Sources of Innovation: The Case of Portuguese Consultancy Sector

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Abstract: This study addresses the effects of external environments on types of innovation introduced by Portuguese consultancy firms (PCs) in computer, technical, and management areas. It distinguishes the most determinant factors for innovation regarding product, process, organization, and marketing. The assessment framework followed three steps: 1) evaluation of propensity to use external sources of information and cooperation with agents, 2) identification of factors used most often during innovation, and 3) derivation of profiles of firms under study. The method generated tree-based classification models that segmented the sample into innovative and non-innovative firms, and distinct profiles that emphasized specificities concerning use of external sources and agents for innovation.

Keywords: innovation; information sources; cooperation; consultancy; CHAID technique; profiles.

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Introduction

In modern dynamic economies consultancy enterprises have achieved strong innovative influence (Kieser, 2002). They increasingly acknowledge that change is not only important, but also compulsory since they constantly face fast-changing markets. As knowledge-intensive firms (Armbrüster, 2006; Empson, 2001; Morris, 2001) they provide a stream of innovations to several agents who need expert knowledge to face business challenges (McKenna, 2006). Portuguese consultancies (PCs) consist of multinationals (with large national/international customers) and small or medium-sized firms whose clients are national. Products from this industry are diverse and possess properties of intangible knowledge (Oliveira & Barata, 2006). Strong interactions between providers and consumers arise, where each transaction is tailored to customers' needs. Thus PCs can help firms identify innovation initiatives (Back, *et. al.*, 2014), turning these companies an interesting ecosystem to study innovation processes. Most studies about innovation in Portugal have focused more on product and process innovations than service innovations (Costa, *et. al.*, 2014). Our work contributes to fill a gap in the literature as we include organizational and marketing types, which are more effective ways of innovating business models and services (Amshoff, *et. al.*, 2015). The purpose of this study is to address the effect of external environments on PCs innovation, analyzing which information sources or cooperation agents most stimulate it. The analysis is divided into four types – product, process, organization, and marketing innovation – making this study distinct from studies that use broad conceptualizations of innovation.

PCs innovation ecosystem

A framework for appraising PCs innovation is needed due to the diversity of concepts consultants create. They create demand for their services by introducing new management tools and practices (Huczynski, 1993; Sturdy, 1997), which include customer service excellence, service portfolios, techniques of quality management, balanced scorecard, among others. As soon as an innovation becomes standardized, consultants seek new approaches or solutions to introduce it to the market (Abrahamson, 1996; Benders & Veen, 2001; Suddaby & Greenwood, 2001). Due to fast changing technologies and business environments, it is more difficult for enterprises to maintain competitive advantages through in-house R&D alone. Recent work suggests addressing these issues to inform stakeholders about drivers, emergent trends and scenarios (Gallouj, *et. al.*, 2015). A relevant foresight is to assess external sources and agents of innovation, their variety and effectiveness (Chang, *et. al.*, 2012). PCs must complement internal resources with those from outside, interacting with a broad range of actors (Lundvall 2010; Laursen & Salter 2006; Chesbrough, *et. al.*, 2006). Consultancies can launch a so diverse range of innovations (Benders & Veen, 2001; Kieser, 1997; Suddaby & Greenwood, 2001), that this work distinguishes product, process, organizational and marketing types. This classification can address important issues regarding innovation ecosystems, analyzing the influence of different information sources and cooperation initiatives regarding innovation.

This study aims to explore whether PCs complement R&D[1] with external knowledge. Other studies examine this topic (Cornish, 1997;

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(1) In consultancy, R&D relates to development, integration, outsourcing, following trends (technological, technical, and scientific) to develop or adapt products/services.

Kalantaridis & Pheby, 1999; De Propris, 2002), but rarely apply the method we used – CHAID (CHi-square Automatic Interaction Detection) – when exploring innovation (Cohen & Levinthal, 1990; Veugelers, 1997; Chesbrough, *et. al.*, 2006).

