Perceived environmental uncertainty in the agrifood supply chain

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Abstract

Purpose – The paper's aim is to develop a diagnosis of the environment of the agrifood supply chain based on members' perceptions of environmental uncertainty.

Design/methodology/approach – Environmental uncertainty is defined as the lack of information about the external environment and is obtained by integrating the perceived dynamism and complexity of the environmental variables. The measurements that are used are the result of applying the Rasch methodology to the information obtained by means of a questionnaire completed by the deciders of firms in the Canary Islands (Spain). Those measures permit the complexity and dynamism perceived by the groups of firms in the supply chain together with the levels of perceived dynamism and complexity of the environmental variables to be jointly positioned on a map.

Findings – According to the perceptions of the members of the agrifood supply chain (agriculture, agrifood industry and distribution), the main sources of environmental uncertainty are demand and competitors. The agricultural sector perceives somewhat more uncertainty than agrifood industry sector, while the distribution sector perceives a stable environment.

Research limitations/implications – The paper presents a useful tool for the business population and public institutions to identify which variables are perceived as the most dynamic and complex and how those variables are perceived by each member of the agrifood supply chain.

Originality/value – The paper operationalises the proposal of Duncan by means of a new application of the Rasch methodology. The results reflect the thinking of the members of all sectors of a supply chain. It is one of the first to study the environmental uncertainty perceived in the agrifood supply chain from a strategic perspective as a fundamental antecedent of the promotion of vertical collaboration in the agrifood supply chain.

Keywords Uncertainty management, Food industry, Decision-making, Management theory

Paper type Research paper

1. Introduction

One of the most widely accepted definitions of the environment in strategic management is that it is a set of relevant factors outside the organisation that must be considered in decision making (Duncan, 1972). Thus, the environmental characteristics become a significant conditioner of the strategic behaviour of businesses (Fahey and Narayanan, 1986; Sutcliffe and Zaheer, 1998).

The agrifood sector is not excluded from that reality, and changes in its environment, such as consumer preferences, market structure or technological development,

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have forced its firms to restructure by using new cooperation strategies throughout the chain (Wijnands *et al.*, 2006). However, since the 1990s, research has focused more on the agrifood supply chain itself than on environmental scanning.

In that context, while information about relations with customers, suppliers and end consumers is of high importance, the information about the general environment[1] with characteristics common to the entire business population of a country or region is no less important. That environment is considered an essential element to revitalise the processes of collaboration among the members of supply chains in general (Balakrishnan and Wernerfelt, 1986; Harrigan, 1985; Porter, 1980, 1985; Zenger and Hesterly, 1997) and the agrifood supply chain in particular.

Uncertainty is the characteristic most used in making an environmental diagnosis (Daft *et al.*, 1988; Duncan, 1972; Lewis and Harvey, 2001; Ondersteijn *et al.*, 2006) and is defined as the lack of information about environmental factors involved in a decision-making situation (Duncan, 1972). That lack of information is due to the perceived dynamism and complexity (Duncan, 1972). In that respect, dynamism is understood as the extent to which environmental variables change frequently and unpredictably (Child, 1972) while complexity includes both the magnitude and the diversity of environmental elements (Daft *et al.*, 1988).

The objective of this work is to make a diagnosis of the environment of the agrifood supply chain based on the environmental complexity and dynamism perceived by the members of that chain.

Thus, this study makes a significant dual contribution. On the one hand, by using the deciders' perceptions, this paper obtains a more realistic view of how the agrifood supply chain members perceive their environment and offers a better understanding of the entrepreneur's attitude toward joint strategies, such as vertical cooperation, throughout the chain. According to Miles and Snow (1978), the organisation responds only to what is perceived, which conditions its subsequent actions (Nadkarni and Barr, 2008; Simsek *et al.*, 2007).

This paper uses the Rasch methodology, which has been applied in the business field over the last decade (Alvarez and Galera, 1999; Kaiser *et al.*, 1999). With regard to the sector to which it is applied, namely, the agrifood sector, the works of the Marketing and Consumer Behaviour Group of the Wageningen University (Fischer *et al.*, 2006) stand out. However, as far as we know, this work is a pioneer in the application of the Rasch methodology in the analysis of the perceptions of the agrifood supply chain's environment from a strategic perspective.

Therefore, to achieve the proposed objective using the Rasch methodology, it is necessary to:

- estimate the measures of the perceptions of the complexity and dynamism of the environment[2] of the firms in the agrifood supply chain;
- estimate the measures of the level of perceived uncertainty of the variables of the environment of the agrifood supply chain; and
- obtain a joint map of the complexity and dynamism, in which the measures of the perceptions of environmental variables and the average perceptions of the groups comprising the agrifood supply chain (agriculture, agrifood industry and distribution).

To accomplish the objective, the work is structured as follows. This introduction is followed by a review of the main issues of the agrifood supply chain and environmental scanning. Then, the methodology is addressed with descriptions of the statistical methodology, the sample, the measurements and their precision and accuracy. The results are presented in the next section, and the work ends with the conclusions, implications and proposals for future research.

