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Environmental scanning

Dynamism with rack and stack from Rasch model

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Abstract

Purpose – This paper aims to propose a method for the longitudinal analysis of the environment considering both firms' and environmental variables.

Design/methodology/approach – The study is based on a sample of firms in Canary Islands (Spain) for 2000 and 2003. Managerial perceptions are considered, based on the cognitive perspective. The measurements used are the result of applying the Rasch model and the rack and stack analyses. This approach provides information about how dynamic the firms perceive the environment and also about how the items are perceived.

Findings – The results show that most firms perceive that dynamism increased between 2000 and 2003. From the perspective of the environmental variables, the most dynamic are perceived to be competition, demand, consumer motivation and technological resources.

Originality/value – This paper proposes a longitudinal method for environmental scanning that include both firms' and environmental variables. It considers managerial perceptions, that is the information entering the decision making process. It is one of the first papers to study environmental scanning with Rasch model and one of the few about longitudinal environmental analyses. It opens a field of research and applications of the Rasch model in the management literature.

Keywords Business environment, Strategic management, Perception, Spain

Paper type Research paper

> The essential character of organizational environments may be changing in ways that require new modes of thought and analysis (Lenz and Engledow, 1986).

1. Introduction

Firms must adapt to their environments to survive and prosper (Dreyer and Gronhaug, 2004; Hambrick, 1982). Moreover, information from the environment is especially important because most studies also mention the growing uncertainty and rivalry in the business environment (Lewis and Harvey, 2001; Sutcliffe and Zaheer, 1998). Thus, all information that enables firms or institutions to know the environmental development will be essential to decision making.

Environmental scanning is a subject of in-depth research in the literature on business management and a topic of methodological debates. Some of those debates address the conceptualization and measurement of the environment (Dess and Rasheed, 1991; Sharfman and Dean, 1991a, 1991b), the choice between the objective environment (Dess and Beard, 1984; Rasheed and Prescott, 1992; Snyder and Glueck, 1982) and the perceived environment (Sutcliffe and Zaheer, 1998; Tan and Litschert, 1994) or which dimensions to use, depending on the approach of the study (Aldrich, 1979).

This work aims to contribute to those debates by proposing a method for the longitudinal analysis of the environment considering both firms and environmental

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variables. This proposal provides preliminary information about how individuals perceive the environment as well as how the environmental variables are perceived over a period of two years. In this case, the study focuses on the dynamism of the environment by applying rack and stack analyses based on the Rasch model (Rasch, 1980). Two of the advantages of this methodology are that it is focused on the individual level and that the Rasch (1980) approach is also stable for small samples (Barnes and Wise, 1991).

After this introduction, the second section addresses the literature's principal ideas about the external environment of organizations. The third section establishes the objectives of the work and the fourth explains the method and analysis of the scale. The fifth part comments on the results of the rack and stack analyses and the final section presents the work's conclusions and limitations and possible future lines of research.

2. Environmental scanning and dynamism

Given the importance of the environment to the strategic process, some methodological debates have taken place. Kreiser and Marino (2002) include the development of the environmental uncertainty construct and some of such perspectives. The first of those perspectives was the subject of one of the great debates in the literature: the environment is an objective reality independent of the person or the environment is a result of perceptions. Following the cognitive approach and the bounded rationality of individuals (Simon, 1957), this research considers that the reality that exists is the perceived reality. Therefore, the environment and its characteristics are those that the deciders perceive. Their perceptions comprise the information considered as input in the strategic process (Sutcliffe and Huber, 1998) and what conditions environmental scanning to a greater extent (Stewart *et al.*, 2008).

The other great debate revolves around which dimensions to use to characterize the business environment. Uncertainty is the principal dimension to diagnose the environment (Daft *et al.*, 1988; Duncan, 1972). It is more difficult to find agreement among authors on which environmental features to include in order to obtain that uncertainty. Environmental dynamism appears in most of the options either because is the major conditioner of uncertainty (Child, 1972) or because is easier to quantify.

For Duncan (1972), the static-dynamic dimension of the environment shows the degree to which external factors remain stable over time or are in a continuous process of change. Some authors, such as Harrington (2001) and Sharfman and Dean (1991a, 1991b), stress the need to differentiate between the rate of change of the elements of the environment and the inability to predict change. This paper identifies the construct of dynamism of the environment as the difficult-to-predict changes that most condition the uncertainty of deciders (Dess and Beard, 1984).

Environmental scanning usually entails more than the mere identification of external events that are important to the firm and its diagnosis. The definition of environmental scanning also includes the identification of external tendencies that guide the firm's future course of action (Aguilar, 1967; Hambrick, 1982; Milliken, 1990). The evolution of the environment is one of the least studied topics. If the general development of the environment is towards greater uncertainty (Fahey and Narayanan, 1986), effort should be made to analyze that development and to identify the causes and consequences. However, the literature does not provide enough examples of longitudinal studies of the environment due to the difficulty of obtaining information..

In that context, Lenz and Engledow (1986) propose the era model to analyze firms over long periods of time, although they themselves are aware of the difficulty of its application.

Other models to explain environmental evolution are the causal textures of Emery and Trist (1965) and the study by Ansoff (1981). In the latter, the author identifies five types of environmental turbulence at a population level. Both of those works conclude that the tendency of the environment is towards increasing turbulence and complexity.

One example of a longitudinal study of environmental dynamism is that of Barry *et al.* (2006). They conclude that volatility leads firms to prefer the use of process technology, the design of standardized components and lower rotation of the work team. They use data for a period of 20 years for a single firm.

3. Research objectives

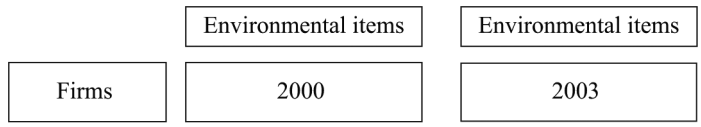
Information about the environment is essential to the organization's decision making process. In times of growing uncertainty it is even more important to analyze environmental evolution in order to check the effectiveness of the actions or to identify possible environmental tendencies. Moreover, the process of noticing and interpreting environmental changes is determinant for the organization's performance and survival (Milliken, 1990). This paper applies a method to identify the evolution of the dynamism perceived by the firm's deciders based on the Rasch approach and applied to the Canary Islands (Spain) between 2001 and 2003. The specific objectives of the proposed method address both the perspective of the firms and that of the variables:

- *Objective 1:* To identify variations in how the environmental variables are perceived in the two years, thus focusing on the movements of the variables over the years. The research includes two perceptions of each variable for each firm and year. This first objective is pursued by means of a rack analysis (Wright, 2003) (Figure 1). For example, the paper considers how dynamic each firm perceives the "level of income of the demand" in 2000 and in 2003.
- *Objective 2:* To make a diagnosis of the evolution of the firms' perceptions between 2000 and 2003 and see whether objective changes in the environment, on the one hand, or certain information policies, improved training, accumulation of experience or any other type of intervention, on the other hand, have any effect on the dynamism perceived by each firm[1]. In this case, the paper applies a stack analysis (Wright, 2003) (Figure 2). For example, this analysis consists of taking the "level of income of demand" and seeing how each firm perceives that variable in 2000 and again in 2003.

