Analysis of Preference of Incentives to Innovation of Dominican Manufacturing and Service Firms

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Abstract

In this paper is analyzed the structure of preference of incentives to innovation of Dominican manufacturing and services firms. The analysis of preference was carried out using a Conjoint Analysis. In total 326 firms were surveyed across the country. According to the main findings, Dominican firms prefer combinations of incentives to minimize tax liabilities but also to reduce uncertainty related to innovation activities. In terms of preference, no statistically significant differences between manufacturing and service firms were found.

Keywords: incentives; innovation; conjoint analysis; dominican republic.

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1. Introduction

This paper aims to analyze the structure of preferences of incentives to innovation of manufacturing and service firms of the Dominican Republic. The main research questions were: 1) What is the structure of preferences of incentives to innovation of Dominican firms? 2) Are there statistical differences in the structure of preference based on firms´ activities and other firms´ characteristics? This is a context-specific research, which means that some firms' characteristics such as size, location, tax regime and others are specific to the Dominican Republic, in the context of the Latin American and Caribbean economies. The fieldwork took place from October 2012 to May 2013, and the sample consisted of 326 firms.

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The Dominican Economy

The Dominican Republic is a country located in the Caribbean Region and occupies two thirds of the Hispaniola Island, which is shared with the Republic of Haiti. It has a population of around 10 million of inhabitants, and a surface of close to 49,000 square kilometers (ONE, 2011). According to the Word Bank, it is a middle income country and the largest economy of Central America and the Caribbean, with a GDP of US$61.16 billion in 2013 (World-Bank, 2015). Until 2010, the country experienced one of the highest growth rates in Latin America and the Caribbean (CEPAL, 2008). In terms of human development, the Dominican Republic is considered a high human development country (PNUD, 2014), in spite of its widely recognized structural distortions in income distribution and deep social inequalities (Attali, 2010).

Around two thirds of the economic activity consists of services, in which telecommunications and tourism play a key role. The industrial sector represents one third of the economic activity, with an important contribution of free zone firms (Banco-Central, 2013), and with a limitation in competitiveness and value creation through innovation that affects the long term possibilities of growth (Hausmann et al., 2011).

Why a Conjoint Analysis?

In ex-ante and ex-post evaluation of public policies, several techniques have been used through time. These techniques include the Delphi Method, which in general terms is based in the consensus of expert groups (Hsu & Sandford, 2007), the Multi-criteria Analysis with a more complex quantitative approach in determining the objective function which equilibrates benefits and costs (Dooley, Smeaton, Sheath, & Ledgard, 2009), and techniques based on opinions of experts, such as the SWOT analysis (strengths, weaknesses, opportunities, threats), which can be categorized as context-based approach (ORR, 2011). The CA provides the opportunity to combine in one technique the capabilities of groups of experts, the survey and sample design, the design of experiments and the choice modeling (Jordan J. Louviere, 1988).

2. Some conceptual basis.

The Conjoint Analysis

The Conjoint Analysis (CA) has been used successfully in marketing studies, in the field of health services, in transportation and infrastructure projects, in prospective studies for energy projects (Paul. E. Green & Srinivasan, 1990), and over the last 25 years it has been intensively used in the fields of environmental economic and in the valuation and management of natural protected areas (Alpízar, Carlsson, & Martinsson, 2001). The CA relies on the approach developed by Lancaster called the "new consumer theory", in which consumers derive utility from the characteristics or objective attributes of the goods or services such as price, size and design, instead of the goods themselves (Lancaster, 1966). The other theoretical component is called "random utility theory", which basically states that the decision-making process is conditioned by the random or unobservable characteristics that lie behind the choices or the preference, such as personal tastes, education or incomes, in the case of consumers (Boxall, Adamowicz, Swait, Williams, & Louviere, 1996).

The CA is classified as a measure of dominance, which consists in numerical assignments to analyze the degree of preference between certain objects (J. J. Louviere, Hensher, & Swait, 2010). There are different types of CA to allow alternative options of analysis of preferences such as: 1) the discrete selection of an option against other competitive options; 2) more dichotomous choices such as "Yes" or "No"; 3) sorting options (order of most preferred to least preferred), among other (Boyle, Holmes, Teisl, & Roe, 2001).

Fiscal incentives in STI policy

For the purpose of this research, incentives can be defined as policy instruments to support changes in the behavior of firms, encouraging them to move towards certain objectives of public policies (Scotchmer, 2004). One of the roles of policy institutions in an NSI is precisely to promote innovative behavior in firms through incentives (Edquist & Johnson, 1997), by offering basically two types of incentives: monetary and non-monetary incentives. The former includes systems of intellectual property protection (Scotchmer, 2004), and the latter includes fiscal incentives and other mechanisms of direct public funding such grants and subsidies (Rivas Sánchez, 2007). The fiscal incentives provide facilities to ease tax liabilities and can operate in two areas: on the tax base (property subject to taxation) and on the tax debt, which is the amount payable as results of tax liabilities incurred in a given period (Rivas Sánchez, 2008).

According to the evidence available in the context of the OCED economies, tax incentives to innovation have a positive effect on the innovative behavior of firms (Guellec & van Pottelsberghe de la Potterie, 2002). In the context of Latin America and the Caribbean, two contributions have special relevance: the contribution of Park on the diffuse impact of tax incentives to innovation in LAC economies (Park, 2002), and the evidence of the crowding-out effect of government support to activities such as R&D (Dominguez, 2008).

In the LAC region, research on STI policies and particularly on tax incentives and their effect on the innovative behavior of firms, has been disperse, and has been undertaken mainly from the perspective of the supply side of policies and in the context of regional cooperation and funding agencies (Vonortas, 2002). The specific contribution of this research is to explore the perspective of firms´ preferences of incentives to innovation in the specific context of the Dominican Republic.

3. Methodology.

Defining attributes and levels

Two experts workshops were conducted in order to define attributes and levels, which is a recommended approach when there isn´t a clear background of the combination of attributes and levels to be presented as choice sets (P. E. Green, Krieger, & Wind, 2001).

