the attention of their firms towards the examination of those external conditions that may be important to them (Pryor *et al.*, 2019). Through a combination of rational and intuitive processes (García-Carbonell *et al.*, 2021), the analysis of the environment aims to gather information about the environment and builds knowledge about it (Sund, 2015). This knowledge about the environment is key in the strategic process of organisations, especially in these difficult times.

Despite the great diversity of dimensions considered in the literature to characterise the environment (Meinhardt *et al.*, 2018), uncertainty is one of the most used characteristics of the environment to make its diagnosis (e.g., Duncan, 1972; Freel, 2005; Leifer and Huber, 1977; Lewis and Harvey, 2001). Thus, environmental uncertainty has been included in numerous works to analyse its impact on different organisational aspects. There are works with the objective of knowing how the degree of uncertainty influences the frequency and the manner in which organisations analyse the environment (Abu-Rahma and Jaleel, 2019; Boyd and Fulk, 1996; Daft *et al.*, 1988; Ebrahimi, 1998; Elenkov, 1997; Sawyerr, 1993; Sund, 2013; Xu *et al.*, 2003; Zhang *et al.*, 2012), how it conditions the business strategies and objectives (Badri *et al.*, 2000; Bourgeois, 1985; DeSarbo *et al.*, 2005; Milliken, 1987; Parnell *et al.*, 2000; Swamidass and Newell, 1987), or how it determines organisational characteristics (Buvik and Gronhaug, 2000; Duncan, 1973; Lawrence and Lorsch, 1967; Sutcliffe and Zaheer, 1988).

As a result, uncertainty has become central to many theories of organisation and strategy (Sund, 2015; Sutcliffe and Zaheer, 1998) [3]. Traditionally, there has been some consensus in defining environmental uncertainty as the lack of information experienced by a *subject* about the facts external to their organisation. In the twenty first century, new information technologies have made possible to have information in a more accessible way, at a lower cost, in a higher quantity and in real time. However, these technologies also provide too much information, most of it irrelevant, unorganised, fragmented and unchecked (Du Toit, 2016), which must then be selected and interpreted by managers. Moreover, due to their bounded rationality (Simon, 1957), managers are still unable to understand all the information related to a given situation. This is the primary reason of the existence of uncertainty, according to Chester Barnard (1938). Therefore, despite the greater availability of information, managers keep facing decision-making about the events surrounding their firm with uncertainty. Thus, in this work we consider environmental uncertainty as an individual's perceived inability to predict the environment accurately (Milliken, 1987) and also prevents him or her from accurately assessing the environment of their firm (Dickson and Weaver, 1997).

From the existing approaches to environmental uncertainty (Ashill and Jobber, 2010), this definition of uncertainty is framed within the perspective of the information processing (Daft *et al.*, 1988) and the cognitive approach to business reality and the environment [4]. Under these approaches, individuals act in response to what they perceive (Sund, 2015), as a way of coping with the complexity of the world around them. In this way, perceptions of the environment, and particularly perceptions of uncertainty, are linked to strategic decisions (Nadkarni and Barr, 2008) and to the strategic orientation of firms (O'Regan and Ghobadian, 2006).

Milliken (1987) considers that environmental uncertainty is not a unitary phenomenon (Huff *et al.*, 2016). Thus, Milliken (1987, 1990) identifies three types of environmental uncertainty depending on their origin: *state uncertainty*, *effect uncertainty* and *response uncertainty*. For this author, *state uncertainty* takes place when managers are not sure that they understand the main events and trends of the environment. *Effect uncertainty* exists when the manager is not capable of predicting the impact of an environmental event or change on the firm. Finally, *response uncertainty* is experienced by the decision-maker when he or she is not certain about how to respond to changes in the environment.

In this way, it becomes necessary to be more specific about the type or source of uncertainty considered or analysed (Huff *et al.*, 2016). Thus, in this work we address the first

component of uncertainty or state uncertainty. It is usually the closest to the most common notion of perceived environmental uncertainty (Sund, 2015) and the first step in the interpretation of the environment (Ashill and Jobber, 2010; Gerloff *et al.*, 1991).

Another thing to bear in mind when studying the environment and its uncertainty is the idea of considering it as an object and decomposing it into segments. Thus, most authors such as Bourgeois (1980), Daft *et al.* (1988), Fahey and Narayanan (1986), Sawyerr (1993) or Thompson (1967) make a distinction between the general environment and one more specific and closer to the organisation. Each one will involve varying degrees of conditioning at strategic levels (Bourgeois, 1980) or different levels of perceived uncertainty (Daft *et al.*, 1988; Sawyerr, 1993). The general environment includes sectors that indirectly affect the organisation, such as socio-cultural, economic or regulatory ones (Daft *et al.*, 1988). On the other hand, the task environment is the source of competitive intensity of an industry. It is defined from the competitive forces identified by Porter (1980): customers, competitors, potential or new competitors, suppliers and substitute products. In some studies, such as Sawyerr (1993), they are usually summarised as competitors, customers and source of resources.