2. The agrifood supply chain and environmental scanning

2.1 The agrifood supply chain and its members

The firms involved in the process of producing and distributing agrifood products for human consumption in a particular society are jointly called the agrifood supply chain. This complex interorganisational chain involves the following organisations or stakeholders: agriculturists, the agrifood industry and distributors (Davis and Goldberg, 1957). The principal characteristics of those stakeholders are summarised in Table I.

Recent years have seen considerable changes in the agrifood supply chain in terms of concentration, internationalisation, product proliferation and diversification, outsourcing, the forming of food groups, technological changes, etc. In that context, there has been much mention of the confrontation between the agrifood industry and mass distribution (Anderson and Narus, 1990; Gaski, 1984; Magrath and Hardy, 1989), and the conditions imposed on the former by the large hypermarket and supermarket chains, such as deferred payments and the continuous pressure on prices.

Given this confrontation, collaboration and cooperation among firms is being given increasing consideration. In that respect, it must be remembered that they are dealing with perishable goods with a high turnover and therefore, there must be considerable coordinative effort to achieve innovative products that meet the standards of quality and safety demanded by society. As Peterson *et al.* (2001) demonstrate, only complete

Agrifood supply chain	Characteristics of the chain members
Agriculture	Highly fragmented sector
	Older entrepreneur
	Entrepreneur with little business training
	Low bargaining power with suppliers and customers
	Poor knowledge of the market
Agrifood industry	Fragmented industry (small and medium enterprises), but with large national or international food groups
	Subject to the power of mass distribution
	Tendency to concentration
	Strong competition between firms
Distribution	Concentrated sector
	High bargaining power with suppliers
	Strong competition in prices
	Implementation of new information technologies
	Mass distribution does not only distribute agrifood products
	Gradual disappearance of many traditional small businesses

Source: The authors

Table I.
Characteristics of the chain members

collaboration and coordination between the agriculturists and the rest of the chain can provide customers with the end products they desire.

Vorst (2000) identifies three main aspects that have aroused interest in cooperation within the agrifood supply chain:

(1) Socio-economic development, which has given rise to an aging and fragmented consumer market that is interested in the environment, concerned about quality and food safety, multicultural, multiracial and with a growing number of one-person households.

(2) The evolution of the market structure with the lowering of trade barriers and the accompanying globalisation, which has not only led to more competitors but also made it easier to purchase raw materials from anywhere in the world. In that respect, the physical distance that the agrifood product must travel from the agriculturist to the consumer, known as "food miles" (Smith *et al.*, 2005), has increased.

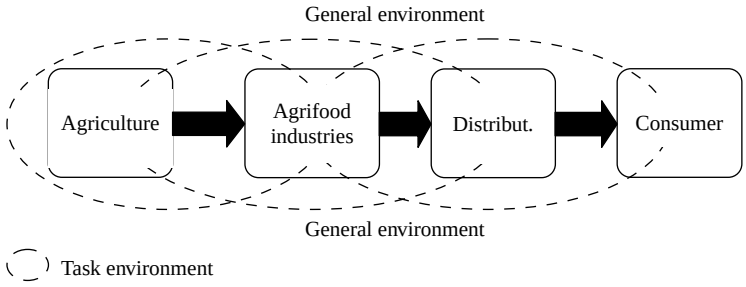
(3) Technological advances, for example, the development of information and communications technologies have been important for logistics, which plays a key role in processes with perishable goods such as agrifood products.

Hobbs (2008) added a fourth aspect focused on the regulations aimed at maintaining the food safety demanded by the markets.

In conclusion, the works of Vorst (2000) and Hobbs (2008) show that many of the initiatives or imperatives that promote cooperation between the agrifood supply chain members come from the environment and will affect all the supply chain members in one way or another. Therefore, it is extremely important to undertake a diagnosis of the environment that covers the entire agrifood chain and that diagnosis is one of the possible sources of reasons to cooperate (Figure 1).

2.2 Environmental scanning

The variables comprising the environment common to the entire business population of a country or region are usually grouped into economic, social, political or technological sectors (Daft *et al.*, 1988; Ondersteijn *et al.*, 2006). Oreja (1999) proposes an adaptation to island environments with his GEPS model, which includes different sub-scales: geographic, economic, politico-legal and socio-cultural. That is the model used in this work to reflect the different characteristics of the island environment in which this study is conducted.



Source: The authors

Figure 1.
Theoretical framework

Uncertainty is the characteristic that is most used in environmental scanning (Daft *et al.*, 1988; Duncan, 1972; Lewis and Harvey, 2001; Ondersteijn *et al.*, 2006). The different contributions in that respect can be grouped into two perspectives (Huber and Daft, 1987; Kreiser and Marino, 2002; Tan and Litscher, 1994). The first perspective, driven by Lawrence and Lorsch (1967) and Duncan (1972), consider the environment a source of information and particularly emphasise perceptions of uncertainty (Tan and Litschert, 1994). From that perspective, environmental uncertainty is due to the lack of information about the medium surrounding the firm (Kreiser and Marino, 2002) and is generated by the level of dynamism and complexity of the external environment (Daft *et al.*, 1988; Zahra *et al.*, 2002; Stewart *et al.*, 2008). The second approach to the environment was initially developed by Child (1972), Pfeffer and Salancik (1978), among others. This perspective defines the environment as a source of scarce resources, states that it is lack of control over those resources that generates environmental uncertainty (Kreiser and Marino, 2002), and employs more objective methods to operationalise uncertainty.