The first workshop was conducted in November of 2011 in Santo Domingo, Dominican Republic. Eight public officials participated in this workshop, from the following offices: the National Tax Bureau, the National Custom Agency,

the National Office of Industrial Property, the National Competitiveness Council, the Ministry of Higher Education, Science and Technology and PROINDUSTRIA, which is the national agency that manages the system of incentives to innovation. The second workshop took place on July 3rd of 2012, in the Complutense Institute of International Studies, in Madrid, Spain, and included the participation of six experts from the Complutense University, the Autonomous University of Madrid and the European University of Madrid. In the first workshop, the experts analyzed a matrix of 14 attributes and their corresponding levels. This first matrix was based on the Dominican tax framework on monetary and fiscal incentives and in several acts, such as the "Competitiveness and Innovation Act" (392-07); the "Higher Education, Science and Technology Act" (139-01), and in the "Industrial Property Act" (20-00). In the first workshop, the matrix was reduced to 12 attributes, and in the second one the resulting matrix from the first workshop was reduced to only 8 attributes, which are shown in table 1. The only exception was the attribute on intellectual property and its levels, which was based on the figure of patent box as tax incentive (Atkinson & Andes, 2011). All attributes and levels were re-arranged by the experts as shown in table 1.

All attributes and their levels were defined and explained in the clearest manner possible, in order to reduce ambiguity and communicate the purpose of the CA to firms. In terms of design, the matrix in table 1 would produce a complex factorial defined as 25x32x4=1,152 of possible combinations or profiles, which is an impractical amount of combinations to be elicited. In order to reduce the number of profiles in an efficient way, it was necessary to carry out a fractional orthogonal design, which consists on finding the optimal number of combinations (DeShazo & Fermo, 2002).

A design is considered orthogonal when it has three characteristics: 1) there is no correlation of attributes and levels; 2) is balanced, meaning that the levels of each attribute appear with equal frequency in the design, and 3) it has a minimum overlap, which means that a level of an attribute is not repeated in a series of alternatives. This must result in a balance of utility of the choice sets or profiles, implying that the expected utility of each alternative within a set of selection is the same (Huber & Zwerina, 1996). To generate an orthogonal fractional design, the ORTHOPLAN procedure of SPSS® 20 was used, allowing a full profile design with orthogonal fractioning and principal effects. The exercise resulted in 18 optimal profiles or choice sets: sixteen of these were used to be elicited by firms and two were used for simulations.

#	Attributes	Levels
1	Tax deferred based on benefits generated by R&D and innovative activities	With tax deferred Without tax deferred
2	Tax deduction based on innovation, R&D and other innovative activities.	With tax deduction Without tax deduction
3	Amortization (depreciation) of capital goods based on R&D and others innovative activities	Planned accelerated depreciation Free accelerated depreciation Without accelerated depreciation
4	Tax credit based on the total expenditure on innovation, R&D and other innovative activities.	With tax credit Without tax credit
5	Tax exemption based on R&D and other collaborative innovative activities.	Collaboration with other firms Collaboration with universities & research centers Collaboration with foreigner organizations Without tax exemption
6	Guarantee funds for innovation and technology transfer projects	With guarantee funds Without guarantee funds
7	Public Funds for co-financing R&D and innovative activities	Public funds as a low rate loan Public funds as subsidy Without public funds at all
8	Tax deduction based on Intellectual Property transfer among universities and firms	With intellectual property transfer Without intellectual property transfer

Table 1. Attributes and levels

Control variables

The control variables were defined to support the analysis of preferences, and refer to basic characteristics of firms. With the collaboration of experts of Santo Domingo and Madrid, 10 categorical control variables were defined: 1) Region (Santo Domingo Metro, North region, East region and South); 2) Localization (urban or rural); 3) Tax regime (ordinary and free zones); 4) Age of firms (young, adult and mature); 5) Capital composition (full national; 10%-50% national; 50%-75% foreigner; full foreigner); 6) Firm size based on the number of workers (small, medium and large); 7) Activity (manufacturing, service); 8) Main market (local, national, regional, international); 9) Technological level of product/services (high level, medium high level, medium low level, low level); and 10) Product/services life cycle (short: <1 year, medium: 1-3 year, long: > 3 years). Two of them ("ages of firms" and "technological levels of product/services") were taken from literature. The former was taken from Berger & Udell (1998), which classified age of firms into three groups: 0-4 years, 5-24 years and more than 25 years. The latter was taken from the classification of manufacturing industries according to their technological intensity, in which products could be classified as: high-tech, medium-high technology, medium-low technology and low technology (Hatzichronoglou, 1997).

In the case of the variable "firm size" the Dominican definition, which is based on number of workers, does not fit with international standards such as the OECD criteria (OECD, 2005). According to the Dominican Law, micro business are composed of 1-15 workers, small business of 16-60, medium businesses of 61-200 and large firms of more than 201 workers (R. Guzmán & Ortíz, 2007). The final survey was piloted on 40 firms, which evaluated the survey and suggested changes that were taken into account for the final fieldwork.

Analysis of preferences

For the analysis of preferences, the CA procedure selected was the decompositional approach. This approach is based on the premise that different levels of attributes make a partial contribution (part-worths) to the total utility, and the obtained scores are equivalent to the regression coefficients and indicate the relative importance of each attribute (P. E. Green et al., 2001). Then, the structure of preferences is estimated by an ordinary least square (Sen), which has a linear and additive form that can be represented as follows:

$$y_i = a + \sum_{i=1}^{I} \sum_{j=1}^{k_i} \beta_{ij} x_{ij} + \varepsilon_t$$

In expression 1, yi represents the ranking of preferences of different profiles to which the firm is exposed; α represents the constant generated by the method of OLS; βij represents the utilities or part-worths associated with different levels of attributes; and xij represents the presence or absence of a given level of attribute in the generated profiles. In simple terms, firms would select profiles or combinations of levels, taking into account that certain levels are more appealing than others and these levels will neutralize those with low attractiveness that otherwise would not have been selected (Huber & Zwerina, 1996).

The part-worths can reduce their own contribution to zero, which would indicate the lowest preference of some levels, and therefore, the minimum contribution to the expected total utility. They also could achieve the maximum score indicating the highest level of preferences, which implies that the selection of a particular profile would be conditioned by the attractiveness of a particular level of an attribute in relation to other levels present in the profile (Huber & Zwerina, 1996).

Segmentation of preferences

In the CA, the disaggregation of preferences is called "segmentation". It helps to analyze differences in preferences inside the collected sample, and can be done in two ways: a priori and post hoc (Picón Prado & Varela Mallou, 2000). In the former, the number of segments, their sizes and characteristics are defined in the design stage of the research, based on the literature review of similar cases and on the experience of the researcher. In the latter, the number of segments and their characteristics are defined after the sample is obtained, according to one or more classification variables or by cluster analysis (Rivera Deán, González Tabares, Martín Santana, Oñate García, & Sánchez Fernández, 2004).