2.2 Perceived environmental uncertainty in SMEs

The analysis of environmental uncertainty in SMEs has received less attention than in large firms (Sopha *et al.*, 2021). Generally, studies on how SMEs cope with the environment try to identify the features that differentiate them from large firms (e.g. Franco *et al.*, 2011). For example, the results show that their strategic decision-makers are usually closer to the environment (Robinson and Simmons, 2018a) or that their managers are frequently responsible for analysing it (Aldehayyat, 2015; Smeltzer *et al.*, 1988) using common sense and intuition rather than sophisticated analytical tools (Wong *et al.*, 2014). Instead of formal market analysis activities (Mohan-Neil, 1995), simulations or scenario analyses, which have been the top priority list in large organisations (Vaaland and Heide, 2007), SMEs obtain the strategic information to reduce uncertainty usually in an informal way (Levy and Powell, 2000; Smeltzer *et al.*, 1988). Thus, managers absorb information about the environment and change it into their own perception of the environment (Weiss and Wittmann, 2018). The brain of the managers becomes the main storage system of information in SMEs (Wong *et al.*, 2014).

An important idea to highlight is the one presented by Stonkute (2015). According to this author, SMEs have limited competencies in marketing, strategy and acquisition of new knowledge and technology (Parnell *et al.*, 2015). SMEs also face greater obstacles to obtain and manage the right information (Costa *et al.*, 2016) than large firms. These characteristics make them more vulnerable (Gaur *et al.*, 2011). Furthermore, although managers of SMEs are much clearer about the information they need (Wong *et al.*, 2014), they have fewer resources to analyse the environment and manage its uncertainty (Robinson and Simmons, 2018b). This resource constraint leads SMEs to underutilise certain external information sources such as annual reports or legislation (Haase and Franco, 2011). SMEs seem to rely mainly on verbal exchanges of information with suppliers, distributors and customers (Johnson and Kuehn, 1987). This circumstance makes the information thus obtained particularly valuable and attractive (Li and Lin, 2006). This way, the analysis of the environment is not carried out as widely or frequently as in large firms (Franco *et al.*, 2011; Haase and Franco, 2011; Strandholm and Kumar, 2003). With a much narrower scope, the analysis of the environment in SMEs focuses mainly on the economy, customers and the competitive environment (Wong *et al.*, 2014), with short communication channels (Stonkute, 2015).

In short, given their own idiosyncrasies, their scarcity of resources and the leading role of the manager, SMEs are more conditioned by the perceptions of the decision-maker than by

objective and formal analyses and diagnoses of the business environment (Parnell *et al.*, 2000).

In relation to the sources of uncertainty perceived by SMEs, Daft *et al.* (1988), obtain that customers, competitors and economic sectors are perceived as more uncertain than the technological, legislative and socio-cultural ones. A similar conclusion is that drawn by Sawyerr (1993) where SMEs in Nigeria perceive more uncertainty in their task environment than in the general one. However, in Elenkov (1997), methodologically similar to the previous two with medium-sized firms in Bulgaria, it is obtained that the main source of uncertainty is the political-legal sector of their environment, followed by suppliers and customers. In the case of Parnell (2013), it is concluded that the sources of uncertainty perceived in SMEs are different depending on the country in which the SME develops its activity. Thus, managers in Peru and Argentina perceive more uncertainty in the market and technology than those in the United States.

On the other hand, Sopha *et al.* (2021), in Indonesian SMEs, identify natural disasters as their main source of uncertainty, followed by macroeconomic sectors.

In short, the uncertainty in the environment perceived by SMEs can arise from different sources, depending on the country, the year of the study and the circumstances. The really important thing is to identify the main sources that generate it to search for the most appropriate information and thus make the best decisions.

Regarding the evolution of environmental uncertainty, there are few studies that empirically provide conclusive results, both about the amount of perceived uncertainty and their sources. However, it does seem to be accepted that the environment of SMEs is increasingly competitive (Parnell *et al.*, 2015), that customers and suppliers are constantly changing thus creating considerable uncertainty (Stewart *et al.*, 2008), and that environmental uncertainty changes over time due to learning acquired (Huff *et al.*, 2016) and in part to changing external circumstances.

2.3 Methodologies for the analysis of perceived environmental uncertainty

Methodologies and types of analysis to characterise the business environment have evolved along with the concept of environment (Kreiser and Marino, 2002). Several techniques have been used depending on the objective of the work. Firstly, given that most works analyse the link between uncertainty or environment and different strategic and organisational characteristics of firms, the treatment of the data is carried out seeking to relate concepts. Thus, the techniques used include, among others, correlation matrixes (Bourgeois, 1985; Daft *et al.*, 1988; Duncan, 1973), linear and multiple regression, sometimes with factorial analysis (Abu-Rahma and Jaleel, 2019; Boulton *et al.*, 1982; Buvik and Gronhaug, 2000; Danneels and Sethi, 2011; Elenkov, 1997; Sund, 2013; Sutcliffe and Zaheer, 1998), or more complex techniques such as structural equation modelling (Badri *et al.*, 2000; Boyd and Fulk, 1996; García-Carbonell *et al.*, 2021; Keats and Hitt, 1988).