This work falls within the view of the environment as a set of information (Duncan, 1972; Lawerence and Lorsch, 1967) and coincides in the general objective of that perspective, which is to analyse how organisations obtain, process and subsequently act on information about their environments (Huber and Daft, 1987). Thus, environmental uncertainty is defined as the lack of information about the external environment and is obtained by integrating the perceptions of dynamism and complexity, as Duncan (1972) proposed with his typology of environments according to their uncertainty (Table II)[3]. The greatest lack of information is perceived in environments comprising numerous elements that change unpredictably (dynamic and complex environments). However, when the environment comprises few elements and those remain stable, it is characterised by a low level of uncertainty (simple and stable environments). Although the other two possibilities (simple and dynamic environments and complex and stable environments) generate moderate levels of uncertainty, it is somewhat higher in the first of those since dynamism contributes more to the perception of uncertainty than complexity does (Child, 1972; Dess and Beard, 1984; Duncan, 1972).

This work achieves its objective by operationalising Duncan's (1972) proposal in the case of the environment of the agrifood supply chain with the measures obtained by

	Dynamism	
Complexity	Dynamic	Static
Simplex	*Moderately high-perceived uncertainty* Small number of components in the environment and similar to one another Components are in continual process of change	*Low-perceived uncertainty* Small number of components in the environment and similar to one another Components remain basically the same and are not changing
Complex	*High-perceived uncertainty* Large number of factors in the environment and are not similar Components are in continual process of change	*Moderately low-perceived uncertainty* Large number of factors in the environment and are not similar Components remain basically the same and are not changing

Source: Adapted from Duncan (1972)

Table II.
Environmental typology based on uncertainty

applying the Rasch methodology to the perceptions of the complexity and dynamism of that environment.

2.3 Environmental uncertainty and the supply chain

The authors have found two approaches to environmental uncertainty in the literature, with different effects on the relational governance structure and the coordination mechanisms of the supply chain (Sutcliffe and Zaheer, 1998), that is, on the degree of cooperation between the chain members. The first approach is the perception of uncertainty among the members of the supply chain and the other is the environmental uncertainty perceived by the members of the entire chain, which has received little attention in the strategic literature[4].

This work focuses on the second perspective: the environmental uncertainty perceived by the members of the entire chain. Folkerts and Koehorst (1998) consider that the agrifood sectors are highly dependent on historical and cultural aspects while Fearne (1998), Folkerts and Koehorst (1998), Poole and Del Campo (1998), Boehlje *et al.* (1998) and Hobbs and Young (2000) indicate that technology, financial factors and consumer preferences are the motors of change in the agrifood chain.

The theoretical works that the authors consulted, such as those of Ziggers and Trienekens (1999) and Diederen and Jonkers (2001), consider various dimensions of the agrifood chain environment, namely, the economic, socio-cultural and climatic dimensions as well as technological development, spatial restrictions, market dynamics and institutional environments. With regard to the empirical works, Matanda and Schroder (2002) measure environmental uncertainty by means of competitive intensity, environmental volatility and market turbulence.

3. Research methodology

3.1 Statistical methodology: Rasch model

The information about environmental dynamism and complexity is obtained by means of questionnaires that generate raw scores.

The questionnaires use Likert-type scales with multiple ordinal categories. Those scales are proposed under two assumptions (Fischer *et al.*, 2006):

(1) that all the items have the same impact on the scoring of the scale; and

(2) that all the categories maintain the same distance from the adjacent category.

In light of the above, it can be concluded, in line with Bond and Fox (2007), that the nature of the data interval is presumed, but they are not really measures since they do not comply with the principals of linearity and additivity.

The transformation of the raw scores into measurements is achieved by applying one of the models of the family of Rasch models. Those models were initially developed by Rasch (1980) and, as models of joint probabilistic analysis (Perline *et al.*, 1979), they constitute the only available technique for the construction of linear measures (Bond and Fox, 2007) from ordinal observations (Fischer, 1995; Linacre, 2004). After the linear and additive measures have been obtained, the most suitable statistical methods can be applied for the analysis.

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 application of this model permits the joint determination, based on the probability of response to the items, of hierarchised measures of the parameters related to the surveyed subjects and to the questionnaire items located on the same Rasch scale.

If the data fit the Rasch model established according to strict theoretical principles, the measures referring to subjects and items will have those properties. This process requires the obtained measures to have a high degree of accuracy and precision for them to be admitted.

The basic principles of the Rasch models are (Bond and Fox, 2007; Wright and Mok, 2004):

(1) unidimensionality of the analysed construct;

(2) probabilistic estimation of the measures;

(3) precision of the measures;

(4) high levels of fit of the items (accuracy); and

(5) the parameter of the subjects being measured and the measurement instrument must be separable (parameter separation).

The measures must be as independent as possible of the specific circumstances of the subject or the questionnaire.