In the post hoc segmentation, a separately CA is performed to the resulting groups to compare the differences in preferences between them (Ramírez Hurtado, Rondán Cataluña, & Guerrero Casas, 2007). In the case of this research and given its exploratory nature, the two types of segmentations were carried out: an a priori segmentation based on firms activities, and a post hoc segmentation based on cluster analysis.

Forecasting preferences

The procedure CONJOINT of SPSS uses three models to estimate the probability of choice: 1) the total utility model or TU; 2) the Bradley-Terry-Luce model or BTL and, 3) the logit model which has been used in several types of Conjoint Analysis (Paul. E. Green & Srinivasan, 1990). In order to

perform a simulation of probabilities of choice, the last two profiles generated during the orthogonal design were utilized. The TU model estimates the probability of choice assuming that the profile with the highest total utility will be the most likely to be chosen (MacFadden, 1980). The selection of the profile with the highest utility follows a relatively simple binary approximation which can be represented as indicated in expression 2 (Ramírez Hurtado et al., 2007).

$$pi = \begin{cases} 1 yes U_i = \max(i_n \in k_{i...n}) \\ 2 no U_i = \min(i_n \in k_{i...n}) \end{cases}$$

The BTL model estimates the probability of choosing by comparing the profiles with the highest utility in relation to the others, and then averaging the balance of utility of respondents and also the probability of choice of all profiles (Huber, Wittink, Fiedler, & Miller, 1993). The functional expression of the BTL model can be represented as:

$$p_i = \frac{\hat{r}_i}{\sum\limits_{j=1}^{J} \hat{r}_i}$$

In expression 3, J represents the total number of profiles. In other words, the probability of choosing a specific combination of levels is given by the utility provided for the sum of all combinations. The third model used by the CONJOINT procedure, the logit model, is the most popular approach in choice experiments (Hanley, Wright, & Adamowicz, 1998). The logit model assumes that preferences are linear, and unlike the BTL it uses a natural logarithm of the utilities to estimate the probabilities of choice. The functional expression can be represented as follows:

$$P_{ni} = \frac{\exp^{\mu L_{ni}}}{\sum\limits_{i \in S} \exp^{\mu L_{ni}}}$$

In expression 4, the probability that profile Lni was selected by the firm n depends on the observable part of the expected utility function of the selected profile, related to the set of alternatives that makeup the set of options S. In this function, μ is a scale parameter associated with the distribution of the utility function, theoretically equal to 1 (Hanley, Mourato, & Wright, 2001).

Sample size

As it has been stated, 326 firms were sampled from a universe of 6,877 firms. This universe of 6,977 firms was taken from the database provided by the Dominican Association of Industries (AIRD for its acronyms in Spanish) and by the National Tax Bureau known in Spanish as "Dirección Nacional de Impuestos Internos". The sample design chosen was a simple random design with proportional allocation by regions and activities (Scheaffer, Mendenhall, & Ott, 2007). The confidence level was of 95% and the margin of error of 5%.

According to literature, the sample size for CA studies tends to vary in a range between 100 to 1000 subjects, and the most typical samples sizes tend to be in a range of 300 to 550 cases, usually for commercial studies (Alpízar et al., 2001). Therefore, the reached sample has the typical range for CA studies.

4. Results

In regards to their general characteristics, the surveyed firms are distributed as follows: 66.3% are located in the metropolitan area of Santo Domingo, and the remaining 33.7% distributed in the other regions; 93.6% of the firms are located in urban areas and the remaining 6.3% are located in rural areas. Based on the number of workers, in the Dominican context 82.5% of the firms are considered small, 12% are considered medium-size and 5.5% are considered large, reflecting the composition of the Dominican industrial sectors (R. M. Guzmán, 2011). In regards to the tax regime, 90% of firms operate in the regular tax system while 10% operate in the free zone tax regime. In regards to their age, 62.6% of firms are considered "adults" (between 5 and 24 years), 31.6% are mature (over 25 years) and only 5% are young firms (0 to 4 years). According to their activity, 57% are manufacturing firms and 43% belong to the service sector.

Concerning the capital structure, 86.2% of the firms are 100% Dominican, 7.4% have a variable mix of Dominican and foreign capital and the reining 6.4% are of foreign capital. Related to the target market, 89.5% of the companies are focused on the domestic market and the remaining 10.5% target the international market. In relation to the degree of sophistication of products/services, 15% of the surveyed firms affirmed to offer products/services with high tech content, 34.7% stated to offer products with a medium-high level of tech content, 20.9% indicated to offer products with a medium-low level of tech content, and 29.4% affirmed to offer products/services with low level of tech content.

In regards to the life cycle of products, 25.5% of the surveyed firms affirmed to offer product/services of a short life cycle (<1 year), 21.5% affirmed to offer product/services of medium life cycle (1-3 years), and 39.6% stated that they offer products/ services of a long life cycle (> 3 years).

Aggregate analysis of preferences

The aggregate analysis of preferences is intended to provide an overall view of the structure of preferences of manufacturing and service firms, which provides an answer to the first research question. The CONJOINT procedure offers the following outputs: 1) a description of the factors (attributes), 2) correlations of observed and estimated preferences, 3) the part-worths or partial contributions of level of attributes, and 4) the relative importance of attributes as shown in table 2 & 3.

Table 2 presents the factors or attributes used to evaluate preferences, indicating that all attributes are discrete and orthogonal, which means that the full profile design was efficient. Table 3 indicates that observed and estimated preferences are correlated, which means that the variables of preference have a good fit (Ramírez Hurtado et al., 2007).