4. Method

4.1 Sample

The geographical setting of this study is the Canary Islands (Spain). The Canary Islands constitute a Spanish autonomous region located in the Atlantic Ocean off the coast of



Source: Adapted from Wright (2003)

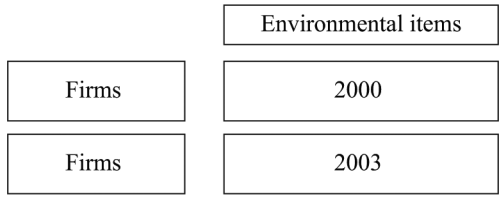
Figure 1.
Rack analysis of environmental dynamism

North-West Africa and more than 2,000 km from mainland Spain and the rest of Europe. These geographical features make the islands one of the most peripheral regions of the European Union. Their geographical location, warm weather, political stability and natural resources make the Canary Islands one of the leading tourism destinations in Spain.. Nearly all the region's economic activities revolve around tourism. The business population of the Canary Islands has the same general characteristics as in the rest of Spain in that it mainly comprises SMEs belonging to commerce and other service sectors.

The information was gathered by means of a questionnaire. It was completed during a personalized interview with a manager of each firm or with someone with strategic responsibilities and overall knowledge of the firm's functioning (Research Contract 981201 FYDE-CajaCanarias – Universidad de La Laguna.). The respondents indicated the level of dynamism they perceive of the environmental variables (Table I). The same questionnaire, albeit with slight modifications, has been used since 1998 to gather information about the Canarian business world and its environment. In this case, the paper focuses on the analysis of dynamism and its evolution between 2000 and 2003.

All the questions were quantified by means of a scale that ranged from (1), which indicated a very low level of dynamism, to (5), which represented a very high level.

The study started with initial samples of 380 firms that developed their activities in the Canaries during 2000 and 394 firms during 2003. After refinement, and prior to the item calibration of the measurements, the final sample comprised the 29 firms appearing in the samples for both of those years[2]. Most of the sample firms operated in the services sector (31.0 per cent retail firms and 51.7 per cent other services) and were small firms (41.4 per cent), which reflects the reality of the region.



Source: Adapted from Wright (2003)

Figure 2.
Stack analysis of environmental dynamism

Sub-scale	Items	Sub-scale	Items
Geographical	Insularity	Economic	Level of development in Canaries
	Orography		Situation of the demand
	Natural resources		Situation of competitors
	Demography		Distance to large/mass markets
Political-legal	Political situation in the Canaries		Market segmentation
	Sector legislation		Natural resources
	Labor legislation		Financial resources
	Consumer protection		Human resources
Socio-cultural	Consumer motivations		Technological resources
	Attitude to the firm		Physical barriers
	Professional training		Economies of scale
			External dependence
			Exchange rate

Source: Based on Oreja (1999)

Table I.
Items of environmental dynamism

4.2 Key aspects of the Rasch model (1980)

The Rasch models[3] were initially developed by Rasch in 1960 and they have mostly been applied in medicine, psychology and education. However, in recent years this approach has been used in organization and management studies. For example, they have been applied to financial issues (Soutar and Cornish-Ward, 1997), to human resources studies (Drehmer *et al.*, 2000), to marketing and consumer behavior topics (Fischer *et al.*, 2006; Salzberger and Sinkovics, 2006) and to tourism management (Oreja-Rodríguez and Yanes-Estévez, 2007). In those areas, Rasch models have a wide range of application and development with implications for institutions, practitioners and researchers alike.

Those models constitute the only available technique for the construction of linear measures (Bond and Fox, 2007) from ordinal observations (Fischer, 1995; Linacre, 2004). Thus, the Rasch models solve the underlying assumptions in Likert scales (Fischer *et al.*, 2006):

- that all the items have the same impact on the scoring of the scale; and
- that all the categories maintain the same distance from the adjacent category.

They are considered models of conjoint probabilistic analysis (Perline *et al.*, 1979).

The Rasch models are also developed as a technique focused on the individual rather than a group level, unlike other proposals that need to make additional assumptions about the distribution of the data (Engelhard, 1984).

The starting point of the application of the Rasch model (Rasch, 1980) is to consider the object of the study (environmental dynamism) as a latent variable in which two different entities interact: the surveyed subjects (firms) and the items of the measurement instruments (environmental variables). The objective is to place the subjects and items on a simple scale representing the latent variable (dynamism). Thus, the subjects and the items are simultaneously positioned on a single linear continuum and many comparisons can be made.

The model used in this work is one of the family of Rasch measurements models (Wright and Mok, 2004), namely, the Rasch Rating Scale Model. This model was developed by Andrich (1978, 1988) specifically for the treatment of information from ordinal multiple category score scales such as Likert type scales.

The parameters are estimated by the maximum likelihood method, using the *Winsteps* program (Linacre, 2007), which considers the PROX and JMLE algorithms (joint maximum likelihood estimation)[4]. Those estimated parameters are the measures included in the Tables II and III, and what the software then uses to obtain Figures 3 and 4.

4.3 Design and calibration of the measures

The scale to measure the perceived dynamism comprises the most relevant variables of an island environment (Oreja, 1999) (Table I). The design of the scale follows the adaptation to the geographical context (Miller, 1997) and the inclusion of subscales that reflect the scope of the phenomenon studied (Lewis and Harvey, 2001). Apart from following the design instructions in the literature, the scale content has been tested in Oreja (1999). The variables on the scale are the result of an in-depth review of the island environment literature that addresses the phenomenon to be analyzed.. Moreover, the scale has been reviewed by researchers in this field and by the anonymous reviewers of international publications who are specialists in both environmental analysis and island economies. With regard to the convergent and discriminant validity, these were tested in Oreja and Yanes (2005).