Research framework

Our first objective is to assess the propensity of using external sources and cooperation regarding innovation, i.e., whether PCs are open to these issues during innovation. A second objective is to identify which sources and cooperation agents PCs use most often concerning each type of innovation (product, process, organizational, and marketing). A third objective is to segment the sample, establishing profiles of PCs concerning each type of innovation. Following these main objectives, the following research questions were raised: 1) Are PCs influenced by external agents/sources? 2) Which agents/sources? 3) Segmented by:

- When developing a new or significantly improved good or service in the market (product innovation);

- When developing a new or significantly improved production, or new and significantly improved methods of supplying services or support (process innovation);

- When developing a new organizational method in the firm's business practices, workplace, or external relations (organizational innovation);

- When developing a new marketing method or strategy that involves significant changes to product design or packaging, placement, promotion, or pricing (marketing innovation).

These three questions are important as consultancy sector is a potential source of innovation for Portuguese economic performance and internationalization is increasingly required (Ischchenko, 2011; Oliveira & Barata, 2006)

Sample and data analysis

This study used the CIS- Community Innovation Survey 2012 dataset (i.e., data from 2010 to 2012). CIS revolved initially around manufacturing inasmuch as its definition focused on technology. However, it also identified features related to service innovations (Tether, 2005). Consultancy has grown to be an essential and independent resource in the business life of national and international enterprises (McKenna, 2006). However, Portugal is facing an economic crisis that imposed adjustments to consulting enterprises due to market restrictions. Portuguese firms, clients of PCs, have reduced or eliminated budgets for this kind of services. Therefore, it is important to know how PCs are adapting to this reality, specifically how they innovate to resist (Ischchenko, 2011). A sample of 218 Portuguese firms belonging to consultancy participated in the study, i.e., the CIS dataset. Table 1 reports their sizes and sub-sectors (NACE) including computer consulting (62), and other consultancy and technical activities (74).

Firm size	(NACE Rev.3)	
	(62) Computer consulting	(74) Other consultancy and technical activities
Small	90	57
Medium-sized	51	0
Large	20	0

Table 1. Average Sample by firm size and sector

Table 2 reports descriptive statistics. The largest percentage of firms (58.3%) does not belong to a group. These firms have a geographic market oriented nationally (52.3%) or locally/regionally (31.2%). Around 53% have a substantial proportion of employees with a university degree (75% to 100%).

Variable		%
(1) Belong to a group		
	Yes	41.7
	No	58.3
(2) Head office location		
	Portugal	28.9
	European country	12.8
	Did Not Respond	58.3
(3) Geographic market		
	Local/Regional	31.2
	National	52.3
	Other European Union, EFTA or EU candidate countries	11.5
	All other countries	5.0
(4) Employees with a university degree		
	0%	1.4
	1% to 4%	2.8
	5% to 9%	2.3
	10% to 24%	8.7
	25% to 49%	11.5
	50% to 74%	21.1
	75% to 100%	52.3

Table 2. Descriptive statistics

For data analysis, the CHAID technique (CHi-square Automatic Interaction Detection) was used to create a tree-based classification model. Based on values from independent variables, this method

classifies cases into groups of predictor values of a dependent variable (Kass, 1980). At each step, it selects the independent variable with the strongest interaction with the dependent variable, producing segments mutually exclusive (Evgeny & Elena, 2010; Legohérel, *et. al.*, 2015). These are produced exhaustively through chi-square tests with significant value adjustments (Bonferroni method). CHAID can be used for classification as well as prediction (in a similar fashion to regression analysis - version XAID). The algorithm effectively yields many multi-way frequency tables. Thus, it has been popular in marketing research to select groups of consumers and predict how their responses to some variables affect other variables. Its output is highly visual and easy to interpret.

Because it uses multi-way splits by default, it needs large sample sizes to work otherwise the respondent groups can quickly become too small for reliable analysis (Evgeny & Elena, 2010). Given the size of our sample and numerous tests, unbiased selection was important because if minimum values used to split nodes were too high, fewer nodes in the tree would result, and consequently diminished results (Hill & Lewicki, 2006). The choice was a growth limit of 3 levels, with a minimum 20 cases in the parent and 10 in the child nodes, which produced acceptable results. This criterion-based technique possesses several advantages in comparison with non-criteria methods, such as cluster analysis, which consider all of the variables interdependently (Chen, 2003). The chi-square test helps to define the profile of the segments which show opposite trends (Agapito, *et. al.*, 2011). CHAID splits the entire dataset (root node) successively into two or more nodes, and starts dividing data by considering the predictor variable that best discriminates the dependent variable, which is the predictor with the lowest p-value in the chi-square tests (Kass, 1980; Evgeny & Elena, 2010).