Correlations*		
Measures	Value	Sig.
R Pearson	0,906	0,000
Tau Kendall	0,750	0,000
*Correlations between observed and estimated preferences		

Table 3. Correlation of the expected preferences

Factors in the model*	Levels	Kind of factors
1. Tax deferred based on benefits of innovation and R&D	2	Discrete
2. Tax deduction based on innovation, R&D and other innovative activities	2	Discrete
3. Amortization (depreciation) of capital goods of R&D and others innovative projects	3	Discrete
4. Tax credit based on the total expenditure on R&D on other innovative activities	2	Discrete
5. Tax exemption based on R&D and other innovative collaborative activities	4	Discrete
6. Guarantee funds for innovation and tech transfer projects	2	Discrete
7. Public funds for co-financing R&D and innovation projects	3	Discrete
8. Tax decuction based on IP transfer among universities and firms	2	Discrete

*All factors are orthogonal

Table 2. Factors in the estimated aggregated model

Coeff.	Level of attributes	Part-worths	Error
a_0	Constant	**8,518**	**0,425**
β_1	Tax deferral based on R&D and innovative activities	0,216	0,385
β_2	No tax deferral based on R&D and innovative activities	-0,216	0,385
β_3	Tax deduction based on R&D and innovative activities.	0,374	0,385
β_4	No tax deduction based on R&D and innovative activities	-0,374	0,385
β_5	Accelerated depreciation of capital goods based on R&D and innovative activities	-0,155	0,513
β_6	*Free accelerated depreciation of capital goods based in R&D and innovative activities*	*-0,672*	*0,601*
β_7	**No accelerated depreciation of capital goods based on R&D and innovative activities**	**0,827**	**0,601**
β_8	Tax credit based on total expenditure on R&D an innovative activities	-0,616	0,385
β_9	No tax credit based on expenditures on R&D and innovative activities	0,616	0,385
β_{10}	*Tax exemption based on innovative collaborative activities with other firms*	*-0,937*	*0,666*
β_{11}	**Tax exemption based on collaborative activities among universities and research centers**	**0,910**	**0,666**
β_{12}	Tax exemption based on collaborative activities with foreigner entities	0,501	0,666
β_{13}	No tax exemption based on collaborative innovative activities	-0,474	0,666
β_{14}	**Guarantee funds for innovation & tech transfer projects**	**0,714**	**0,385**
β_{15}	*No guarantee funds for innovation and tech transfer projects*	*-0,714*	*0,385*
β_{16}	Public funds as low rate loan for co-financing innovation and tech transfer projects	0,082	0,513
β_{17}	Public funds as subsidies for co-financing R&D and other innovative activities	0,167	0,601
β_{18}	No public funds for co-financing R&D, tech transfer projects and other innovative activities	-0,249	0,601
β_{19}	Tax deduction based on intellectual property transfer among universities and firms	0,291	0,385
β_{20}	No tax deduction based on IP transfer among universities and firms	-0,291	0,385

Table 4. Part-worths of levels of incentives to innovation at aggregated level of firms)

Table 4 shows the most important results of the research, which are the structure of preferences of incentives to innovation. The part-worths are equivalent to the coefficients of a regression model, in which the positive scores indicate a higher expected utility and the negative ones indicate an aversive expectation or rejection (Boyle et al., 2001). In the table 4 the three most valued levels by firms are highlighted in bold, and the three most rejected in italic. An interesting finding to be highlighted is the positive valuation of the collaboration between firms with universities and research centers, in contrast with the unwillingness to collaborate with other firms. In regards to the relative importance of attributes by themselves, chart 1 shows the preferences of the surveyed firms.

Segmentation of preferences

Two segmentations were made: a priori and post-hoc, in order to provide an answer to the second research question. The first one shows the preferences based on activities and the second shows the preferences based on cluster analysis. The segmentation based on activities is shown in tables 5 and 6.
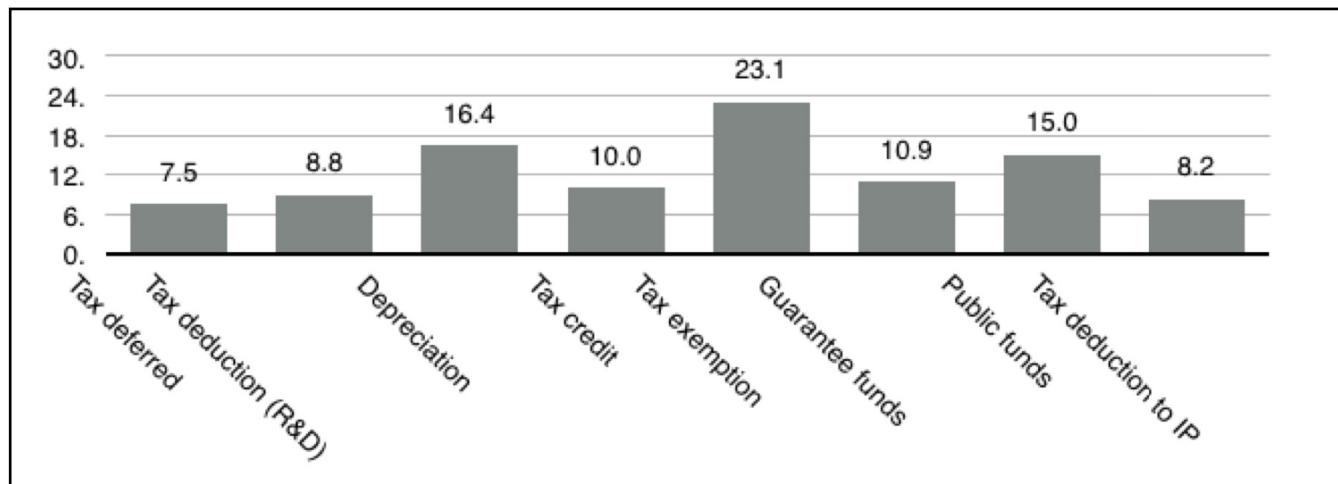
Chart 1. Relative importance (%) of attributes at the aggregated level of firms

Correlations*		
Measures	Manufacturing	Services
R Pearson	0,926	0,872
Sig.	0,000	0,000
Tau Kendall	0,778	0,717
Sig.	0,000	0,000
*Correlations between observed and estimated preferences		

Table 6. Part-worths of level of incentives of manufacturing and service firms

Table 5 shows the correlations among observed and estimated preferences of both manufacturing and service firms. In both types of firms the correlation indicates that the variables of preference have a good fit, but slightly better in manufacturing firms than in the case of service firms. Regarding to the most important output shown in table 6, it can be appreciated that, although the levels of attributes report some differences between manufacturing and service firms, the total utility is very similar, as it has been reported in other CA studies (Ramírez Hurtado et al., 2007). In table 6, the attributes with the highest scores are emphasized in bold, and the worst ranked in are emphasized in italic. Some scores show interesting findings, such as the $\beta 1$ level, where the utility is visibly lower for service firms than for manufacturing firms, and the $\beta 3$ level, which generates more utility for manufacturing than for service firms. Chart 2 shows the relative importance of attributes for both types of firms.

Examining the attributes, it is obvious that both types of firms have a converging structure of preferences. However, given the observed differences in the structure of preferences in table 6 and despite the similarities shown in chart 2, the central question is whether the differences in preference of attributes between both types of firms will become statistically significant.