Code		Measure	Model S.E.	INFIT MNSQ	INFIT ZSTD	OUFIT MNSQ	OUFIT ZSTD	PTMEA
Insul	Insularity (2000)	1.13	0.23	1.22	0.8	1.24	0.8	0.24
	Insularity (2003)	0.94	0.21	1.33	1.2	1.19	0.7	0.39
Orog	Orography (2000)	1.23	0.23	1.87	2.4	1.72	1.9	0.17
	Orography (2003)	0.81	0.21	1.84	2.7	1.68	2.2	0.28
NatRes	Natural resources (2000)	1.51	0.27	1.64	1.7	1.63	1.5	0.12
	Natural resources (2003)	0.85	0.21	1.25	1.0	1.25	0.9	0.15
Demo	Demography (2000)	0.15	0.18	1.39	1.6	1.38	1.6	0.43
	Demography (2003)	0.09	0.19	1.12	0.6	1.10	0.5	0.44
Develop	Development Canaries (2000)	−0.36	0.19	0.34	−3.70	0.35	−3.50	0.74
	Development of Canaries (2003)	−0.90	0.21	0.61	−1.60	0.62	−1.60	0.36
Deman	Situation of the demand (2000)	−0.85	0.21	0.71	−1.10	0.71	−1.10	0.43
	Situation of the demand (2003)	−1.32	0.23	0.50	−2.10	0.49	−2.10	0.52
IncoDem	Income of the demand (2000)	−0.61	0.20	0.58	−1.80	0.61	−1.60	0.61
	Income of the demand (2003)	−0.58	0.20	0.71	−1.20	0.71	−1.10	0.64
Comp	Competitors (2000)	−0.43	0.19	1.58	2.1	1.56	2.0	0.39
	Competitors (2003)	−0.94	0.21	1.25	1.00	1.23	0.90	0.45
LarMark	Distance large markets (2000)	0.64	0.20	1.10	0.50	1.14	0.60	0.37
	Distance large markets (2003)	0.05	0.19	0.93	−0.20	0.98	0.00	0.31
MarkSe	Market segmentation (2000)	0.19	0.18	0.92	−0.30	0.95	−0.10	0.66
	Market segmentation (2003)	0.19	1.19	0.75	−1.10	0.81	−0.80	0.22
NaRes	Natural resources (2000)	1.19	0.24	0.97	0.00	1.00	0.10	0.04
	Natural resources (2003)	0.46	0.19	1.33	1.4	1.46	1.80	0.08
FinRes	Financial resources (2000)	−0.36	0.19	1.04	0.30	1.05	0.30	0.40
	Financial resources (2003)	−0.51	0.19	0.77	−0.90	0.83	−0.60	0.04
HumRes	Human resources (2000)	−0.15	0.18	1.11	0.50	1.09	0.50	0.21
	Human resources (2003)	−0.58	0.19	0.95	−0.10	0.99	0.00	0.28
TechRes	Technological resources (2000)	−0.62	0.20	0.99	0.10	0.99	0.10	0.40
	Technological resources (2003)	−0.66	0.20	1.11	0.50	1.07	0.30	0.27
PhysBa	Physical barriers (2000)	0.56	0.19	1.06	0.30	1.03	0.20	0.40
	Physical barriers (2003)	−0.12	0.18	0.95	−0.10	.96	−0.10	0.40
EcoSc	Economies of scale (2000)	0.49	0.20	0.98	0.00	1.02	0.20	0.28

(*continued*)

Table II.
Rack analysis of the environmental dynamism (2000-2003)

Table II.

Code		Measure	Model S.E.	INFIT MNSQ	INFIT ZSTD	OUFIT MNSQ	OUFIT ZSTD	PTMEA
	Economies of scale (2003)	−0.12	0.19	0.80	−0.80	.82	−0.70	0.19
ExtDep	External dependence (2000)	0.04	0.19	1.28	1.2	1.27	1.10	0.38
	External dependence (2003)	−0.05	0.18	1.15	0.70	1.15	0.70	0.16
Exchan	Exchange rate (2000)	0.49	0.20	1.27	1.10	1.26	1.0	0.21
	Exchange rate (2003)	0.49	0.19	1.16	0.70	1.14	0.60	0.24
PolSit	Political situation (2000)	0.43	0.19	1.29	1.3	1.26	1.10	0.33
	Political situation (2003)	−0.12	0.18	0.90	−0.30	0.90	−0.40	0.69
SecLeg	Sector legislation (2000)	−0.02	0.18	0.98	0.00	1.02	0.2	0.42
	Sector legislation (2003)	−0.51	0.19	0.72	−1.10	0.73	−1.10	0.47
LabLeg	Labour legislation (2000)	0.19	0.18	0.84	−0.70	0.83	−0.70	0.32
	Labour legislation (2003)	−0.22	0.19	0.56	−2.1	0.58	−2.0	0.72
CoProt	Consumer protection (2000)	−0.05	0.18	0.72	−1.30	0.71	−1.30	0.67
	Consumer protection (2003)	−0.22	0.19	0.82	−0.70	0.82	−0.70	0.56
ConMoti	Consumer motivation (2000)	−0.15	0.18	1.10	0.50	1.10	0.50	0.55
	Consumer motivation (2003)	−0.87	0.21	0.63	−1.50	0.61	−1.60	0.56
Attit	Attitude to the firm (2000)	−0.05	0.18	1.08	0.40	1.07	0.40	0.71
	Attitude to the firm (2003)	−0.30	0.20	0.64	−1.5	0.65	−1.5	0.56
ProfTrai	Professional training (2000)	0.02	0.18	1.14	0.70	1.17	0.80	0.49
	Professional training (2003)	−0.44	0.20	0.91	−0.30	0.92	−0.20	0.74
	Mean	0.00	0.20	1.02	0.00	1.02	0.00	
	Standard devaiation	0.62	0.02	0.32	1.30	0.30	1.20	