The variables

The dependents

Distinctively from many studies that make use of the general concept of innovation, this work divides it in four types: 1) product/service; 2) process; 3) organizational; and 4) marketing. And this division proceeds to address important issues regarding the effect of the external environment on each type of innovation, analyzing if a certain type of information source or cooperation agent stimulates the enterprise's innovation activities more than another. The analysis was implemented using the software IBM SPSS Statistics v.21.

1) Product innovation

Product innovation occurs when a firm introduces a new or significantly improved good (INPDGD), or service regarding its capabilities, technical specifications, user friendliness, components, or sub-systems (INPDSV). The improved product does not need to be new to the market, but it must be new to the firm, regardless of whether the firm or external partners developed it. The two variables were transformed into a single variable (INOV_PRD_SRV), with zero (No) and 1 (Yes) coding.

2) Process innovation

Process innovation occurs when a firm implements new or significantly improved production (INPSPD), or new or significantly improved methods of supplying services (INPSLG) or support (INPSSU). Purely organizational or managerial changes were excluded. The innovation need not be new to the market, but it must be new to the firm, again regardless of whether the firm or external partners developed it. The three variables were transformed into a single variable (INOV_PROC), with zero (No) and 1 (Yes) coding.

3) Organizational innovation

Organizational innovation is a new organizational method in a firm's practices (ORGBUP), including knowledge management, or workplace organization (ORGWKP) or external relationships (ORGEXR). This type of innovation results from manager's strategic decisions, excluding mergers or acquisitions. The three variables were transformed into a single variable (INOV_ORG), with zero (No) and 1 (Yes) coding.

4) Marketing innovation

Marketing innovation occurs when a firm implements a new marketing method or strategy that involves significant changes to product design/packaging (MKTDGP), or placement (MKTPDL), or promotion (MKTPDP) or pricing (MKTPRI). These four variables were transformed into a single variable (INOV_MKT), with zero (No) and 1 (Yes) coding.

The predictors

Since R&D must be complemented with external knowledge and actors (Lundvall, 2010; Szulanski, 1996; Laursen & Salter, 2006), it is essential to evaluate the importance of internal sources of innovation when combined with external agents or information sources (see Table 3). Both internal and external information sources, and cooperation initiatives toward innovation, were used as predictors (a total of nineteen independent variables). Information for innovation projects may come from eleven different sources (A1-internal; from A2 to A4-external), each one having different possible degrees of importance. Regarding cooperation on innovation activities, firms may cooperate with eight different partners (i.e., B1) at different scales (i.e., B2-internal; B3- external).

Description	Codification
A1. How important to the firm's innovation activities is the information source within the firm or firm's group? (Internal source)	0= No innovation activities; 1=Not used; 2=Low; 3=Medium; 4=High (ordinal)
A2. How important to the firm's innovation activities is the information source (Market sources): i. Suppliers of equipment, materials? ii. Customers (private sector)? iii. Customers (public sector)? iv. Competitors or other firms in the sector? v. Consultants, commercial labs or private R&D institutes?	0= No innovation activities; 1=Not used; 2=Low; 3=Medium; 4=High (ordinal)
A3. How important to the firm's innovation activities is the information source (Institutional sources): i. Universities or other higher education institutions? ii. Government or public research institutes?	0= No innovation activities; 1=Not used; 2=Low; 3=Medium; 4=High (ordinal)
A4. How important to the firm's innovation activities is the information source (Other sources): i. Conferences, trade fairs, exhibitions? ii. Scientific journals and trade/technical publications? iii. Professional and industry associations?	0= No innovation activities; 1=Not used; 2=Low; 3=Medium; 4=High (ordinal)
B1. Most important partner of Cooperation on innovation activities	0=No Cooperation; 1=Other firms from the group; 2=Suppliers; 3=Private customers; 4=Public customers; 5=Competitors; 6=Consultants; 7=Universities; 8=R&D institutions (nominal)
B2. Cooperation for innovation activities with - Other firms within the firm's group (Internal source)	0=None; 1=National firms; 2=National & European firms; 3=National & European & ROW[2] firms (ordinal)
B3. Cooperation for innovation activities with: 1. Suppliers of equipment, materials, components, or software 2. Customers (private sector) 3. Customers (public sector) 4. Competitors or other firms in the sector 5. Consultants, commercial labs or private R&D institutes 6. Universities or research institutes	0=None; 1=National firms; 2=National & European firms; 3=National & European & ROW firms (ordinal)