According to the performed ANOVA test (P. E. Green & Srinivasan, 1978), no statistically significant differences were found in the preference structure of levels of attributes in the two types of firms (Annex 1).

Related to the post-hoc segmentation via cluster analysis, two combined procedures were used to enforce the segmentation process, following several authors: k-means and discriminant analysis (Sánchez & Gil, 1998). As a result, two clusters were defined: 186 firms were included in the first cluster and 137 in the second cluster, and 3 firms were disregarded. One of the most relevant differences between cluster 1 and cluster 2 is that in cluster 1 there are more service firms and medium sized-firms than in cluster 2; and in cluster 2 there are more manufacturing firms and small-sized firms than in cluster 1. Table 7 shows the part-worths corresponding to clusters 1 and 2. (Insert table 7)
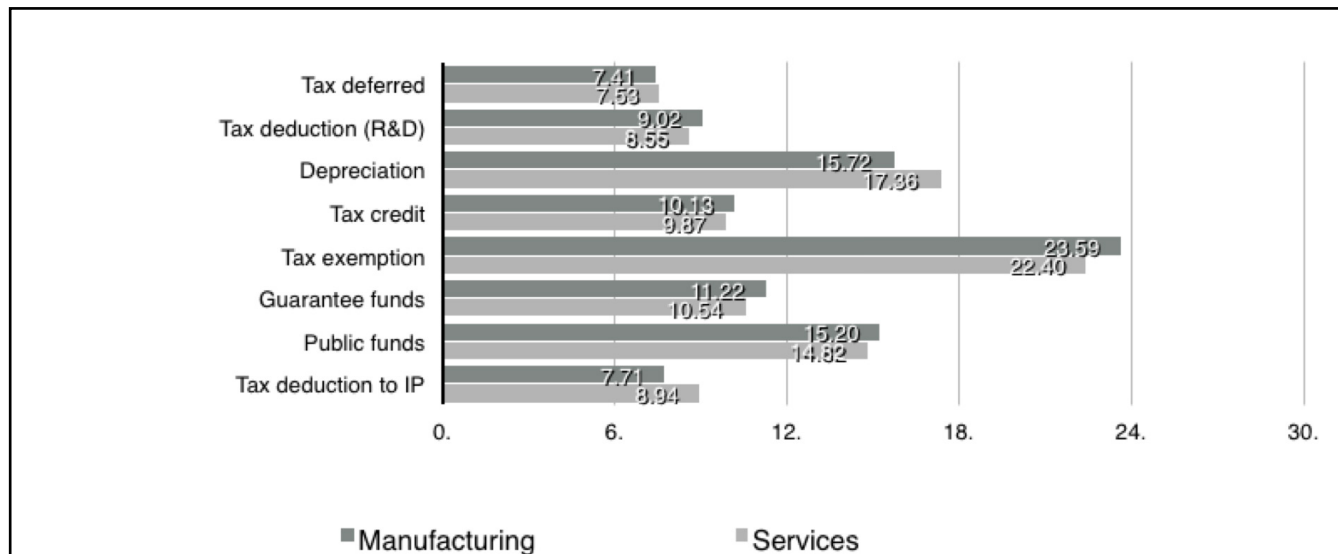

Chart 2. Relative importance (%) of attributes for manufacturing and services firms

Coeff.	Levels of attributes	Part-Worths	
		Cluster 1	Cluster 2
a_0	Constant	8,504	8,564
$ß_1$	Tax deferral based on R&D and innovative activities	0,151	0,321
$ß_2$	No tax deferral based on R&D and innovative activities	-0,151	-0,321
$ß_3$	Tax deduction based on R&D and innovative activities.	0,445	0,308
$ß_4$	No tax deduction based on R&D and innovative activities	-0,445	-0,308
$ß_5$	Accelerated depreciation of capital goods based on R&D and innovative activities	0,005	-0,434
$ß_6$	*Free accelerated depreciation of capital goods based in R&D and innovative activities*	*-0,820*	*-0,422*
$ß_7$	**No accelerated depreciation of capital goods based on R&D and innovative activities**	**0,815**	**0,856**
$ß_8$	Tax credit based on total expenditure on R&D an innovative activities	*-0,547*	*-0,705*
$ß_9$	No tax credit based on expenditures on R&D and innovative activities	0,547	0,705
$ß_{10}$	*Tax exemption based on innovative collaborative activities with other firms*	*-0,974*	*-0,876*
$ß_{11}$	**Tax exemption based on collaborative activities among universities and research centers**	**0,934**	**0,890**
$ß_{12}$	Tax exemption based on collaborative activities with foreigner entities	0,473	0,505
$ß_{13}$	No tax exemption based on collaborative innovative activities	-0,432	*-0,519*
$ß_{14}$	**Guarantee funds for innovation & tech transfer projects**	**0,673**	**0,765**
$ß_{15}$	*No guarantee funds for innovation and tech transfer projects*	*-0,673*	*-0,765*
$ß_{16}$	Public funds as low rate loan for co-financing innovation and tech transfer projects	-0,021	0,179
$ß_{17}$	Public funds as subsidies for co-financing R&D and other innovative activities	0,210	0,160
$ß_{18}$	No public funds for co-financing R&D, tech transfer projects and other innovative activities	-0,189	-0,340
$ß_{19}$	Tax deduction based on intellectual property transfer among universities and firms	0,324	0,229
$ß_{20}$	No tax deduction based on IP transfer among universities and firms	-0,324	-0,229
Total utility		**8,505**	**8,563**

Table 7. Part-worths of level of incentives of innovation in clustered firms

The differences in the structure of preference in cluster 1 and 2 are quite obvious in the coefficients for both positive and negative part-worths. Table 7 shows the attributes with the highest part-worts in bold and the worse ranked in italic. Two levels of attributes stand out: in the score of $\beta5$ the part-worths for cluster 1 is positive and for cluster 2 is negative, and it is the opposite for $\beta16$, in which the score is negative for cluster 1 and positive for cluster 2. This highlights the differences in structure of preferences despite the fact that the total utility is similar. Chart 3 shows the relative importance of attributes for the clusters.

In regards to the statistical differences in the structure of preferences of attributes for innovation, the ANOVA test (Annex 2) shows statistically significant differences on preferences in the two clusters contrasting with the results of the a priori segmentation.