Code		Measure	Model S.E.	INFIT MNSQ	INFIT ZSTD	OUTFIT MNSQ	OUTFIT ZSTD	PTMEA
E1	Firm 1 (2000)	−0.95	00.22	1.21	0.90	1.29	1.10	0.43
	Firm 1 (2003)	−0.76	0.23	1.13	0.60	1.12	0.50	0.53
E2	Firm 2 (2000)	0.40	0.22	1.01	0.10	0.95	−0.10	0.60
	Firm 2 (2003)	−0.06	0.21	1.00	0.10	0.96	−0.10	0.68
E3	Firm 3 (2000)	−1.35	0.23	1.63	2.10	1.57	1.70	0.45
	Firm 3 (2003)	−0.19	0.21	0.37	−3.20	0.38	−3.10	0.52
E4	Firm 4 (2000)	−0.95	0.22	0.92	−0.20	0.93	−0.20	0.25
	Firm 4 (2003)	−1.77	0.26	1.83	2.30	1.43	1.20	0.51
E5	Firm 5 (2000)	−0.77	0.21	0.76	−0.90	0.74	−1.00	0.58
	Firm 5 (2003)	−0.41	0.21	0.61	−1.70	0.64	−1.50	0.38
E6	Firm 6 (2000)	−0.86	0.21	1.32	1.30	1.22	0.90	0.60
	Firm 6 (2003)	0.50	0.22	1.69	2.20	1.79	2.40	0.22
E7	Firm 7 (2000)	−0.41	0.21	1.45	1.60	1.53	1.80	0.27
	Firm 7 (2003)	−0.36	0.21	0.88	−0.40	0.88	−0.40	0.75
E8	Firm 8 (2000)	0.82	0.23	1.74	2.3	1.57	1.80	0.72
	Firm 8 (2003)	0.55	0.23	0.82	−0.60	0.82	−0.60	0.75
E9	Firm 9 (2000)	−0.68	0.21	1.11	0.50	1.08	0.40	0.62
E10	Firm 10 (2000)	−0.33	0.21	1.40	1.50	1.38	1.40	0.60
	Firm 10 (2003)	−0.19	0.21	0.63	−1.60	0.60	−1.70	0.67
E11	Firm 11(2000)	−2.13	0.30	0.58	−1.20	1.04	0.20	0.12
	Firm 11 (2003)	−0.68	0.21	1.14	0.60	1.20	0.80	0.50
E12	Firm 12 (2003)	1.17	0.25	1.14	0.50	1.09	0.40	0.74
E13	Firm 13 (2000)	0.07	0.21	1.15	0.60	1.21	0.80	0.22
	Firm 13 (2003)	−0.41	0.21	0.97	0.00	0.95	−0.10	0.71
E14	Firm 14 (2000)	−0.46	0.21	1.38	1.40	1.48	1.70	0.03
	Firm 14 (2003)	0.40	0.22	1.84	2.60	1.75	2.40	0.21
E15	Firm 15 (2003)	0.40	0.22	0.67	−1.30	0.69	−1.20	0.04
E16	Firm 16 (2000)	−0.63	0.21	1.34	1.30	1.29	1.10	0.40
	Firm 16 (2003)	−0.28	0.21	0.50	−2.30	0.53	−2.10	0.45
E17	Firm 17 (2000)	0.21	0.22	0.47	−2.40	0.48	−2.30	0.30
	Firm 17 (2003)	0.71	0.23	1.78	2.4	1.71	2.20	0.16
E18	Firm 18 (2000)	−0.59	0.21	0.83	−0.60	0.81	−0.70	0.73
	Firm 18 (2003)	0.40	0.22	0.80	−0.70	0.85	−0.50	0.31
E19	Firm 19 (2000)	−0.19	0.23	1.88	2.60	1.81	2.40	0.35
	Firm 19 (2003)	0.50	0.22	0.28	−3.70	0.29	−3.60	0.66
E20	Firm 20 (2003)	−0.68	0.21	0.92	−0.20	0.91	−0.30	0.51
E21	Firm 21 (2000)	−1.57	0.25	1.07	0.30	0.88	−0.30	0.67
	Firm 21 (2003)	−0.46	0.21	0.76	−1.00	0.73	−1.00	0.73
E22	Firm 22 (2000)	−0.41	0.21	1.20	0.80	1.17	0.70	0.58
	Firm 22 (2003)	0.01	0.23	0.72	−1.00	0.74	−0.09	0.49
E23	Firm 23 (2000)	−0.03	0.22	1.15	0.60	1.14	0.60	0.77
	Firm 23 (2003)	−0.81	0.21	0.61	−1.70	0.59	−1.70	0.63
E24	Firm 24 (2003)	−0.40	0.24	0.63	−1.40	0.60	−1.50	0.71
E25	Firm 25 (2003)	−1.84	0.27	0.90	−0.20	0.83	−0.30	0.47
E26	Firm 26 (2000)	−0.68	0.21	0.31	−3.80	0.32	−3.50	0.83
	Firm 26 (2003)	0.21	0.22	1.05	0.30	1.07	0.30	0.81
E27	Firm 27 (2000)	−0.46	0.21	0.50	−2.40	0.50	−2.30	0.73
	Firm 27 (2003)	−0.06	0.21	0.76	−0.90	0.73	−1.10	0.64
E28	Firm 28 (2000)	−1.14	0.22	1.51	1.80	1.45	1.50	0.45
	Firm 28 (2003)	0.07	0.21	0.85	−0.50	0.89	−0.30	0.08
E29	Firm 29 (2000)	−0.90	0.21	0.69	−1.30	0.69	−1.20	0.69
	Mean	−0.36	0.22	1.02	−0.10	1.01	−0.10	
	Stand. deviation	0.68	0.02	0.42	1.60	0.39	1.50	

Table III.
Stack analysis of the environmental dynamism (2000-2003)