In this work, the Rasch rating scale model is applied separately to each environmental characteristic (complexity and dynamism) by means of the Winsteps 3.63 program (Linacre, 2006). The results obtained are the probabilistic measurements referring to:

- the agrifood supply chain member firms' perceptions of the complexity/dynamism of the environment (hereafter firms' perceptions); and
- the levels of perceived complexity/dynamism of the environment of the supply chain (hereafter, level of perception of environmental variables).

3.2 Data collection

This study uses information obtained from a sample of firms located within a specific Spanish autonomous community, namely, the Canary Islands. That archipelago is one of Spain's leading tourist destinations and, consequently, tourism constitutes the region's economic motor on which the rest of the activities, such as agrifood, largely depend. Some sectors, such as tomatoes and bananas, compete successfully in the national and international markets (Consejo Económico y Social de Canarias, 2005). Moreover, tourism contributes to the maintenance of the food industry, which is a key element of Canarian industry since it represents 24.56 per cent of the added value of regional industry (Consejo Económico y Social de Canarias, 2005).

The initial sample of this study comprised 74 firms belonging to agriculture (14 firms), the agrifood industry (29 firms), and distribution (31 firms)[5]. With the objective of sector representativeness, our sample was selected by means of intentional sampling.

The data were obtained from a questionnaire completed by a manager of each firm in the period from February to June 2003.

The questionnaire comprised some closed questions about various aspects of business management and the respondents were asked to indicate, on a scale from 1 (low level) to 5 (high level), their perceptions of the levels of complexity and dynamism of the 25 variables most representative of the island environment (Oreja, 1999) (Table III).

Sub-escale	Variables	Sub-escale	Variables
Geographical	Insularity	Economic	Development in Canary
	Orography		Demand situation
	Natural resources		Level of demand incomes
	Demography		Distance to main markets
Political-legal	Political situation in Canary Islands		Market segmentation
	Sector legislation		Financial resources
	Labour legislation		Human resources
	Consumer defence/quality		Technological resources
Socio-cultural	Consumer motivation		Physical barriers
	Attitude to the firm		Economies of scale
	Professional training		External dependence
			Exchange rate

Source: Adapted from Oreja (1999)

Table III.
Sub-scales for perceived environmental uncertainty

3.3 The measurements and their precision and accuracy

The scale used was designed in accordance with the proposals in the literature: the integration of subscales (Lewis and Harvey, 2001; Miller, 1992) and the adaptation of the variables to the geographical context of the study (Miller, 1997). The result was a scale with four subscales (Oreja, 1999), GEPS, that included the relevant environmental elements and was adapted to the geographical context of the work. The inclusion of the geographical subscale has a precedent in Miller's (1992) study, which considers a subscale to reflect natural uncertainties and in Kim and Uysal (2002), who identify an ecological factor in the analysis of island environments. Each of the subscales considers the variables that Oreja (1999) highlights in his analysis of the relevant characteristics of an island environment after an extensive review of the literature (Table III). With such support from the literature, we can verify the content validity.

The measures obtained show high levels of Rasch reliability in both environmental characteristics. In the case of dynamism, the measurements of the firms' perceptions display a level of Rasch reliability of 90 per cent while, in that of the levels of perception of environmental variables, the reliability is 93 per cent. With regard to complexity, the measures of the firms' perceptions and the perception of environmental variables show a level of Rasch reliability of 87 per cent. Those levels of reliability can be interpreted in a similar way to the traditional Cronbach indices of reliability (Linacre, 1997), thus enabling us to highlight their accuracy in line with the criteria usually used in measurements of survey reliability.

The analysis of the accuracy considered the limits established by Linacre (2002). If the values of the fit statistic (Mean-square (MNSQ) Infit/Outfit)[6] are between 0.5 and 1.5, the observations are productive for the measurement while if they are above 1.5 and below 2.0, they are unproductive for the construction but do not degrade the measurement.

In reference to the measures of firms' perceptions, the analysis of misfits led to the elimination of seven firms in the case of complexity and three in that of dynamism since their MNSQ exceeded the recommendable limits (Linacre, 2002).

In the calibration of the levels of perception of the environmental variables, there was only one misfit in environmental dynamism, namely, related to the variable outer

dependence, with an MNSQ (Infit) of 1.52, while the MNSQ (Outfit) was within the limit. According to Linacre (2002), this factor is unproductive for construction of measurement, but not degrading; therefore, since it was so close to the lower limit, it was decided to accept the validity of the measurement of the factor (Tables IV and V).

For the analysis of the perceptions of each of the groups comprising the agrifood supply chain, the average of the scores for firms' perceptions was used (Table VI).

The unidimensionality required of the measures is accepted in accordance with the basic principles of the Rasch models and considering various indices: principal components analysis of residuals (PCAR)[7] for each dimension, the level of Rasch reliability and that of the fit of the data and the point-measure correlations (PTMEA)[8] of firms' perceptions and of the levels of perceptions of the environmental variables. In light of the above and in line with Linacre (2006), we can conclude that, although there are tensions of dimensionality, the validity of the results is not threatened.