Secondly, other studies try to find and analyse groups of firms with similar characteristics. To do this, they use techniques to identify homogeneous groups of units that are different from each other. For example, clustering or analysis of variance. This is the case of Huber *et al.* (1975), Franco *et al.* (2011), Parnell *et al.* (2000) or Sutcliffe and Huber (1998) who consider uncertainty to find out whether perceptions of the environment are conditioned by the ownership of the firm and by the industry.

Finally, we can also highlight the use of some methodologies of the cognitive approach. For example, causal maps (Barr and Huff, 1997; Fahey and Narayanan, 1989), the *repertory grid* (Daniels *et al.*, 1995), or the taxonomic mental models of competition (Hodgkinson and Johnson, 1994; Porac *et al.*, 1989).

In short, this variety of techniques reflects the increasing complexity of the object of study, the environment. However, although there is some consensus that the business environment is becoming increasingly uncertain, “a longitudinal study investigating the perceived organizational uncertainty is missing” (Meinhardt *et al.*, 2018) [5].

In order to take on this challenge and carry out a longitudinal analysis of perceived environmental uncertainty, the methodology of Rasch (1960) is applied in this work, which is another notable contribution. This methodology is considered one of the most appropriate methods in the field of Strategic Management (Marcoulides, 1998).

3. Research methodology

3.1 Data collection

The sample of this work is made up of 209 SMEs classified as SMES according to the Recommendation of the European Commission 2003/361/CE of 6 May 2005 (DOUE 20.05.2003) [6]. These firms are situated in the Canary Islands (Spain). This sample is representative of the sectorial distribution of the businesses in the Canary Islands: 3.9% belong to the industrial sector; 11% to the construction sector; 24% to the commercial sector, and 60.7% to the rest of services. Given that the objective of this study is to analyse the environmental uncertainty perceived by SMEs with a longitudinal character, the information needed was collected in two different years: 2016 (90 SMEs) and 2019 (119 SMEs). The sectorial representativeness is also met in each of those two years. Regarding the age of the SMEs, 69% of them are between 0 and 10 years old, 12.4% between 11 and 20 years old and the remaining 18.6% are over 20 years old.

The necessary information was obtained with a questionnaire of closed questions about the environment and some descriptive characteristics of SMEs. After the pre-test, during the months of January and February of each year considered in the study, the manager with strategic responsibilities in the firm, or if applicable, the person with an overall knowledge of it, answered the questionnaire.

3.2 The Rasch Measurement Theory (1960)

The application of the Rasch Measurement Theory (1960) to Business and Management (e.g. Drehmer *et al.*, 2000; Fischer *et al.*, 2006; García-Pérez *et al.*, 2014; Martin *et al.*, 2016; Salzberger and Sinkovics, 2006; Sapiyi *et al.*, 2021; Yanes-Estévez *et al.*, 2018) is one of the most recent methodological contributions in this scientific area, after its great development in other disciplines like Education, Medicine or Psychology.

In essence, this methodology analyses latent variables, which are not directly observable and which are the most common ones in Strategic Management. Here, the latent variable to be analysed is the environmental uncertainty. For this purpose, a group of subjects (SMEs) evaluates a series of items (the variables of the environment). With their assessments, we estimate a model to explain this latent variable by means of some parameters also estimated, both for the subjects or people (SMEs) and for the items (variables of the environment). Both parameters lie on a linear continuum that explains or represents the latent variable to be studied.

Thus, the parameters of the SMEs (subjects- β_n) and the parameters of the variables of the environment (items- δ_i) are simultaneously positioned on the linear continuum (Figure 1). This placement along the continuum gives these items a character that ranges from high uncertainty (items located lower on the continuum, that is, items with the smaller measurements) to low uncertainty (items located higher on the continuum, that is, items with the larger measurements). Similarly, SMEs parameters are also placed along the continuum indicating whether the SMEs perceive an environment with a degree of uncertainty ranging

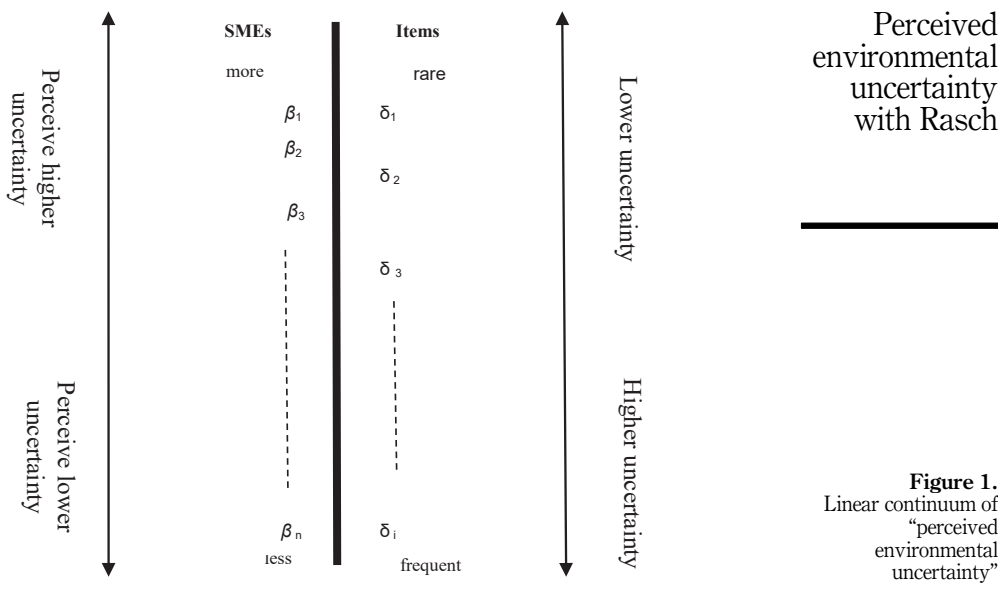


Figure 1.
Linear continuum of
“perceived
environmental
uncertainty”