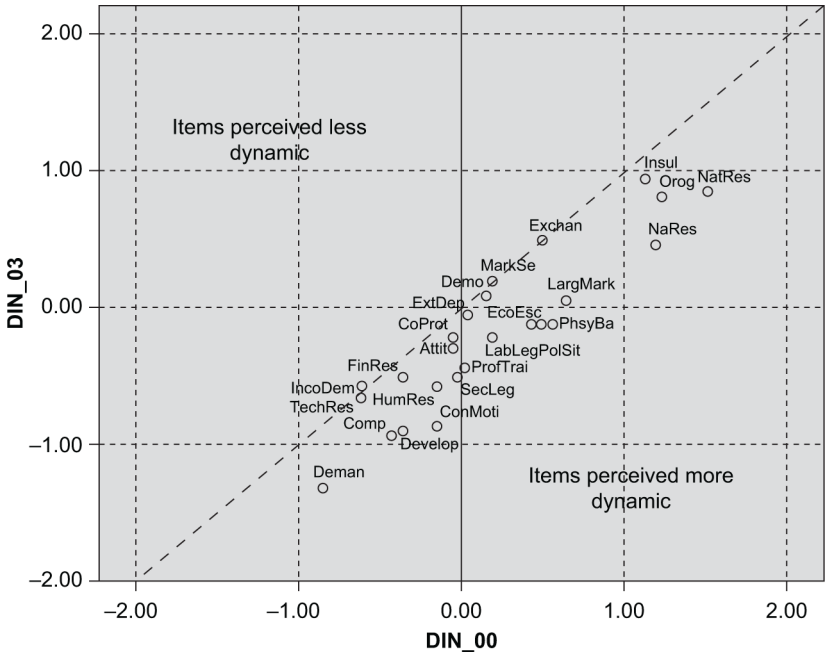


Figure 3.
Rack analysis of environmental dynamism (2000-2003)

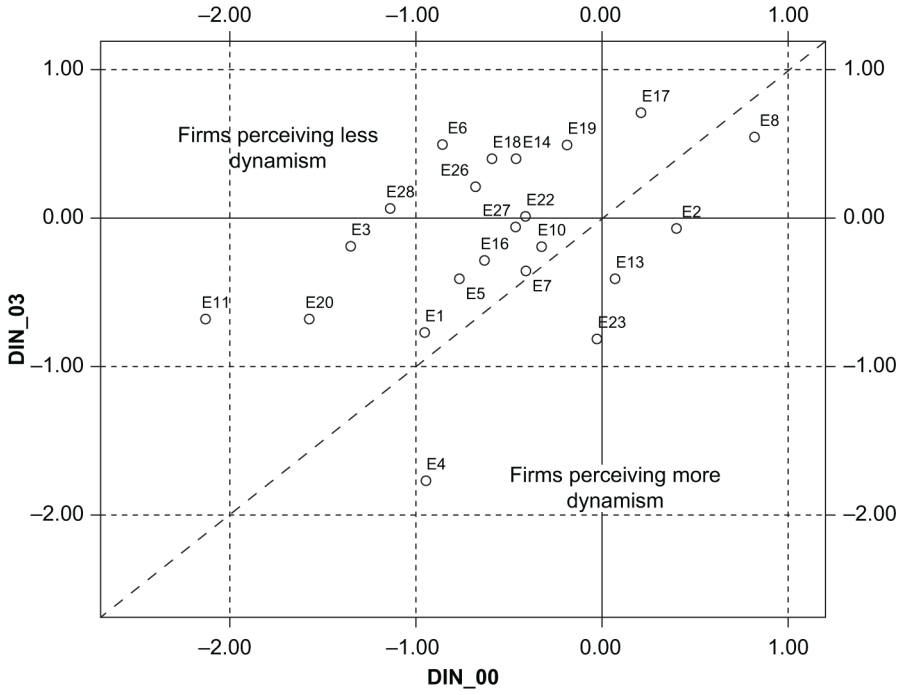


Figure 4.
Stack analysis of environmental dynamism (2000-2003)

The managers indicated how dynamic they perceived these 25 items to be (Table I).

Following the proposals in the literature, environmental dynamism includes the most difficult-to-predict changes in the environment, that is, those that most condition the uncertainty of the deciders (Dess and Beard, 1984). Thus, this paper takes into account not only the variability of the environment but also its prediction.

The reliability of the measures was analyzed both for the firms and for the items of the dynamism scale. The levels obtained are acceptable to carry out the research, in both the rack and the stack analyses, in accordance with Andrich (1982). Thus, the dynamism of the environment can be evaluated using the variables on the questionnaire (Table IV).

The validity of the measures is evaluated with the analysis of the fits. Its objective is to identify the items and subjects that do not behave as expected by the model. To that end, the Rasch model (Rasch, 1980) provides the OUTFIT and INFIT analysis for each item and subject, and for each year studied. The OUTFIT statistics reflect the model's sensitivity to unexpected behaviors that affect the responses to items that are distant from the measure of dynamism perceived by the firms. The INFIT statistics are sensitive to unexpected behaviors close to that measure (Wright and Mok, 2004). Both can be expressed in the form of MNSQ (mean-square) and ZSTD (standardized z value). As a result, the authors eliminate two firms from the rack analysis and seven from the stack analysis. They generate significant misfits for the model. Apart from that validity at an individual level, we complement the test of validity with that of overall fit, since its OUTFIT and INFIT are close to the expected value of 1 (Table IV). Those characteristics confirm both the validity at the individual level with the fit of each item and subject and also the global validity of the model.

Another requisite of this method, and one that forms an operative hypothesis of the model, is its unidimensionality. This feature ensures that the researchers analyze a single dimension of a specific reality represented by the construct. In this paper, unidimensionality is demonstrated, on the one hand, by verifying the reliability and validity of the process and, on the other, by analyzing the explained variance. The program indicates that the model explains 45 per cent and 55.82 per cent of the variance in the rack and stack analyses respectively. Moreover, the eigenvalues of the unexplained variance are 6.8 and 3.5. Those values are close to the limits of 60 per cent and eigenvalues of 3 to identify a single dimension in the construct. Together with the high PTMEA values[5], those results lead us to confirm unidimensionality in the stack analysis. However, since the values are slightly below the threshold, a major review and a study of the possible dimensions for future research in the rack analysis would be required.

5. Results

The rack and stack analyses are two longitudinal analyses that are developed as one more application of the proposals of Rasch (1980). Each one focuses on analyzing different aspects in order to obtain greater information for decision making and the strategic process.