Table 3. Independent variables selection[3]

(3) Note: for example a private customer 'acts' as an information source when it provides information for new innovation projects or to the completion of existing projects; and 'acts' as a cooperation agent when is an active participator with other enterprises/institutions on innovation activities (pure contracting out of work is excluded).
(2) Rest Of the World.

Innovation activities include not only all types of R&D activities, but also the acquisition of machinery, equipment, buildings, software, and licenses; engineering and development work, design, training, and marketing (DGEEC, 2014). Although the CIS instrument assumes these activities to be specifically undertaken to develop and/or implement a product or process innovation, we also expect an impact on the occurrence of firms' marketing and organizational innovations.

Results

Product innovation

The CHAID tree for product innovation indicates that 58.3% of the sample introduced a new or significantly improved good or service (from 2010 to 2012). The tree has two hierarchical levels, with three terminal nodes (or firm segments). Two predictors correlated with the dependent variable: information sources within the firm/firm group and trade/technical publications. The tree had an estimated risk[4] of 0.092, with a standard error of 0.020, meaning an overall percentage of correct classification of 90.8%. The cross-validation method demonstrated a risk ratio[5] of 0.106. Figure 1 shows the three segments (terminal nodes 1, 3 and 4) for product innovation.

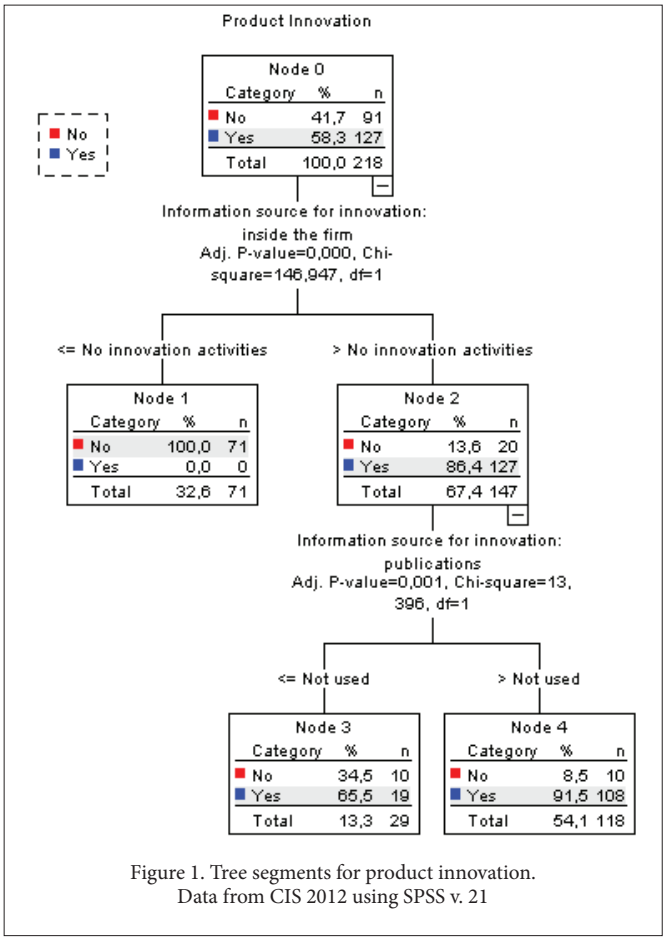

Figure 1. Tree segments for product innovation.
Data from CIS 2012 using SPSS v. 21

From the 218 consulting firms in our sample, 127 developed product innovation. These used internal information sources (86.4%) relying also on the information provided by external trade/technical publications (91.5%).