from high uncertainty (SMEs placed higher on the continuum, that is, the SMEs with the larger measurements) to less uncertainty (SMEs placed lower on the continuum, that is, the SMEs with the smaller measurements).

One of the main features that make this methodology different is that it uses the same units of measurement (logits) for item and person parameters. By placing both parameters simultaneously on the linear continuum representing the latent variable and measuring them with the same unit, they can be analysed at the same time. This is known as joint measurement.

Another distinctive characteristic of this methodology is that it focuses on an individual level of analysis. Each item and each SME is addressed individually rather than characterising the data set. This presents another advantage: not having to assume that the data set follows a normal distribution (Engelhard, 1984). The reason is that this methodology does not intend to characterise the population of individuals or a group of items as a whole.

Because of these features, some accepted assumptions of additive scales do not have to be accepted with the Rasch Measurement Theory (1960). Among those assumptions are (Fischer *et al.*, 2006): (1) all items have the same impact on the score of the scale; and (2) all categories maintain the same distance to the next one. This methodology thus solves one of the criticisms made by Sund (2015) about the weight of each element of the environment in the scales.

Thus, Rasch’s models constitute the only methodology available for the construction of linear measurements (Bond and Fox, 2007) from ordinal observations (Fischer, 1995; Linacre, 2004). They are considered models of joint probabilistic analysis (Perline *et al.*, 1979).

Furthermore, Rasch’s methodology (1960) designs an ideal model to explain the latent variable. This model is designed from the subjects’ evaluations and fulfils the desirable characteristics from a measurement standpoint (Engelhard, 1984). Unlike other methodologies, in this case, it is the data that fits the ideal model. This way, it is also

possible to identify those individuals and items that do not follow this ideal model and that generate misfits. The study of misfits, based on the individualised analysis of items and subjects, is another of the great possibilities of this methodology.

This methodology also offers the differential item analysis for groups of subjects (*differential item functioning, DIF*). The estimation of the DIF is made by using a hypothesis contrast to determine if the difference in the measurements of the items is significant for two sets of subjects. This paper uses DIF to find out whether the uncertainty perceived by the SME group in 2016 of each environment item is significantly different from the uncertainty perceived by the SME group in 2019.

The model used in this work belongs to the family of Rasch measurement models (Wright and Mok, 2004) known as *Rasch Rating Scale Model*. This model was developed by Andrich (1978, 1988) especially for the treatment of ordinal multi-category scale data. It specifies the probability P_{nij} of a person n with skill β_n choosing category j on a common scoring scale applied to item i of difficulty δ_i . Its opposite would be the probability $P_{ni(j-1)}$ of selecting category $(j-1)$, therefore, the Neperian logarithm of the defined ratio odds would be:

$$\ln \frac{P_{nij}}{P_{ni(j-1)}} = \beta_n - \delta_i - \tau_{ij}$$

where β_n and δ_i represent the measurements already indicated in the dichotomous Rasch model, and τ_j is the Rasch-Andrich threshold or calibration of the stage. It would be the point in the latent variable at which the probability of selecting category j is the same as that of selecting category $(j-1)$, considering the difficulty of item i .

The expression of that probability would be:

$$P_{nij} = \frac{1}{\gamma} \exp \left[j(\beta_n - \delta_i) - \sum_{k=1}^j \tau_k \right]$$

where τ_1 is 0 and γ a normalized/standardized factor that reflects the sum of all the possible numerators.

The work is undertaken with two facets that interrelate in the Rasch Model (SMEs and items of the environment), where

β_n is the parameter of the skill of SME n , and whose field of variation $n = \{1, \dots, N\}$ (sample of SMEs).

δ_i is the parameter of the difficulty of item i , and whose field of variation is $i = \{1, \dots, L\}$ (sample of items considered), which would be the uncertainty of the item.

The parameters are estimated using a maximum likelihood method through the program *Winsteps 3.92.1* (Linacre, 2016), which considers the algorithms PROX and JMLE (*joint maximum likelihood estimation*) [7].

3.3 Description of the scale used

To obtain the perceived environmental uncertainty, seven items have been used, adapted from Duncan (1972) and Daft *et al.* (1988). They include both the general and the task environments: customers, competitors, suppliers, economic situation of the country/region, political-legal situation, technology and socio-cultural characteristics.