5.1 Rack analysis of the data

The aim of the rack analysis is to study the items (environmental variables). To that end, the rack compares perceptions at two different points of time: two observations about the variables per subject, one for each year. In this case, the initial sample comprised 27 firms that evaluated each of the 25 environmental variables (Table I) in 2000 and again in 2003. The result was a data base comprising 27 firms and 50 variables (25 variables $\times$ 2 years). A single application of the program on a joint sample permits the observations for

		Raw score	Count	Measure	Model error	INFIT MNSQ	INFIT ZSTD	OUTFIT MNSQ	OUTFIT ZSTD
Rack analysis									
Of the firms'									
Mean		139.3	49.0	−0.24	0.14	1.01	0.0	1.02	0.0
St. deviation		21.8	1.8	0.44	0.01	0.25	1.3	0.24	1.3
Separation index									
Real	2.70								
Model	2.85								
Reliability									
Real	2.70								
Model	2.85								
Of the items'									
Mean		75.2	26.5	0.00	0.20	1.02	0.0	1.02	0.0
St. deviation		16.8	0.8	0.62	0.02	0.32	1.3	0.30	1.2
Separation index									
Real	2.72								
Model	2.94								
Reliability									
Real	0.88								
Model	0.90								
Stack analysis									
Of the firms'									
Mean		68.4	24.6	−0.36	0.22	1.02	−0.1	1.01	−0.1
St. deviation		14.6	1.0	0.68	0.02	0.42	1.6	0.39	1.5
Separation index									
Real	2.64								
Model	2.90								
Reliability									
Real	0.87								
Model	0.89								
Of the items'									
Mean		139.6	50.2	0.00	0.15	1.01	0.0	1.01	0.0
St. deviation		28.8	0.9	0.65	0.01	0.27	1.3	0.26	1.3
Separation index									
Real	3.87								
Model	4.10								
Reliability									
Real	0.94								
Model	0.94								

Table IV.
Analysis of the measures of environmental dynamism

the two years to be positioned on the same linear continuum. Thus, they can be compared, which constitutes one of the great advantages of this application. The measures obtained for the items (Table II) are displayed on a graph (Figure 3) that shows how the perception of each variable evolved between 2000 and 2003.

Each variable is positioned on the graph according to their measurement obtained from the application of the Rasch (1980) model. The more negative its measurement is, the more dynamic the environmental item is perceived to be.

For better interpretation of the results, take the diagonal as a reference. Any deviation from that diagonal indicates that there is a perceived difference in the

variable. The variables positioned on or very close to the diagonal are equally dynamic in the two years. This occurs in the cases of exchange rate and market segmentation.

Variables above the diagonal indicate a reduction of dynamism of those items. This case is limited to income of the demand, with a scarcely perceptible difference between the two years.

The last possibility is when variables are situated below the diagonal. This occurs with the vast majority of the variables, including competition, the situation of the demand, consumer motivation, sector legislation and technological resources and others. In those cases, the decider perceived frequent or unpredictable changes.

The results confirm that the demand is increasingly more informed and consumer motivation and behavior are not at all predictable and the consumers' reactions differ from previous reactions. The dynamism of the technological, human and financial resources available in the market, together with the political-legal and even geographical frameworks are added. The environment that surrounds the firm is definitely moving in an unpredictable fashion.

5.2. Stack analysis of data

The other perspective in the longitudinal study of data under the Rasch (1980) method starts from the comparison of the firms' perceptions of dynamism. The stack analysis compares each subject's scores for the same variables at two different times. Thus, there are 25 columns representing the variables and two rows per variable that correspond to each firm's perceptions of dynamism in the years 2000 and 2003. Using the two responses from each of the 29 firms participating in the two surveys and after the calibration of the measures, the Winsteps program (Linacre, 2007) was run for a total of 51 firms and 25 environmental variables. Thus, the Rasch (1980) model situates the firms' observations for both years on a single linear continuum so that they share the same model for comparison. The measures of the firms (Table III) are displayed in Figure 4. Its axes indicate the measure assigned each year to the firms' perceptions of dynamism in order to draw conclusions from the stack analysis. In this case, the more positive the measure obtained by the subjects, the greater the dynamism that they perceive in their environment.

The diagonal is the reference to identify differences between the perceptions for the two years. Thus, the graph shows firms in three situations:

(1) The firms positioned on, or very close to, the diagonal maintain their scores for perceived dynamism in the two years or the difference in the two scores is almost negligible. This situation is the case of firm E7, which perceives almost the same level of dynamism in the two years.

(2) The firms positioned above the diagonal perceive greater environmental dynamism in 2003 than in 2000. This group includes firms E11, E20, E6, E3 and others.

(3) The firms situated below the diagonal, such as firms E4, E2 and E23, perceive a lower level of dynamism in 2003 than in 2000.

The number of firms in each group leads us to conclude that there are more firms that perceive an increase in the dynamism of the environment between 2000 and 2003.

6. Conclusions, implications and future lines of research

The business environment in the vast majority of sectors and regions is more dynamic and uncertain. Therefore, an in-depth analysis of the evolution of environmental dynamism is essential for firms to be competitive. However, the difficulty not only of

obtaining but also of treating data means that the longitudinal analysis of the environment does not receive enough attention. This paper contributes to the field by proposing a method to study the environment over a period of time.

This work applies the rack and stack analyses of the Rasch (1980) model to the study of environmental dynamism between 2000 and 2003. Based on the features of the Rasch model (Rasch, 1980) and the possibility of studying both firms and environmental variables, this proposal shows who moves (firms with stack analysis) and what moves (environmental variables with rack analysis).

The main conclusions include the following points:

- From the perspective of the items, the rack analysis reveals that the majority of environmental variables are perceived to be more dynamic in 2003 than in 2000. Thus, the environment analyzed is characterized by an increase in environmental dynamism. This may be because, objectively, those variables change unpredictably or, even when the changes follow a known tendency, the managers' perceptions lead them to interpret them as dynamic. In any event, their perceptions constitute the information entered in their decisions and strategic process.
- From the perspective of the firms, the stack analysis reveals that most of the firms perceive an increase in environmental dynamism. According to the managers' perceptions and interpretations of reality, the environmental variables change more frequently and also with less predictable tendencies. This means, among other things, that the information to which those deciders have access or their experience in the sector perhaps do not soften the possible objective changes of external variables.

Apart from those conclusions and implications for firms in Canary Islands (Spain), the great added value of this research is the methodology applied. With the rack and stack analyses from the Rasch (1980) method, this research achieves the following advantages for longitudinal analyses:

- Managers, research centers and authorities in charge of promoting entrepreneurial behavior have a tool to identify which variables need their attention, which variables or areas need an extra formative effort or which variables most condition the perceived dynamism and, consequently, the uncertainty of the environment over time.
- This method enables researchers, practitioners and authorities to identify how objective changes affect the environmental perceptions of firms. Thus, if they include size, age or economic sector in the study, it will be possible to know the effects of certain events on the perceptions in each type of firm and consequently which kind of firm it is necessary to place more emphasis on. The Rasch model (Rasch, 1980) provides all that information by means of a hierarchy of the perceptions of the firms. Furthermore, it is possible to make individualized analyses of each firm because the Rasch model (Rasch, 1980) uses an individual unit of analysis.