Process innovation

The CHAID tree for process innovation shows that 51.4% of firms implemented new or significantly improved production, or new or significantly improved methods of supplying services or support. The tree has two terminal nodes (or firm segments). One main predictor correlated with the dependent variable: information sources from suppliers (see Figure 2). This one-level tree had an estimated risk of 0.161, with a standard error of 0.025, meaning an overall percentage of correct classification of 83.9%. The cross-validation method demonstrated a risk ratio of 0.161.

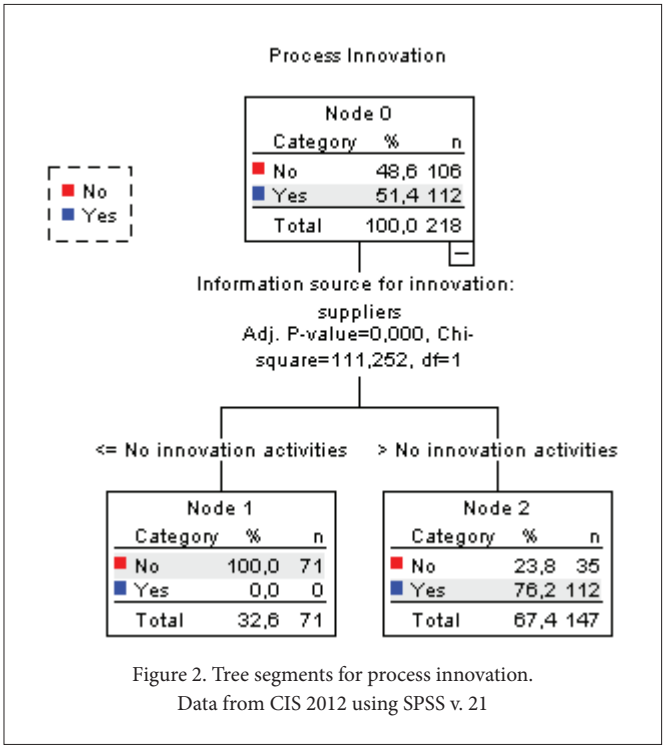

Figure 2. Tree segments for process innovation.
Data from CIS 2012 using SPSS v. 21

The 112 consulting firms engaged in process innovation trusted more on market information sources, mainly suppliers (76.2%), for transforming their processes.

Organizational innovation

According to the CHAID tree for organizational innovation, about 60.1% of the sample implemented a new organizational method in business practices, workplace organization, or external relations. The tree had four terminal nodes (suggesting four firm segments). Three predictors correlated with the dependent variable: information

(4) Risk estimation identifies a tree's predictive accuracy by estimating the proportion of cases classified incorrectly.
(5) Cross-validation risk is the average risk of all trees defined for the validation method.

sources from customers; information sources from publications; and R&D institutions as cooperation partners. This three-level tree had an estimated risk of 0.216, with a standard error of 0.028, meaning an overall percentage of correct classification of 78.4%. The cross-validation method demonstrated a risk ratio of 0.229. The four segments obtained (terminal nodes 1, 3, 5 and 6) are illustrated in Figure 3.