4. Results

After the Rasch application to the dynamism and complexity perceived by firms in the agrifood supply chain, the measures obtained (Tables IV and V) are integrated in a joint

Variables	Measure	Model SE	MNSQ Infit	MNSQ Outfit	PTMEA CORR
Exchange rate	0.91	0.14	1.09	1.05	0.57
Political situation	0.74	0.13	0.90	0.87	0.58
Orography	0.37	0.13	1.33	1.30	0.61
Economies of scale	0.31	0.13	0.91	0.95	0.50
Physical barriers	0.31	0.13	0.78	0.78	0.61
Professional training	0.15	0.12	0.80	0.80	0.43
Natural resources	0.15	0.13	1.39	1.39	0.55
Labour legislation	0.12	0.12	0.56	0.59	0.49
Demography	0.11	0.12	1.11	1.09	0.48
Development	0.11	0.11	0.73	0.71	0.51
Attitude to the firm	0.07	0.12	0.57	0.59	0.44
Technological resources	0.05	0.13	0.80	0.80	0.60
Natural resources	0.04	0.13	1.42	1.40	0.42
Segmentation	0.02	0.13	1.09	1.09	0.47
Consumer defence	0.01	0.13	1.08	1.07	0.47
Financial resources	−0.07	0.13	0.88	0.94	0.38
Human resources	−0.24	0.13	0.72	0.74	0.45
Distance to market	−0.24	0.13	1.41	1.41	0.48
Sector legislation	−0.24	0.13	0.60	0.60	0.68
Demand income	−0.38	0.13	0.99	1.02	0.12
Insularity	−0.41	0.13	1.70	1.66	0.62
Competitors	−0.41	0.13	0.96	0.95	0.38
Outer dependence	−0.45	0.13	1.44	1.38	0.53
Consumer's motiv.	−0.48	0.13	0.87	0.86	0.40
Demand	−0.56	0.13	1.06	1.12	0.27
Media	0.00	0.13	1.01	1.01	
SD	0.36	0.00	0.30	0.28	

Table IV.
Measures of level of perceived complexity

Source: The authors

Variables	Measure	Model SE	MNSQ Infit	MNSQ Outfit	PTMEA CORR
Orography	0.93	0.14	1.17	1.09	0.61
Insularity	0.88	0.14	1.42	1.27	0.63
Exchange rate	0.81	0.14	0.92	1.02	0.57
Physical barriers	0.61	0.13	0.72	0.74	0.63
Political situation	0.43	0.13	0.93	0.94	0.58
Natural resources	0.39	0.13	1.32	1.33	0.55
Natural resources	0.26	0.13	1.27	1.31	0.43
Demography	0.26	0.13	1.15	1.13	0.51
Economies of scale	0.21	0.13	0.86	0.84	0.62
Professional training	0.12	0.12	0.81	0.84	0.48
Segmentation	0.11	0.13	0.77	0.76	0.63
Development	0.00	0.12	0.69	0.71	0.45
Attitude to the firm	−0.08	0.12	0.82	0.86	0.44
Labour legislation	−0.10	0.12	1.03	1.11	0.38
Financial resources	−0.15	0.12	0.93	0.92	0.58
Distance to market	−0.19	0.13	1.40	1.36	0.56
Sector legislation	−0.19	0.12	0.93	0.92	0.62
Outer dependence	−0.23	0.13	1.52	1.49	0.54
Human resource	−0.24	0.13	0.95	0.95	0.52
Technological resources	−0.31	0.13	1.15	1.14	0.50
Consumer defence	−0.50	0.13	0.95	0.97	0.54
Demand income	−0.64	0.13	0.86	0.86	0.54
Consumer's motiv.	−0.75	0.13	0.94	0.93	0.59
Demand	−0.76	0.13	0.72	0.81	0.57
Competitors	−0.86	0.13	0.92	0.90	0.44
Mean	0.00	0.13	1.01	1.01	
SD	0.49	0.00	0.23	0.21	

Source: The authors

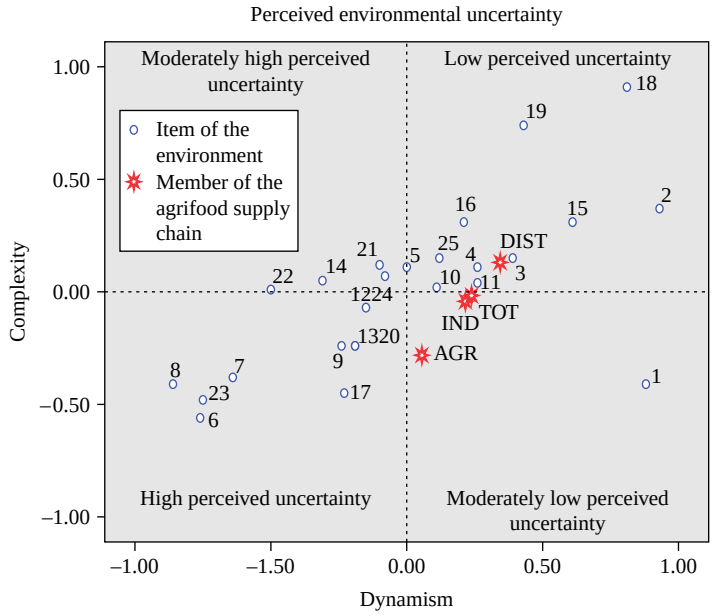
Table V.
Measures of level of perceived dynamism