These items are shown to the manager, who must indicate the degree of perceived uncertainty for each one, on a scale from 1 (low perceived uncertainty) to 5 (high perceived uncertainty) (Annex). This way, in this study, the authors have chosen a simple measurement of uncertainty according to the classification of Kresler and Marino (2002), because, in accordance with the purpose of this paper, we are not interested in its origin but in the differences in the degree of uncertainty perceived during the two years. Other studies, such as

Parnell (2013), Parnell *et al.* (2015), Sutcliffe and Zaheer (1998), Gaur *et al.* (2011) and DeSarbo *et al.* (2005) among others, have used this same approach in SMEs [8].

To assess the quality of the measurements of perceived environmental uncertainty, overall reliability of SMEs and the items on the scale [9], the overall and individual validity of the model for both SMEs and items are all considered using the indicators of the Rasch Measurement Theory (Rasch, 1960).

Regarding reliability, the results obtained to carry out the study are satisfactory (Andrich, 1982): between 0.72 (real) and 0.76 (model) for items and 0.98 (real and model) for SMEs.

On the other hand, to analyse the validity of the measurements, misfits were considered, both at a global level of the firm and at the individual level of firms and items. In both cases, the validity is confirmed since, firstly and at a global level, the validity of the model is adequate, with OUTFIT and INFIT values [10] close to the expected level of 1. Second, in the analysis of validity at an individual level, the significant misfits of SMEs are managed individually.

Finally, the unidimensionality of the measurements, a requirement for the application of Rasch models (1960), is analysed by means of several indexes: reliability and fit of the data, point-measure correlations (PTMA) and Rasch-residual-based Principal Components Analysis (PCAR) [11]. After carrying out such analyses, and given the level of the eigenvalues obtained, these indicate a certain tension of multidimensionality, which could correspond to the general and specific environment considered in the design of the scale.

4. Results

4.1 Analysis of the perceived environmental uncertainty of SMEs 2016–2019

The Winsteps 3.92.1 program is run with the respondents' assessments about environmental uncertainty. As a result, the linear continuum that represents the latent variable "perceived environmental uncertainty" (Figure 2) is obtained. The environment variables can be observed on one side, and the subjects or SMEs on the other. To analyse the differences between both years, SMEs that perceive the environment in 2016 are represented as "6", and SMEs in 2019 as "9".

The economic characteristics represent the greatest source of uncertainty for most SMEs (item with the smallest measurement: -0.75 logits). For managers and owners the economy is the main problem and the political-legal framework is in second place (-0.58 logits).

This result seems logical in these years because several electoral processes took place in Spain. The electoral results added some instability to the country due to the vote fragmentation and the emergence of new political parties. These circumstances forced the political parties to engage in lengthy negotiation processes for the governance of the institutions. As these events were new in Spain, these political-legal circumstances also created economic uncertainty due to the extension of the National budget for several years and the delay of major projects and investments.

On the opposite end of the continuum, and perceived as the source generating the lowest uncertainty, are the suppliers (item with the largest measurement: 0.83 logits). This result is explained by the service activity of most SMEs in the sample. In services firms, the relation with their suppliers is not as important as in other sectors like the industrial one. Moreover, the SMEs in the sample are located in the Canary Islands (Spain), geographically distant from the rest of Europe and with high external dependence. However, these SMEs have been able to identify trusted suppliers thus reducing the uncertainty they create.

In short, the two main sources of uncertainty for all SMEs belong to the general environment whereas the area for which they have the most information, in other words, the one that generates the least uncertainty, the suppliers, belongs to the task environment.