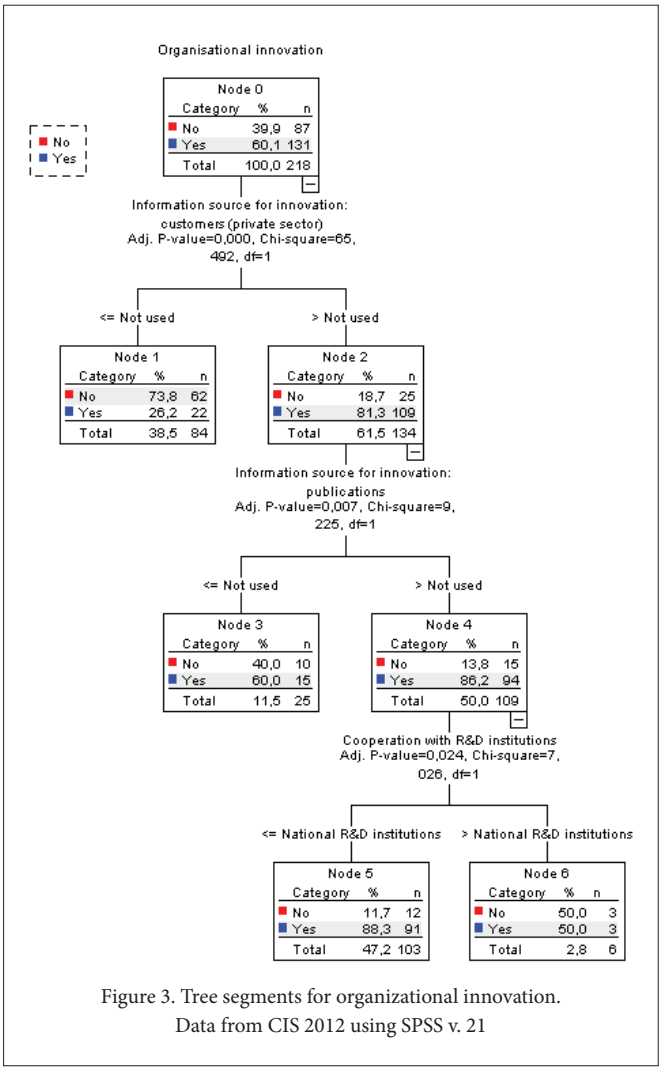

Figure 3. Tree segments for organizational innovation.
Data from CIS 2012 using SPSS v. 21

From the 218 sample firms, 131 developed organizational innovation. About 81.3% of them used the knowledge from private customers. These innovators also used information from scientific journals and publications (86.2%). Node 5 shows that they rely less on R&D institutions as cooperation partners.

Marketing innovation

Regarding marketing innovation, 53.7% of firms implemented a new marketing method or strategy involving significant changes to product design/packaging, placement, promotion, or pricing. The tree had three terminal nodes (suggesting three firm segments). Two predictors correlated with the dependent variable: internal information sources within the firm/firm's group; and information from publications. The tree had an estimated risk of 0.257, with a standard error of 0.030, meaning the overall percentage of correct classification of 74.3%. The cross-validation method demonstrated a risk ratio of 0.266. Three firm segments (terminal nodes 1, 3 and 4) resulted for marketing innovation as showed in Figure 4.

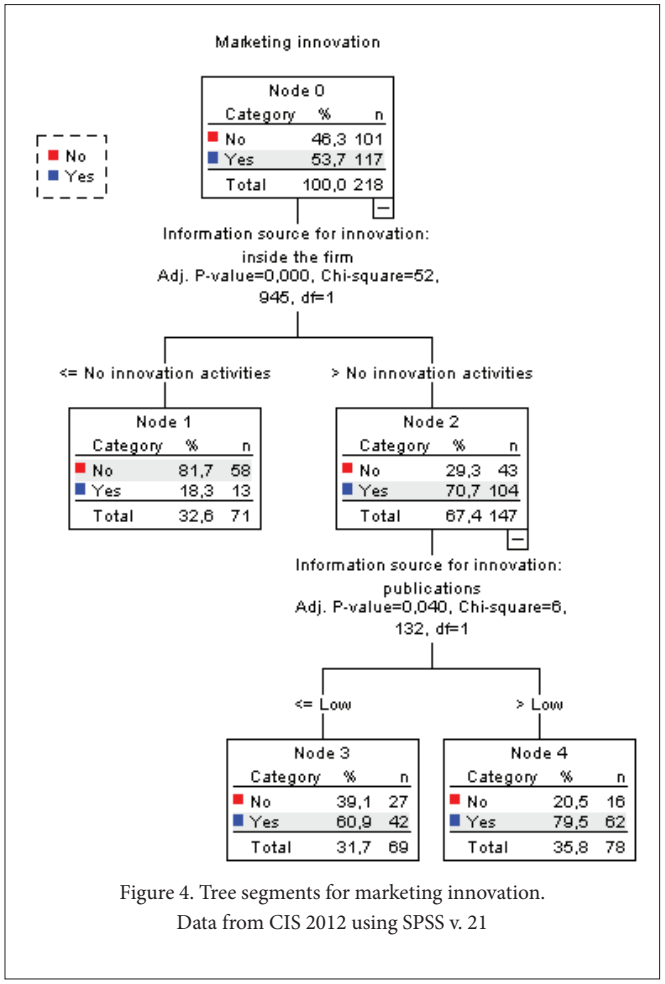

Figure 4. Tree segments for marketing innovation.
Data from CIS 2012 using SPSS v. 21

According to the sources used, marketing and product innovation trees are similar, nevertheless product innovation use those sources more intensively (see Figures 1 and 4).