The a priori segmentation did not find statistical differences between groups taking into account their activities. This does not imply that such differences don't exist, but it does indicate that these differences are not statically significant. However with the post-hoc segmentation such differences were found, given the more stylized way in grouping firms by

this cluster analysis technique (Picón Prado & Varela Mallou, 2000). The key issue here is that despite the similarity of the structure of preferences of the two segmentation groups, it may not make sense to compare them because they are the result of a different decision making process which cannot be transferred between groups (Geanakoplos, 1996). Related to firm´s characteristics and the preferences of incentives to innovation, and based on the MANOVA test (Steven, 1980), in the case of manufacturing firms the characteristic "size" seems to affect the election. In the case of service firms, two characteristics seem to affect the election: tax regime and capital composition (Annex 3).

Forecasting preferences

As it has been stated before, 18 profiles of level of attributes were generated using the CONJOINT procedure. Two of the 18 profiles were not evaluated by firms and were used to codify a simulation on the probability of choice by using the three models explained before: the Total Utility model, the BTL model and the logit model. Table 8 shows the probability of choice based on the estimations of the three models, and table 9 shows the composition of the analyzed profiles based on the aggregate level of analysis of preferences.
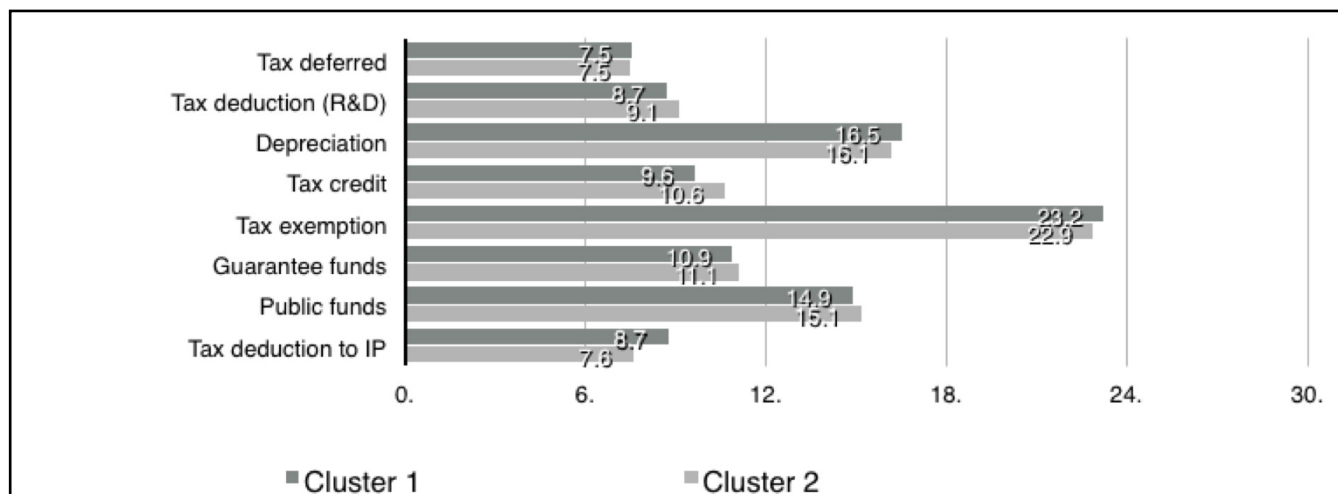

Chart 3. Relative importance (%) of attributes for clusters 1 and 2

According to the three probabilistic models in table 8, profile 1 was the most the selected given its specific composition of levels of attributes. The two profiles share the same part-worths for the first four levels, but after the fourth level strong differences arise (Table 9). At the aggregate level of preferences and in the context of the Dominican Republic, the simulation indicates that firms will prefer those combinations that maximize direct public funding. In regards to the probabilities of choice based on firm´s segmentation, the results are quite similar to the aggregate level of preferences, and are shown in Table 10.

Probabilities of choice				
Profiles	ID	TU model	Bradley-Terry-Luce	Logit
17	1	77,90%	61,60%	73,50%
18	2	22,10%	38,40%	26,50%

Table 8. Probabilities of choices of the simulation profiles at the aggregated level

Profile 17		Profile 18	
Level of attributes	Part-worths	Level of attributes	Part-worths
1. No tax deferral based on R&D and innovative activities	-0,216	1. No tax deferral based on R&D and innovative activities	-0,216
2. Tax deduction based on R&D and innovative activities.	0,374	2. Tax deduction based on R&D and innovative activities.	0,374
3. Accelerated depreciation of capital goods based on R&D and innovative activities	-0,155	3. Accelerated depreciation of capital goods based on R&D and innovative activities	-0,155
4. No tax credit based on expenditures on R&D and innovative activities	**0,616**	4. Tax credit based on total expenditure on R&D an innovative activities	-0,616
5. No tax exemption based on collaborative innovative activities	*-0,474*	*5. Tax exemption based on innovative collaborative activities with other firms*	*-0,937*
6. Guarantee funds for innovation & tech transfer projects	**0,714**	*6. No guarantee funds for innovation and tech transfer projects*	*-0,714*
7. Public funds as subsidies for co-financing R&D and other innovative activities	0,167	7. No public funds for co-financing R&D, tech transfer projects and other innovative activities	-0,249
8. Tax deduction based on intellectual property transfer among universities and firms	0,291	8. No tax deduction based on IP transfer among universities and firms	-0,291
Total utility	**1,317**	**Total utility**	**-2,804**

Table 9. Structure of preference of profiles 17 & 18

5. Concluding remarks

Policy implications

The analysis of preferences of incentives to innovation provided the opportunity to explore in depth and in different levels, the structure of preferences of Dominican firms. At the aggregate level of preferences, the most preferred attributes (tax exemption, depreciation and public funds) could anticipate a "crowding-out" effect of the public funding of the business expenditure in R&D and other innovative activities. This means that the private efforts on innovation could be offset by the government dominance, which was highlighted by Park in the context of LAC countries (Park, 2002). Although in LAC countries the private support to R&D and other innovative activities has increased in recent years (RICYT, 2010), the fact is that the public sector still is the main funder of R&D (Arocena & Sutz, 2001).

The structure of preferences that were found, could express a deep cultural background and dependency of public funding and also a learning path to take into account for STI policy making in the Dominican Republic, which is a late comer country in regards to STI policies in the context of Latin-American countries.

Identifying and analyzing the underlying patterns that could explain the preferences of Dominican firms is beyond the scope of this research, as these are related to the complex dynamics of learning in developing countries, including the technological paradigms and trajectories, which, in turn, depend on the STI institutional context (Breschi, Malerba, & Orseingo, 2000).

It is important to remember that the surveyed firms develop their activities embedded in a particular STI institutional context with defined rules and placed restrictions on what firms can and cannot do, conditioning the possibilities of learning and the incorporation of new knowledge and innovations (Nelson & Nelson, 2002).