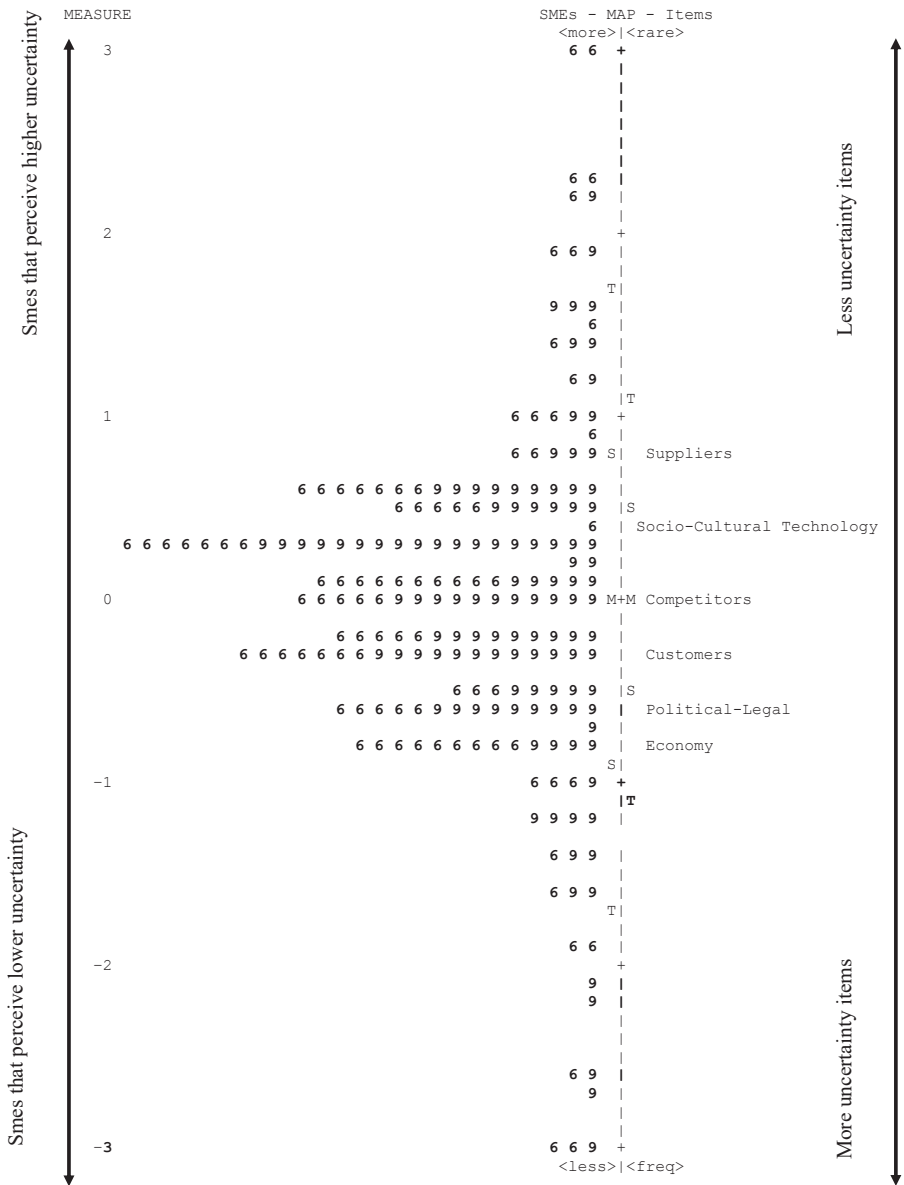


Figure 2.
Perceived
environmental
uncertainty by SME

If we analyse the other side of the continuum, the SMEs, at first glance, it seems that the SMEs of 2016 and those of 2019 are almost equally distributed along the continuum. However, it could be highlighted in a descriptive way that out of the 23 SMEs that perceive the most environmental uncertainty (their measurements are bigger than the measurements of all items), fourteen are SMEs of the year 2016 and nine are of the year 2019. When we analyse the other end, out of the 24 SMEs that perceive the lowest uncertainty (their measurements are

smaller than those of all items), ten belong to the year 2016 and fourteen to the year 2019. Accordingly, the SMEs of 2016 predominate among those perceiving the most uncertainty, and the SMEs of 2019 among the ones perceiving the least uncertainty.

4.2 Differential analysis of the perceived environmental uncertainty of SMEs 2016–2019

To identify the possible significant differences in the environmental uncertainty perceived by SMEs between 2016 and 2019, a *Differential item analysis* (DIF) [12] is applied.

The DIF tries to identify if any of the items of the environment behaves differently depending on the group of SMEs considered (2016 vs 2019). For a difference to be considered significant, the probability must exceed 0.05 (*prob.* < 0.05) and also be sufficiently perceptible (*DIF contrast* > 0.43 logits) (Linacre, 2016) [13].

The analyses allow us to identify significant and sufficiently perceptible differences for two of the seven items considered (Table 1); the economic and the political-legal sectors. The environmental uncertainty that is perceived in both cases is higher in 2016 than in 2019. This result seems logical given that the economic and political-legal circumstances around the SMEs are better as the years go by and the exit from the 2008 crisis becomes more evident. On the other hand, it should also be noted that the rest of the segments, including the entire task environment, the socio-cultural and technological sectors, are perceived with an equal degree of uncertainty in both years.

5. Conclusions, implications and future research lines

5.1 Conclusions

The limited resources of SMEs increase their vulnerability to uncertainty (Bodlaj and Cater, 2019) and make their decision making process difficult. Therefore, the contribution of this work is important when analysing the evolution of the uncertainty perceived by SMEs and identifying its main sources. A novel methodology in this field is also proposed, the methodology of Rasch (1960), particularly suitable for latent variables, such as the perceived environmental uncertainty.

In a first stage, it is obtained that the economy of the region and the country is the sector in which managers perceive more uncertainty or about which they feel the most unable to predict its future trend accurately. It is followed by the political-legal situation as source of uncertainty and instability. This result shows the internalisation that managers have made of the complex Spanish political life in recent years. Contrary to what is possibly expected, suppliers are the agents from which SMEs feel the most able to predict their future actions. Developing their activities in geographically distant conditions, in addition to insularity, is the starting situation to be overcome by all firms in the Canary Islands (Spain). Hence, to reduce the external dependence, the detailed analysis and the search for trusted suppliers is one of the first and most vital steps to be taken by the managers of SMEs. To this, given the predominance of the service sector, suppliers are not the most important force of the task

	DIF measure SMES 2016	DIF SE	DIF measure SMES 2019	DIF SE	DIF contrast	Prob
Customers	-0.20	0.12	-0.38	0.10	0.19	0.2295
Competitors	0.16	0.12	-0.11	0.10	0.26	0.0863
Suppliers	0.91	0.12	0.77	0.10	0.14	0.3927
Economic sector	-1.12	0.13	-0.51	0.10	-0.61	0.0003
Political-legal sector	-1.00	0.13	-0.31	0.10	-0.69	0.0000

Table 1.
Differential item analysis of perceived environmental uncertainty between 2016 and 2019

environment for these SMEs. Therefore, they are not a source that generates special uncertainty for them.