	Dynamism					Complexity				
	n	Min.	Max.	Mean	SD	*n*	Min.	Max.	Mean	SD
Agriculture	14	−1.10	1.04	−0.0557	0.6510	13	−0.73	1.07	0.2815	0.5649
Agrifood industry	26	−1.26	1.42	−0.2158	0.6433	26	−0.52	1.25	0.0423	0.4388
Distribution	30	−1.60	1.64	−0.3437	0.7362	28	−1.55	1.66	−0.1311	0.6825
Total chain	70	−1.60	1.64	−0.2386	0.6851	67	−1.55	1.66	0.0163	0.5872

Source: The authors

Table VI.
Measures of perceptions of the groups of firms in the agrifood supply chain

map to determine the nature of the environment in terms of perceived uncertainty, as shown in Figure 2. That figure also includes the measures of the perceptions of the firms comprising the agrifood supply chain, considering the average for each group in order to determine the differences in the level of uncertainty that they perceive in their common environment (Table VI)[9]. Figure 2 shows four quadrants with different levels of perceived uncertainty, as proposed by Duncan (1972).



Code	Environmental variable	Code	Environmental variable
1	Insularity	14	Technological resources
2	Orography	15	Physical barriers
3	Natural resources	16	Economies of scale
4	Demography	17	External dependence
5	Development in canaries	18	Exchange rate
6	Demand situation	19	Political situation
7	Level of demand incomes	20	Sector legislation
8	Competitors	21	Labour legislation
9	Distance to main markets	22	Consumer defence / quality
10	Market segmentation	23	Consumer motivation
11	Natural resources	24	Attitude to the firm
12	Financial resources	25	Professional training
13	Human resources		

Code	Member of the agrifood supply chain	CODE	Member of the agrifood Supply chain
Agr	Agriculture	DIST	Distribution
Ind	Agrifood industry	TOT	Total sample

Figure 2.
Perceived environmental uncertainty

In the quadrant referring to high-perceived uncertainty, there are two blocks of variables. One constitutes the distance to large markets and outer dependence, which indicates the difficulty that the firms' island situation entails for their management. This block also contains the human and financial resources, whose acquisition constitutes one of the main problems for the firms, characterised by their small size, as reflected in the examples in Table VII. The sector legislation also generates uncertainty since the agrifood activity falls within an increasingly complex regulatory framework to ensure that products placed on the market meet the required standards of quality and food

Table VII. Sources of the uncertainty in human, technological and financial resources as perceived by the Canarian agrifood supply chain members

	Human resources	Technological resources (production process technology and new information technologies)		Financial resources
Agriculture	Fewer Canarians wish to work in agriculture; therefore, the entrepreneur has to resort to immigrant labour	Given the characteristics of the agriculture and livestock entrepreneur, the implementation of technology is likely to be low	In no case can the cold chains be broken. Agrifood logistics are based on new information technologies (e.g. electronic data interchange and enterprise resource planning)	Aid and subsidies from the different administrations
Agrifood industry	–	Production process technologies will be used in the agrifood transformation stage		ZEC[a], aid and subsidies, up to 150 days deferment of payments from the industry to distribution
Distribution	–	In the end stages of the agribusiness supply chain (principally where mass distribution occurs), where the use of new technologies is more evident		

Notes: [a]The Canary Islands Special Zone (ZEC) is a low-tax zone created within the framework of the Canary Islands Economic and Fiscal Regime for the purpose of promoting the economic and social development of the Islands and diversifying their production structure; it was authorised by the European Commission in January 2000 (www.zec.org)
Source: The authors

safety (see examples in Table VIII). As Wijnandas *et al.* (2006) state, agrifood firms consider their sector regulation an obstacle because of its variability and lack of clarity due to legislation at European, Spanish and autonomous community levels.

The other group of variables in the quadrant of high-perceived uncertainty contains the situation of the demand, the level of income of the demand and consumer motivation, which are all focused on one of the main forces of collaboration between members of the agrifood supply chain, namely, the end consumer (Hobbs, 2008; Wijnandas *et al.*, 2006), whose habits in recent years have varied more in qualitative than in quantitative terms. This group also includes the situation of competitors since it is a mature sector characterised by intense competitive rivalry, the competition being mainly in price, and in which purchase habits change, with a growth in sales of cheaper "own brands" or imported products in times of increasing energy prices, as has occurred since 2002, or of more expensive money.

Defence of the consumer/quality and labour legislation appear in the quadrant of moderately high-perceived uncertainty, which, added to the entrepreneur's perception of the sector-specific legislation confirms the earlier statement about the complicated regulatory framework (see examples in Table VIII).

This quadrant also contains the technological resources, related both to the productive technological processes most used in the agroindustry and to the information and communications technologies most used in distribution (see examples in Table VII). Finally, the attitude toward the firm generates moderately high uncertainty in the entrepreneur of the agrifood supply chain since the market's evaluation of the firm is fundamental in a sector subject to frequent food alerts and the consumer cannot visually assess the quality and safety of food (Hobbs, 2008). Therefore, the food quality and safety guaranteed by the firm and recognised by the consumer represent a key factor for the firm to be able to compete.

The moderately low perceived uncertainty quadrant contains only insularity, although the entrepreneur in the agrifood supply chain considers aspects such as distance to the large markets and outside dependence as aspects entailing high uncertainty.