In such institutional context, informal learning processes probably have more impact on the innovativeness of firms than the formal dynamics of R&D. In the case the Dominican Republic, the innovativeness of firms could be conditioned by factors ranging from availability of human capital, technological infrastructure, linkages with universities and research centers to financing (Metcalfe & Ramlogan, 2008). The ideological and cultural context related to STI policies of a developing economy such as the Dominican Republic may significantly condition the preferences of incentives to innovation of firms, and take the shape of mental models or conceptual maps that lead the decision making process (Denzau & North, 1994).

Regarding the use of the Conjoint Analysis

Given the exploratory nature of this research, the selection of a CA based on ranking was correct, as well as the decompositional and partial contributions approaches. The results were consistent with the literature on CA as well as with the somewhat sparse literature on incentives to innovation in LAC countries.

The CA is not a methodological panacea for ex-ante evaluation of STI public policies on innovation, but can supplement other qualitative approaches such as focus groups, the Delphi method, and opinion surveys. As it has ben stated before, the advantages of the Conjoint Analysis methods is their capability as choice modeling tools.

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Annex

Annex 1.
One-way ANOVA based on a priori segmentation

One Way ANOVA						
Profiles	*Variance*	*Sum of square*	*gl*	*Root mean square*	*F*	*Sig.*
Profile 1	Inter-groups	0,61	1	0,61	0,032	0,859
	Intra-groups	6220,59	321	19,38		
	Total	6221,21	322			
Profile 2	Inter-groups	12,99	1	12,99	0,479	0,489
	Intra-groups	8711,00	321	27,14		
	Total	8723,99	322			
Profile 3	Inter-groups	28,55	1	28,55	1,424	0,234
	Intra-groups	6435,51	321	20,05		
	Total	6464,06	322			
Profile 4	Inter-groups	3,58	1	3,58	0,185	0,667
	Intra-groups	6198,92	321	19,31		
	Total	6202,50	322			
Profile 5	Inter-groups	51,78	1	51,78	2,725	0,100
	Intra-groups	6100,02	321	19,00		
	Total	6151,80	322			
Profile 6	Inter-groups	3,20	1	3,20	0,192	0,661
	Intra-groups	5339,65	321	16,63		
	Total	5342,85	322			
Profile 7	Inter-groups	25,15	1	25,15	1,213	0,272
	Intra-groups	6654,48	321	20,73		
	Total	6679,63	322			
Profile 8	Inter-groups	17,07	1	17,07	0,878	0,349
	Intra-groups	6243,03	321	19,45		
	Total	6260,10	322			
Profile 9	Inter-groups	76,04	1	76,04	3,762	0,053
	Intra-groups	6489,17	321	20,22		
	Total	6565,21	322			
Profile 10	Inter-groups	115,39	1	115,39	5,970	0,015
	Intra-groups	6204,56	321	19,33		
	Total	6319,95	322			
Profile 11	Inter-groups	0,93	1	0,93	0,046	0,831
	Intra-groups	6545,80	321	20,39		
	Total	6546,73	322			

Profile 12	Inter-groups	12,20	1	12,20	0,497	0,481
	Intra-groups	7880,30	321	24,55		
	Total	7892,50	322			
Profile 13	Inter-groups	5,65	1	5,65	0,230	0,632
	Intra-groups	7888,03	321	24,57		
	Total	7893,67	322			
Profile 14	Inter-groups	4,53	1	4,53	0,189	0,664
	Intra-groups	7672,30	321	23,90		
	Total	7676,83	322			
Profile 15	Inter-groups	51,57	1	51,57	2,100	0,148
	Intra-groups	7883,83	321	24,56		
	Total	7935,39	322			
Profile 16	Inter-groups	65,06	1	65,06	2,176	0,141
	Intra-groups	9597,57	321	29,90		
	Total	9662,63	322			

Annex 2.
One-way ANOVA based on post hoc segmentation

One Way ANOVA						
Profiles	*Variance*	*Sume of square*	*gl*	*Root mean square*	*F*	*Sig.*
Profile 1	Inter-groups	252,77	1	252,77	13,595	0,000
	Intra-groups	5968,44	321	18,59		
	Total	6221,21	322			
Profile 2	Inter-groups	319,84	1	319,84	12,216	0,001
	Intra-groups	8404,15	321	26,18		
	Total	8723,99	322			
Profile 3	Inter-groups	248,49	1	248,49	12,833	0,000
	Intra-groups	6215,57	321	19,36		
	Total	6464,06	322			
Profile 4	Inter-groups	492,11	1	492,11	27,663	0,000
	Intra-groups	5710,39	321	17,79		
	Total	6202,50	322			
Profile 5	Inter-groups	158,78	1	158,78	8,505	0,004
	Intra-groups	5993,02	321	18,67		
	Total	6151,80	322			
Profile 6	Inter-groups	564,50	1	564,50	37,922	0,000
	Intra-groups	4778,35	321	14,89		
	Total	5342,85	322			

Profile 7	Inter-groups	1081,19	1	1081,19	61,992	0,000
	Intra-groups	5598,44	321	17,44		
	Total	6679,63	322			
Profile 8	Inter-groups	13,51	1	13,51	0,694	0,405
	Intra-groups	6246,59	321	19,46		
	Total	6260,10	322			
Profile 9	Inter-groups	161,74	1	161,74	8,108	0,005
	Intra-groups	6403,47	321	19,95		
	Total	6565,21	322			
Profile 10	Inter-groups	193,95	1	193,95	10,163	0,002
	Intra-groups	6126,00	321	19,08		
	Total	6319,95	322			
Profile 11	Inter-groups	679,67	1	679,67	37,186	0,000
	Intra-groups	5867,06	321	18,28		
	Total	6546,73	322			
Profile 12	Inter-groups	723,82	1	723,82	32,411	0,000
	Intra-groups	7168,68	321	22,33		
	Total	7892,50	322			
Profile 13	Inter-groups	2424,22	1	2424,22	142,276	0,000
	Intra-groups	5469,45	321	17,04		
	Total	7893,67	322			

Profile 14	Inter-groups	2359,31	1	2359,31	142,423	0,000
	Intra-groups	5317,52	321	16,57		
	Total	7676,83	322			
Profile 15	Inter-groups	2070,04	1	2070,04	113,289	0,000
	Intra-groups	5865,36	321	18,27		
	Total	7935,39	322			
Profile 16	Inter-groups	1364,13	1	1364,13	52,767	0,000
	Intra-groups	8298,50	321	25,85		
	Total	9662,63	322			