The Rasch (1960) Measurement Theory applied to obtain the results allows us to make a longitudinal analysis of the uncertainty and, in the last step of the work, to analyse the possible differences during the years considered. Thus, it is obtained that the uncertainty created by the competitive forces of the task environment (customers, suppliers and competitors) remains equal during the two years of the study. The same happens with the technological and socio-cultural sectors. However, SMEs perceive that uncertainty has decreased significantly in relation to the political-legal and economic segments. The reason may be that 2016 was particularly uncertain at the political level. The long period of interim government after the election or the lengthy negotiations between the political parties generated high levels of uncertainty in SMEs. In addition, those were new situations that had never happened before in Spain.

This uncertainty from the political framework had important consequences on the economy and especially on the expectations, savings and investment decisions of the economic agents (Consejo Económico y Social de España, 2017). From an objective point of view, the aggregate uncertainty of the Spanish economy also increased slightly during 2016 compared to previous years (Gil *et al.*, 2017). To this, we must add other sources of uncertainty with an international character, such as *Brexit* and the change of government in the United States (Consejo Económico y Social de España, 2017), with important economic consequences to firms. In short, objectively, the environment that surrounded the SMEs in 2016 also presented a clear source of uncertainty with its origin in political-legal and economic circumstances.

5.2 Implications

One of the first implications of this research focuses on SMEs managers. In this work, the results show that the sectors of the general environment also generate uncertainty that must be managed (Daft *et al.*, 1988). For the entrepreneurs and managers, one way of managing uncertainties, in this case, political and economic ones but also applicable to any other source, would be to acquire the routines or capacities to analyse the environment and obtain the information that allows them to make decisions in better conditions. Thus, if the scarcity of resources of SMEs greatly conditions them, the best option is to establish networks of contacts with other firms, other agents, institutions or attend forums, for example, to gather information from the reality around them. On the other hand, SMEs with a minimum size could, hire a person in charge of continuously analysing the environment using all the resources available. The firms that have the information on the environment more easily available tend to feel more in control of the situation (Kuvaas, 2002), which will undoubtedly have an impact on their stability and growth.

At this point, the actions of public administrations and institutions are important. They could propose support programmes in two directions. According to the existing literature, the more uncertainty SMEs perceive, the more their managers analyse the environment (Abu-Rahma and Jaleel, 2019). So while SMEs are predisposed to analyse the environment, institutions must facilitate it. On the one hand, they could try to make known and explain in a clearer, more detailed and closer way the political-legal and economic proposals that they are developing, as well as their future plans. This way, the political-legal and economic uncertainty perceived by the managers of these SMEs could be reduced. For example, actions to support the creation and consolidation of SMEs should become a revitalising factor of firms instead of *walls* of bureaucracy that are often difficult for SMEs to deal with. On the other hand, public administrations and institutions could also design training programmes for managers to convince them of the need to analyse their environment with a strategic

vision. This strategic vision is necessary for the achievement and maintenance of a competitive advantage, even more so in the case of SMEs. As pointed out by [Sund \(2013\)](#), the more the environment is analysed, the less uncertainty and the better results will be obtained, both for SMEs and for the society in general. It should be borne in mind that uncertainty has a negative impact on employment growth and its effects are first and foremost felt by SMEs ([Ghosla and Ye, 2015](#)). Hence the effort that the institutions have to make.

Finally, this work has important implications for the academic world by proposing a tool of analysis with great potential and high applicability in the field of strategic management, the [Rasch \(1960\)](#) Measurement Theory. As demonstrated in this paper, it is a methodology particularly suitable for this field given the nature of the variables that are used in the empirical works in this area (subjective, ordinal and non-observable). Furthermore, this methodology is based on the individualised analysis of SMEs (subjects) and items; gives a differentiated weight to each item on the scale of measurement according to the assessments of the participants in the study; allows the joint analysis of items and SMEs by placing both on the same continuum and using the same unit of measurement, or enables the differential analysis of items for different groups of SMEs, as seen in this work.

5.3 Future research lines

This work is an approach to the longitudinal study of the environmental uncertainty perceived by SMEs. Thus, in addition to addressing in a novel way this existing gap in the literature, another of its contributions is that it opens a wide range of new lines of research to be developed.

One of the first studies to be carried out in the future should focus on making uncertainty operational in a multidimensional way based on the integration of the perceived degree of dynamism and complexity, following the recommendations of the information processing perspective (for example, [Daft et al., 1988](#); [Duncan, 1972](#)). This way, it could be identified whether the reduction of the uncertainty of the political and economic sectors, between 2016 and 2019, is due to the fact that they are more stable, simpler or both.

In addition, other differentiating variables, such as the age of SMEs, their size or their results, should be included. Thus, by applying the [Rasch \(1960\)](#) methodology's DIF, it would be possible to know, for example, whether the SMEs that perceive the higher or lower uncertain obtain better or worse results.