The quadrant indicating the greatest stability, namely the low-perceived uncertainty quadrant, contains variables of the geographical context, such as orography, natural resources and demographics. In addition, physical barriers, natural resources and market segmentation do not seem to cause the entrepreneur any great management problems and, although they belong to the economic framework, they are closely linked to the geographical condition of the firms. The fact that the development of the Canary Islands and economies of scale do not generate uncertainty for the agrifood supply chain entrepreneurs may indicate that, although most of the analysed firms are small, those aspects are not a cause of concern for the entrepreneurs either because lack of entrepreneurial training, because they have achieved a good position with specialisation/differentiation (strategies in which costs are not a priority) or simply because they are in a situation of survival. The political situation of the Canaries is another aspect that does not generate uncertainty in the agrifood supply chain entrepreneurs, which leads to the conclusion that the surveyed entrepreneurs are more concerned about the legislative framework that regulates the three sectors of the supply chain than about the political situation itself. Finally, this quadrant also contains

Table VIII. Sources of the uncertainty in sector-specific legislation, labour legislation and consumer protection as perceived by the Canarian agrifood supply chain members

	Sector-legislation		Labour legislation	Consumer protection
Agriculture	World Trade Organization, common agriculture policy, subsidies and aid or agricultural and livestock exports, requirements for the installation of farms, etc.	Legislation on labelling, packing and packaging, legislation on fraudulent agrifood advertising, etc.	*Compulsory courses*: phytosanitary produce handler, occupational health and safety, health surveillance in the firm, etc.	There is an increasing number of initiatives from the administrations that regulate the agrifood supply chain as a whole and homogenise the European legislations with the aim of protecting the heath and lives of food consumers, promote the free movement of human and animal food without danger to health, and establishing
Agrifood industry	ZEC		*Compulsory courses*: food handler, occupational health and safety, health surveillance in the firm, etc. Compulsory possession of food worker permit, etc.	
Distribution	ZEC, licences to install new premises, opening hours, etc. of establishments, etc.			

Source: The authors

professional training, which seems to indicate that the supply chain mainly comprises small firms, many of which do not have or do not hire trained employees.

With regard to the position occupied by each sector of the agrifood supply chain, Figure 2 shows that it is the agriculture sector that has, in average terms, a moderately low level of perceived uncertainty, followed by the agrifood industry and, with a low level of perceived uncertainty, the distribution sector. The reason for that moderately low level of uncertainty of the agroindustry[10] lies in the complexity. However, the distances between those components of the agrifood supply chain is not very high, that fact is confirmed by the application of an ANOVA, which resulted in p-values of 0.106 and 0.427 and F-values of 2.323 and 0.863 for complexity and dynamism, respectively, which indicates non-significant differences of means.

5. Conclusions, implications and future lines of research

5.1 Conclusions and implications

The approach developed for the analysis of uncertainty by applying the rating scale Rasch model (Andrich, 1978) to implement Duncan's (1972) typology (Table II) enables us to obtain a mental model that reflects the thinking of the agrifood supply chain and its members, considering the perceptions of environmental uncertainty on the basis of complexity and dynamism.

A practical application has been developed for the business context, by diagnosing how the environment is perceived, and for public administrations, by providing a tool to identify which variables are perceived as more simple/complex and more stable/dynamic and how each member in the supply chain perceives them. Thus, they can design lines of action to improve the competitiveness of the chain by developing cooperation strategies.

With regard to the results of the analysis, the agrifood supply chain components that perceive a moderately low uncertainty are agriculture followed by the agrifood industry, with a slightly lower level of perceived uncertainty and distribution, which is positioned in the quadrant referring to a stable environment. Since those differences are non-significant, they are interpreted more as indications than as proven realities.

The moderately low environmental uncertainty perceived by the agroindustry seems to be due to its low level of market orientation, which is in line with the statements of some authors such as Grunert *et al.* (1996) and Sangam (2003). Those authors conclude that, in general, market orientation in the agrifood sector is low and the Canary Islands constitute an example of that since they comprise the Spanish autonomous community with the second lowest number of agrifood firms with ISO 9000 certifications (only six) (information provided by Berga and González, 2001). Folkerts and Koehorst (1998) indicate that the agrifood sector requires a consumer oriented approach, which, in turn, requires an integrated supply chain with a shift from a chain whose production is driven by the supply (push) to one whose production is driven by the market (pull).

Moreover, the situation of competitors seems to be the origin of the environmental uncertainty perceived by the agroindustry. On the one hand, the structural conditions of agriculture in the Canaries make it difficult to compete in price and, on the other, the Canarian agrifood industry adds little value to its products since it is mainly focused on the final links in the value chain (packing and distribution) and also has to compete with more competitively priced imported products with greater added value.

The differentiated geographical character of the firms must also be added to the difficulty to compete in a mature sector like agrifood. The uncertainty generated by the distance to large markets and dependence on the outside is explained by the fact that the flow of material resources (purchase of inputs and sale of outputs) and information has to pass numerous organisational, corporate and geographical barriers throughout the entire agrifood supply chain. The proper management of those flows requires considerable effort in coordination and significant interorganisational skills. As Nassimbeni (1998) concludes, the greater the geographical, cultural, organisational or legal separation between the organisations, the more necessary coordination among the firms in the chain becomes.