Annex 3.a
MANOVA based on a priori segmentation

Multivariate tests							
Activities	Effect	Test	Value	F	DF hypothesis	DF error	Sig.
Manufacturing	Intercept	Pillai´s Trace	0,853	52,485	16,000	145,000	0,000
		Wilks´s Lambda	0,147	52,485	16,000	145,000	0,000
		Hotelling´s Trace	5,791	52,485	16,000	145,000	0,000
		Roy´s largest root	5,791	52,485	16,000	145,000	0,000
	Region	Pillai´s Trace	0,253	0,847	48,000	441,000	0,757
		Wilks´s Lambda	0,765	0,849	48,000	432,060	0,754
		Hotelling´s Trace	0,284	0,850	48,000	431,000	0,752
		Roy´s largest root	0,138	1,271	16,000	147,000	0,223
	Tax regimen	Pillai´s Trace	0,129	1,345	16,000	145,000	0,178
		Wilks´s Lambda	0,871	1,345	16,000	145,000	0,178
		Hotelling´s Trace	0,148	1,345	16,000	145,000	0,178
		Roy´s largest root	0,148	1,345	16,000	145,000	0,178
	Age of the firm	Pillai´s Trace	0,242	1,256	32,000	292,000	0,168
		Wilks´s Lambda	0,770	1,262	32,000	290,000	0,163
		Hotelling´s Trace	0,282	1,269	32,000	288,000	0,159
		Roy´s largest root	0,203	1,848	16,000	146,000	0,030
	Capital composition	Pillai´s Trace	0,414	1,066	64,000	592,000	0,345
		Wilks´s Lambda	0,642	1,066	64,000	569,925	0,347
		Hotelling´s Trace	0,475	1,064	64,000	574,000	0,349
		Roy´s largest root	0,218	2,020	16,000	148,000	0,015
	Firms´size	Pillai´s Trace	0,295	1,579	32,000	292,000	**0,028**
		Wilks´s Lambda	0,725	1,583	32,000	290,000	**0,028**
		Hotelling´s Trace	0,352	1,586	32,000	288,000	**0,027**
		Roy´s largest root	0,237	2,164	16,000	146,000	**0,009**
	Principal market	Pillai´s Trace	0,355	1,234	48,000	441,000	0,144
		Wilks´s Lambda	0,681	1,242	48,000	432,060	0,137
		Hotelling´s Trace	0,418	1,250	48,000	431,000	0,131
		Roy´s largest root	0,238	2,189	16,000	147,000	0,008
	Technological level products/servi ces	Pillai´s Trace	0,262	0,880	48,000	441,000	0,701
		Wilks´s Lambda	0,758	0,879	48,000	432,060	0,703
		Hotelling´s Trace	0,293	0,877	48,000	431,000	0,705
		Roy´s largest root	0,145	1,335	16,000	147,000	0,184
	Life cicle of products/servi ces	Pillai´s Trace	0,294	1,000	48,000	441,000	0,478
		Wilks´s Lambda	0,733	0,993	48,000	432,060	0,491
		Hotelling´s Trace	0,329	0,985	48,000	431,000	0,504
		Roy´s largest root	0,155	1,423	16,000	147,000	0,138

Annex 3.b
MANOVA based on a priori segmentation

Multivariate tests							
Activities	*Effect*	*Test*	*Value*	*F*	*DF hypothesis*	*DF error*	*Sig.*
Services firms	Intercept	Pillai´s Trace	0,674	13,444	16,000	104,000	0,000
		Wilks´s Lambda	0,326	13,444	16,000	104,000	0,000
		Hotelling´s Trace	2,068	13,444	16,000	104,000	0,000
		Roy´s largest root	2,068	13,444	16,000	104,000	0,000
	Region	Pillai´s Trace	0,397	1,009	48,000	318,000	0,462
		Wilks´s Lambda	0,652	1,001	48,000	310,116	0,477
		Hotelling´s Trace	0,464	0,992	48,000	308,000	0,492
		Roy´s largest root	0,219	1,448	16,000	106,000	0,134
	Tax regimen	Pillai´s Trace	0,219	1,826	16,000	104,000	**0,037**
		Wilks´s Lambda	0,781	1,826	16,000	104,000	**0,037**
		Hotelling´s Trace	0,281	1,826	16,000	104,000	**0,037**
		Roy´s largest root	0,281	1,826	16,000	104,000	**0,037**
	Age of the firm	Pillai´s Trace	0,243	0,906	32,000	210,000	0,617
		Wilks´s Lambda	0,772	0,898	32,000	208,000	0,628
		Hotelling´s Trace	0,277	0,891	32,000	206,000	0,639
		Roy´s largest root	0,159	1,040	16,000	105,000	0,422
	Capital composition	Pillai´s Trace	0,638	1,269	64,000	428,000	**0,090**
		Wilks´s Lambda	0,488	1,287	64,000	409,418	**0,079**
		Hotelling´s Trace	0,815	1,305	64,000	410,000	**0,068**
		Roy´s largest root	0,423	2,829	16,000	107,000	**0,001**
	Firms´size	Pillai´s Trace	0,331	1,300	32,000	210,000	0,142
		Wilks´s Lambda	0,696	1,292	32,000	208,000	0,147
		Hotelling´s Trace	0,399	1,285	32,000	206,000	0,153
		Roy´s largest root	0,242	1,589	16,000	105,000	0,084
	Principal market	Pillai´s Trace	0,337	0,838	48,000	318,000	0,769
		Wilks´s Lambda	0,695	0,840	48,000	310,116	0,764
		Hotelling´s Trace	0,394	0,843	48,000	308,000	0,760
		Roy´s largest root	0,222	1,469	16,000	106,000	0,125
	Technological level products/servi ces	Pillai´s Trace	0,439	1,135	48,000	318,000	0,261
		Wilks´s Lambda	0,620	1,125	48,000	310,116	0,276
		Hotelling´s Trace	0,521	1,114	48,000	308,000	0,291
		Roy´s largest root	0,243	1,613	16,000	106,000	0,078
	Life cicle of products/servi ces	Pillai´s Trace	0,483	1,271	48,000	318,000	0,119
		Wilks´s Lambda	0,587	1,266	48,000	310,116	0,124
		Hotelling´s Trace	0,589	1,260	48,000	308,000	0,129
		Roy´s largest root	0,292	1,936	16,000	106,000	0,025