Another promising line of research is the identification and study of misfits. Being able to identify which SMEs do not follow the ideal model designed by the methodology according to the behaviour of the sector means knowing which SMEs are moving away from what the rest of the SMEs in the sector do and why. The analysis of the causes (they perceive more uncertainty than the rest, they do not innovate like the rest, they are the smallest or the oldest, their strategy is different, for example) could help to increase their results and thus to improve their survival and growth.

Notes

1. [Meinhardt et al. \(2018\)](#) review the literature on the organisational environment: its dimensions, its measurement, its influence on the organisational decisions or its consideration as moderating variable.
2. For [Huber and Daft \(1987\)](#), the acquaintance with uncertainty means that it is easy to assume that one knows what he is talking about without the need to define it. As a result, numerous studies that include environmental uncertainty in their analyses do not define it or sometimes excessively broad definitions are proposed ([Duncan, 1972](#)).
3. In [Kreiser and Marino \(2002\)](#), a historic analysis of the evolution of the concept of uncertainty can be read, as well as the two perspectives for its conceptualisation (information and resource

dependence) or the different approaches for its measurement (objective vs perceived measures and simple vs complex measures). On the other hand, [Weiss and Wittman \(2018\)](#) delve into the process of perceiving environmental uncertainty and propose a conceptual model that includes the moderating factors that can cause a gap between the objective and the perceived environment.

4. The other alternative to approach environmental uncertainty is to define it with objective and independent data of the decision-maker, as in the works of [Aldrich \(1979\)](#), [Dess and Beard \(1984\)](#) or [Tosi et al. \(1973\)](#). [Lueg and Borisov \(2014\)](#) explain the conceptual and methodological differences between archival environmental uncertainty (AEU) and perceived environmental uncertainty (PEU).
5. According to the latest detailed review of the literature on environmental analysis ([Meinhardt et al., 2018](#)), the only study that has empirically demonstrated the growing perception of environmental dynamism throughout the years is [Oreja-Rodríguez and Yanes-Estévez \(2010\)](#). Other two longitudinal studies are [McNamara et al. \(2003\)](#) and [Castrogiovanni \(2002\)](#), which perform longitudinal analyses of the environment but with objective measures.
6. Micro-enterprise (0–9 employees), small enterprise (10–49 employees), and medium-sized enterprise (50–250 employees).
7. To delve deeper into the fundamental and probabilistic mathematical developments of this methodology see, among others, [Wright and Stone \(1999\)](#).
8. Most studies that choose to operationalize uncertainty in a complex or multidimensional way obtain it from the consideration of the degree of dynamism and complexity perceived by managers in their environment. Hostility is sometimes added. The reference studies of this perspective are those of [Daft et al. \(1988\)](#) or [Duncan \(1972\)](#).
9. The Rasch Measurement Theory ([Rasch, 1960](#)) and its application through the Winstep program provide a reliability index for individuals and another for item reliability. Both indices are expressed in model and real terms, which respectively represent the upper and lower limits of the interval in which the true reliability is found ([Linacre, 2004](#)).
10. OUTFIT values reflect the sensitivity of the model to unexpected behaviours that affect responses to items that are far from the measurements. INFIT values are sensitive to unexpected behaviours that are close to the measurements ([Wright and Mok, 2004](#)). Both can be expressed in terms of MNSQ (mean-square) and ZSTD (standardized *z* values).
11. Point-measure correlations (PTMEA) is the correlation between the observations of an item and the corresponding measure of the items ([Linacre, 2016](#)). Rasch-residual-based Principal Components Analysis (PCAR) shows the contrast between opposite factors, not the load on a factor ([Linacre, 2016](#)).
12. Differential Item Functioning analysis (DIF) is a tool provided by the Rasch Measurement Theory (1960). The analysis of the residuals derived from the process of data adjustment to the model allows verifying the presence of a differential item functioning (DIF) between the groups of subjects. The estimation of this DIF is performed using a hypothesis contrast to determine whether the difference in the location measures of the items in each subsample is significant.
13. According to [Linacre \(2016\)](#), a DIF measure lower than 0.43 indicates that the difference between subgroups is insignificant; between 0.43 and 0.64 the difference is moderate, and over 0.64, the difference is large.

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Annex

A) FIRMS CHARACTERISTICS

1. Name: _____
2. Year of foundation: _____
3. Island where is located:

1. Tenerife	<input type="checkbox"/>
2. La Palma	<input type="checkbox"/>
3. La Gomera	<input type="checkbox"/>
4. El Hierro	<input type="checkbox"/>
5. Gran Canaria	<input type="checkbox"/>
6. Lanzarote	<input type="checkbox"/>
7. Fuerteventura	<input type="checkbox"/>

4. Sector of the main activity.....
5. Number of employees_____

B) ENVIRONMENT

6. Think about today circumstances around your firm and indicate the level of uncertainty generated by the following elements

	Low uncertainty		High uncertainty		
	1	2	3	4	5
1. The customers	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
2. The competitors	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
3. The suppliers	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
4. The national and regional economic situation	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
5. The national and regional politic-legal situation	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
6. The technology La tecnología	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
7. The socio-cultural society characteristics	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>