Moreover, since the agroindustry sector is dominated by small and medium enterprises (SME) and those firms have fewer possibilities of access to human, financial and technological resources, it seems logical that those resources generate moderately low uncertainty in the environment of those firms as opposed to the powerful distribution sector. In that respect, it is appropriate to indicate the need for horizontal (e.g. cooperatives) rather than vertical cooperation so that the difference between the agroindustry and distribution sectors' possibilities of accessing resources is reduced. Zuurbier *et al.* (1996) and Neven and Reardon (2002) consider that horizontal cooperation could drive the development of vertical cooperation. Vaaland and Heide (2007) also propose some solutions to facilitate vertical cooperation, such as horizontal cooperation with other SMEs to share competences and other resources without assuming the risk and financial cost autonomously.

Finally, there is the complex regulatory framework, which generates moderately low uncertainty among the first components of the agrifood supply chain. This perception seems to be shared by sector associations at a European level, who recommend the simplification of the legal framework of the agrifood activity[11].

Therefore, the moderately low level of uncertainty perceived by the agroindustry due to the previously mentioned environmental variables may serve as a motor to drive vertical cooperation processes and thus bring the industry closer to the distribution sector and the end consumer. That vertical cooperation process probably requires a previous process of horizontal cooperation through which the agroindustry can become larger and acquire greater market power, share risks, access resources that they do not currently possess, control the regulatory framework and, in short, be able to compete in better market conditions. Thus, the small gap between the environmental uncertainty perceived by the agrifood industry and by the distribution sector will be reduced.

5.2 Future lines of research

Although this work represents an advance by pioneering the analysis of the agrifood supply chain environment with a strategic perspective, it is even more important for future research works.

In order to extend the analysis of uncertainty, some additional studies are recommendable. The first comprises an analysis of the probability of each firm perceiving each environmental variable as more or less complex or dynamic (in line with the work of Fischer *et al.* (2006)).

A second work would address the analysis of the misfits offered by the Rasch methodology. This would lead to the identification of the firms in the chain that do not follow or share the patterns expected in the model and to clarify and to predict

many of the actions in the agrifood sector, since different perceptions can lead to different strategies.

Another line of research would focus on analysing the strategic consequences of perceiving a certain level of uncertainty, both for firms and for the design of the supply chain. The results would reveal whether the uncertainty perceived by the entrepreneur really favours strategies of cooperation between the members of the agrifood supply chains in the Canaries and even whether the region's insularity means that vertical relations differ from those in the continental agrifood supply chains.

Notes

1. The other level of environmental study (Bourgeois, 1980) is the task environment, which comprises Porter's (1980) competitive forces: customers, suppliers, current and potential competitors, and substitute products. In this work, the authors focus on the general environment by including the external characteristics common to all members of the agrifood supply chain. Hereafter, it is referred to as the environment.
2. The complexity and dynamism of the environment are unidimensional constructs conceptually defined on the basis of the literature on the environment. In this work, the authors consider both as characteristics of the environment whose integration results in uncertainty, as justified in the review of the theoretical bases of this work.
3. Related to the three types of uncertainty defined by Milliken (1987): state, effect and response, this research considers state. It means that managers do not understand how components of the environment might be changing and also may involve an incomplete understanding of the relationships between elements in the environment.
4. The first type of uncertainty has a negative relationship with the supply chain members' propensity to establish cooperative relationships among themselves while the second type has a positive relationship. With regard to that second type, there are many works based on the transaction costs theory (Coase, 1937; Williamson, 1975, 1985) that conclude that vertical integration is an efficient response to uncertainty. However, works with a strategic approach (Harrigan, 1985; Porter, 1980, 1985) suggest that firms faced with uncertainty must be flexible and collaborative; a characteristic that is achieved not so much with vertical integration as with vertical cooperation.
5. Although this may not be the optimum size for a sample, the Rasch (1980) model is robust when used with small samples (Barnes and Wise, 1991) and, if the sample is well designed, that problem is overcome (Berger, 1997).
6. MNSQ fit statistics show the size of the randomness. MNSQ are χ^2-statistics divided by their degree of freedom. Infit means inlier-sensitive or information-weighted fit. Outfit means outlier-sensitive fit (Linacre, 2002).
7. Rasch-residual-based PCA show contrasts between opposing factors, not loadings on one factor (Linacre, 2006).
8. PTMEA is the correlation between the observations on an item and the correspondent person measure, or vice versa (Linacre, 2006).
9. For the levels of perceptions of the environmental variables and the perceptions of the firms in the agrifood supply chain to be integrated in Figure 2, and for the conceptual explanation coincides with Duncan's (1972) proposal in both cases, the directions of the two perceptions have been equated by changing the polarity of the measures of firms' perceptions (change of sign).

10. Agroindustry includes agriculture and the agrifood industry in order to facilitate explanations since their positions in Figure 2 coincide.
11. In "CIAA benchmarking report 2006. The competitiveness of the European Union food and drink industry". Confederation des industries agro-alimentaires de PUE/Confederation of the food and drink industries of the European Union.

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