Segment profiles

Following the descriptions of the CHAID tree segments, an analysis was conducted to identify segment profiles concerning firm size; employee qualifications, etc. (Table 4). Some groups were undefined (i.e., imprecise probability of success) due to their mixes of innovators and non-innovators. These relied more on internal sources than external (either information or cooperation agents).

Innovators	Product/Service Innovation	Information source - Within the firm or firm's group + Information source – Scientific journals and trade/technical publications	Small firm National Market High percentage of employees with university degree	(N) 127 Firms
	Process Innovation	Information source – Suppliers of equipment, materials, components, or software	Small firm National Market High percentage of employees with university degree	(N) 112 Firms
	Organizational Innovation	Information source – clients/customers (private) + Information source – Scientific journals and trade/technical publications	Small firm National Market High percentage of employees with university degree	(N) 131 Firms
	Marketing Innovation	Information source - Within the firm or firm's group + Information source – Scientific journals and trade/technical publications	Small firm National Market Medium percentage of employees with university degree	(N) 117 Firms
Innovation - imprecise probability of success		Firms rely on/use: Internal R&D or External information sources and cooperation agents	Small firm National Market Medium/high percentage of employees with university degree	
Non-Innovators		Firms do not rely on/use both: Internal R&D and External information sources and cooperation agents	Small firm Local/regional market Medium/high percentage of employees with university degree	

Table 4. Main findings' summary

Discussion and conclusion

The four models (i.e., product, process, organizational, and marketing innovation trees) offered considerable evidence to divide the sample into two groups: innovative and non-innovative firms. The type most developed was organizational innovation (60.1%), followed by product (58.3%) and marketing (53.7%). This result can be related with the present economic crisis whose worst influences began in 2008. With lower investments, product/service innovations were likely postponed. However, other CIS periods will be necessary for more accurate longitudinal discussions.

Segment profiles emerged from analysis, emphasizing disparities in the use of information and cooperation partners during innovation. Approximately 50% of sample firms recognized themselves as non-innovators. From the CHAID results, through the trees, these firms generally did not assign importance to information sources, internal or external. Segments with more non-innovative firms (i.e.,

node 1 of product, process and marketing innovation trees) did not consider in-house information sources or suppliers when innovating (and other external partners to a lesser extent).

In terms of information sources firms favored two types: within the firm/firm's group, and scientific journals and trade/technical publications. This latter was rated with significance on three trees: product, organizational and marketing innovations. Results reveal that in-house and scientific/trade/technical publications are very important innovation sources for this industry. Although most companies are small-sized and focus on the national market, they have a medium/high percentage of employees with university degree which internally provide innovative ideas/competences.

Other external sources (besides publications) emerged in organizational and process innovators: private customers and suppliers respectively. There is a relation with R&D institutions for organizational innovations, which is still weak maybe due to related costs.

Results suggest the need to complement internal with external sources (as other authors defend: Von Hippel, 2005; Lundvall, 2010; Szulanski, 1996; Laursen & Salter, 2006). Use of only one type does not guarantee the success since innovation grants an imprecise probability of success. Indeed, innovation is higher in firms that use internal and external environments jointly (Cohen & Levinthal, 1990; Veugelers, 1997; Chesbrough, *et. al.*, 2006). Outsiders who provide diverse solutions to complex problems and foster combinatorial innovation to generate new ideas and applications influence a firm's ability to innovate positively. The trend is toward open innovation due to crises, globalization, Internet potential, and innovation sustainability.

The uniqueness and multi-functionality of products and experiences require specialized competencies that experts must deliver. Thus, partnerships and other integrated initiatives and information are fundamental. A global crisis is influencing Portugal's economy, affecting consultancy among other industries. Future research should explore this topic using other CIS datasets to verify whether findings are exceptional given the context, especially regarding which changes occur concerning information sources and cooperation agent choices.

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