Definitively, the longitudinal analysis of environmental dynamism by means of rack and stack analyses based on the proposals of Rasch (1980) gives more detailed knowledge of which variables are perceived as more and less dynamic, and which firms perceive more and less dynamism over time. The main differences from other studies are that the users can make individual diagnoses of each firm and variable and

observe the possible tendencies in variables and firms, while a single model explains all the information.

Moreover, the future research lines to be developed from this point are also even more relevant. For example, future works could analyze the characteristics of the firms in each of the three previously mentioned situations: those perceiving more dynamism, less dynamism or unchanged dynamism between the two years. Such a study could reveal any common characteristic in the group of firms in each location: their sector, age or size, or, from the perspective of the deciders, their experience or training or the sources of information that they trust. The differences in the characteristics of firms in each group could help identify the reasons for their dynamism perceptions and how to help the firms.

From the perspective of the environmental variables, the next step is to discover why the decider perceives the vast majority of variables as dynamic despite the greater availability of information and the possible efforts of the administrations. Perhaps the reason lies in the experience of the managers, in their training, in the information or in the fact that the need to be in a permanent state of alert has not been internalized as a habit.

The rack and stack analyses and the potential of the Rasch model (Rasch, 1980) even permits users to know which variables and for which year the perceptions of each firm do not fit what the model expects according to the rest of their perceptions. This analysis of the misfits will provide a greater knowledge about each firm in the sample.

Apart from the application to environmental scanning, the rack and stack analyses could easily be applied to other topics of business administration, such as strategies, human resources or innovations in different departments of a firm. Thus, these rack and stack analyses offer deciders, institutions and researchers a whole range of possibilities for longitudinal analysis. Unlike other techniques, the Rasch model (Rasch, 1980) can handle as many years and data as the researcher has with hardly any increase in its complexity. Thus, this method offers much more detailed knowledge of firms by considering a greater number of years as well as more information for each year, thanks to the vast capacity of the software used to apply it, Winstep (Linacre, 2007).

It is suitable for small samples and, its capacity to treat almost infinite data and, more importantly, its potential for development are enormous.

Notes

1. The objective of this paper is to analyze the change in perceptions. It is beyond its scope to know whether the changes are caused by the objective modifications of the environment or by how they are interpreted by deciders. That study is another interesting line of research to be developed in the future.
2. Although the sample size it is not optimal, the Rasch (1980) model is stable for small samples (Barnes and Wise, 1991). In addition, this study must be considered preliminary and its conclusions taken with some caution.. Apart from the implications for Canary Islands (Spain), the great added value of this paper is the methodological perspective for longitudinal analysis that it proposes.
3. This section explains the application of the rack and stack based on the Rasch (1980) model. More details of the method and application to a single year can be found in the work of Oreja and Yanes (2007), which studies perceived environmental uncertainty in the tourism sector.
4. The JMLE displays some estimation bias when using small samples, "but this rarely exceeds the precision of the measures" (Linacre, 2007). The Rasch (1980) proposal is stable for small samples (Barnes and Wise, 1991) and, if the sample is well designed, that problem is overcome (Berger, 1997).

5. The PTMEA is the point-measure correlation and is computed in the same way as the point bi-serial, except that Rasch measures replace total scores (Linacre, 2007).

References

Aguilar, F.J. (1967), *Scanning the Business Environment*, Macmillan, New York, NY.

Aldrich, H.E. (1979), *Organizations and Environments*, Prentice-Hall, Englewood Cliffs, NJ.

Andrich, D. (1978), "A rating formulation for ordered response categories", *Psychometrika*, Vol. 43 No. 4, pp. 561-73.

Andrich, D. (1982), "An index of person separation in latent trait theory, the traditional KR.20 index and the Guttman scale response pattern", *Educational Research and Perspectives*, Vol. 9, pp. 95-104.

Andrich, D. (1988), *Rasch Models for Measurement*, Sage, Newbury Park, CA.

Ansoff, I. (1981), *Strategic Management*, Halsted Press, New York, NY.

Barnes, L.L.B. and Wise, S.L. (1991), "The utility of a modified one-parameter IRT model with small samples", *Applied Measurement in Education*, Vol. 4 No. 2, pp. 143-57.

Barry, E., Kemerer, C.F. and Slaughter, S.A. (2006), "Environmental volatility, development decisions and software volatility: a longitudinal analysis", *Management Science*, Vol. 52 No. 3, pp. 448-64.

Berger, M.P.F. (1997), "Optimal design for latent variable models: a review in applications of latent trait and latent class models", in Rost, J. and Langehein, R. (Eds), *The Social Sciences*, Waxmann Verlag, Berlin.

Bond, T.G. and Fox, Ch.M. (2007), *Applying the Rasch Model. Fundamental Measurement in the Human Sciences*, 2nd ed., Erlbaum, Mahwah, NJ, (1st ed. published in 2001).

Child, J. (1972), "Organization structure, environment and performance", *Sociology*, Vol. 6, pp. 1-22.

Daft, R.L., Sormunen, J. and Parks, D. (1988), "Chief executive scanning, environmental characteristics and company performance: an empirical study", *Strategic Management Journal*, Vol. 9, pp. 123-39.

Dess, G.G. and Beard, D.W. (1984), "Dimensions of organizational task environments", *Administrative Science Quarterly*, Vol. 29, pp. 52-73.

Dess, G.G. and Rasheed, A.A. (1991), "Conceptualizing and measuring organizational environments: a critique and suggestions", *Journal of Management*, Vol. 17 No. 4, pp. 701-10.

Drehmer, D.E., Belohlav, J.A. and Coye, R.W. (2000), "An exploration of employee participation using a scaling approach", *Group and Organzation Management*, Vol. 25 No. 4, pp. 397-418.

Dreyer, B. and Gronhaug, K. (2004), "Uncertainty, flexibility and sustained competitive advantage", *Journal of Business Research*, Vol. 57, pp. 484-94.

Duncan, R. (1972), "Characteristics of organizational environment and perceived environment uncertainty", *Administrative Science Quarterly*, Vol. 17, pp. 313-27.

Emery, F.E. and Trist, E.L. (1965), "The causal texture of organizational environments", *Human Relations*, Vol. 18, pp. 21-32.

Engelhard, G. (1984), "Thorndike, Thurstone and Rasch: a comparison of their methods of scaling psychological and educational test", *Applied Psychological Measurement*, Vol. 8 No. 1, pp. 21-38.

Fahey, L. and Narayanan, V.K. (1986), *Macroenvironmental Analysis for Strategic Management*, West, St Paul, MN.

Fischer, A.R.H., Frewer, L.F. and Nauta, M.J. (2006), "Toward improving food safety in the domestic environment: a multi-item Rasch scale for the measurement of the safety efficacy of domestic food-handling practices", *Risk Analysis*, Vol. 26 No. 5, pp. 1323-38.

Fischer, G.H. (1995), "Derivations of the Rasch model", in Fischer, G.H. and Molenaar, I.W. (Eds), *Rasch Models. Foundations, Recent Developments, and Applications*, Springer-Verlag, New York, NY, pp. 14-38.

Hambrick, D.C. (1982), "Environmental scanning and organizational strategy", *Strategic Management Journal*, Vol. 3, pp. 159-74.

Harrington, R. (2001), "Environmental uncertainty within the hospitality industry: exploring the measure of dynamism and complexity between restaurants segments", *Journal of Hospitality and Tourism Management*, Vol. 25 No. 4, pp. 386-98.

Kreiser, P. and Marino, L. (2002), "Analyzing the historical development of the environmental uncertainty construct", *Management Decision*, Vol. 40 No. 9, pp. 895-905.

Lenz, R.T. and Engledow, J.L. (1986), "Environmental analysis: the applicability of current theory", *Strategy Management Journal*, Vol. 7, pp. 329-46.

Lewis, G.J. and Harvey, B. (2001), "Perceived environmental uncertainty: the extension of Miller's scale to the natural environment", *Journal of Management Studies*, Vol. 38 No. 2, pp. 201-33.

Linacre, J.M. (2004), "Estimation methods for Rasch measures", in Smith, E.V. Jr and Smith, R.M. (Eds), *Introduction to Rasch Measurement. Theory, Models and Applications*, JAM Press, Maple Grove, MN, pp. 25-47.

Linacre, J.M. (2007), "Winsteps. Rasch measurement computer program", Winsteps.com. Chicago, available at: www.winsteps.com/winman/index.htm (accessed 3 July 2009).

Miller, K.D. (1997), "Measurement of perceived environmental uncertainties: response and extension", Paper 97-004, Center for International Business Education and Research, Purdue University, West Lafayette, IN.

Milliken, F.J. (1990), "Perceiving and interpreting environmental change: an examination of college administrators' interpretation of changing demographics", *Academy of Management Journal*, Vol. 32 No. 1, pp. 42-63.

Oreja-Rodríguez, J.R. (1999), "El método GEPS de análisis y diagnóstico del entorno empresarial. Aplicaciones para entornos insulares", in Oreja-Rodríguez, J.R. (Ed.), *Entorno En Las Actividades Empresariales*, Fyde CajaCanarias-IUDE, Tenerife, pp. 33-64.

Oreja-Rodríguez, J.R. and Yanes-Estévez, V. (2005), "La incertidumbre del entorno como condicionante del riesgo estratégico asumido por el decisor", Cuadernos de Economía y Direcci, Granada.

Oreja-Rodríguez, J.R. and Yanes-Estévez, V. (2007), "Perceived environmental uncertainty in tourism: a new approach using the Rasch model", *Tourism Management*, Vol. 28, pp. 1450-63.

Perline, R., Wright, B.D. and Wainer, H. (1979), "The Rasch model as additive conjoint measurement", *Applied Psychological Measurement*, Vol. 3 No. 2, pp. 237-55.

Rasch, G. (1980), *Probabilistic Models for Some Intelligence and Attainment Tests*, University of Chicago Press, Chicago, IL, (originally published in 1960, Danish Institute for Educational Research, Copenhagen).

Rasheed, A.M.A. and Prescott, J.E. (1992), "Towards an objective classification scheme for organizational task environments", *British Journal of Management*, Vol. 3, pp. 197-206.

Salzberger, T. and Sinkovics, R.R. (2006), "Reconsidering the problem of data equivalence international marketing research: contrasting approaches based on CFA and the Rasch model for measurement", *International Marketing Review*, Vol. 23 No. 4, pp. 390-417.

Sharfman, M.P. and Dean, J.W. (1991a), "Conceptualization and measuring the organizational environment: a multidimensional approach", *Journal of Management*, Vol. 17 No. 4, pp. 681-700.

Sharfman, M.P. and Dean, J.W. (1991b), "Dimensions and constructs: a response to Dess and Rasheed", *Journal of Management*, Vol. 17 No. 4, pp. 711-5.

Simon, H.A. (1957), *Administrative Behaviour*, Macmillan, New York, NY.

Snyder, N.H. and Glueck, W.F. (1982), "Can environmental volatility be measured objectively?", *Academy of Management Journal*, Vol. 25 No. 1, pp. 185-92.

Soutar, G.N. and Cornish-Ward, S.P. (1997), "Ownership patterns for durable goods and financial assets: a Rasch analysis", *Applied Economics*, Vol. 29 No. 7, pp. 903-11.

Stewart, W.H., May, R.C. and Kalia, A. (2008), "Environmental perceptions and scanning in the United States and India: convergence in entrepreneurial information seeking?", *Entrepreneurship: Theory and Practice*, Vol. 32 No. 1, pp. 83-106.

Sutcliffe, K.M. and Huber, G.P. (1998), "Firm and industry as determinants of executive perceptions of the environment", *Strategic Management Journal*, Vol. 19, pp. 793-807.

Sutcliffe, K.M. and Zaheer, A. (1998), "Uncertainty in the transaction environment: an empirical test", *Strategic Management Journal*, Vol. 19, pp. 1-23.

Tan, J.J. and Litschert, R.J. (1994), "Environment-strategy relationship and its performance implication", *Strategic Management Journal*, Vol. 15, pp. 1-20.

Wright, B.D. (2003), "Rack and stack: time 1 vs time 2", *Rasch Measurement Transactions*, Vol. 17, pp. 905-6.

Wright, B.D. and Mok, M.M.C. (2004), "An overview of the family of Rasch measurement models", in Smith, E.V. and Smith, R.M. (Eds), *Introduction to Rasch Measurement, Theory and Applications*, JAM Press, Maple Grove, MN, pp. 1-24.

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