Identification of Differences in the Productive Profile of the Exporting and Non-Exporting Companies of the Atlantic-Colombia Department:

An Application of the Discriminating Analysis

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Abstract

In the Atlántico Department of Colombia, more than 4000 companies from different industrial sectors are established. However, less than 20% of them are exporting their products, although this department is located in a privileged geographic location that allows easy access to river, sea and air ports. The main objective of this research was to characterize the productive profile of the exporting and non-exporting companies of the Department of the Atlantic to identify their main differences. For this, multivariate statistical analysis was used, specifically the discriminant analysis that allows to find classification functions for each type of company and a discriminant function that summarizes the main differences of the
two populations, based on a series of previously identified variables. As a result of the research, the relevant variables were obtained to compare the two types of companies, an instrument for measuring these variables, the classification functions and the discriminant function. As a central conclusion, it was shown that there are differences in the productive profiles of the exporting and non-exporting companies of the Atlántico Department of Colombia.

**Keywords:** Discriminant Analysis, Exporting Potential, Discriminant Function

1. Introduction

The Colombian government, since the beginning of the economic opening in the 90's, is making a great effort to internationalize the companies of all its industrial subsectors. The Department of Atlántico, due to its privileged geographical position, should be one of the departments with the highest number of exporting companies in the country. However, in spite of the fact that the exporting dynamics of the Department of Atlántico has been increasing with the passing of the years, still the percentage of companies that have managed to incursion in international markets does not exceed 25%. The reason why the effort to internationalize Colombian products continues is because it is estimated that exports can increase the per capita income of Colombians, promote business growth which increases employment and the quality of life of people increasing the competitiveness of the country. Observing that only few companies export, it could be inferred that there are differences in the productive profiles of the exporting and non-exporting companies of the Department of Atlántico. An interesting question is what do exporting companies currently have that non-exporting companies do not have? This question was the one that motivated the development of the present research, in which, through field work and the use of Multivariable Statistical Analysis tools, it was possible to find the main differences in the productive profiles of the exporting and non-exporting companies of the Atlantic Department. In the course of this article, the stages carried out for this purpose will be presented and explained, such as: the identification of the appropriate variables to represent the profile of the companies in the Department of Atlántico, the gathering of information from the experimental units selected in a previous sampling, the construction of discriminatory models, the validation of the models, the analysis of the results and the presentation of the main conclusions.

2. Methodology

Discriminant analysis is a multivariate technique that can be used to generate rules
by which a sector of a population can be classified. The discriminate analysis is similar to the regression analysis, except that the dependent variable is categorical, rather than continuous; with this analysis we seek to predict the belonging to a class of a particular observation, based on a set of predictive variables. This Discriminant analysis has been used in a variety of fields of knowledge, this leads us to think that the application of multivariate statistical tools such as Discriminant Analysis, supported by a reliable group of management indicators of companies that measure their productive profile, applied to populations of exporting and non-exporting companies, can be very useful to identify the main differences that exist between them to finally create new strategies that allow more of our industries to take advantage of the opportunities that the state has to place their products in international markets.

In order to achieve the main objective of this research, which is to construct a discriminatory rule that allows companies with export potential to be classified, it was necessary to develop several phases, which are described below:

2.1 Identification of Variables:

At this stage of the research, the objective was to identify the most relevant variables to measure the export potential of a company. In order to develop this phase of the research, people from different industrial sectors were interviewed who work in entities such as the Chamber of Commerce of Barranquilla, Proexport, Zeyki of the Universidad del Norte, Acopi and ProBarranquilla. In addition, the results of the doctoral thesis of Engineer Alirio Estupiñan Paipa were taken into account, which identified the productivity indicators of the companies in the food sector of Barranquilla and Cartagena, presented at the Third International Latin American and Caribbean Conference on Engineering and Technology (LACCET) "Advances in Engineering and Technology: A Global Perspective", 8-9 June 2005, Cartagena of Indias.

Finally, an exhaustive analysis of each variable was carried out in order to select those that would be used in the project. It was necessary to use those that met 3 fundamental requirements:

1) Universality: that it was relevant for any company of any industrial sector.
2) Significance: that it was related to the export potential of a company.
3) Independence: that was linearly independent of the other selected variables.
The final variables are:

- X1: Percentage of reprocessed units
- X2: Average percentage of raw material wasted monthly
- X3: Percentage of monthly demand met
- X4: Percentage of capacity utilisation of machinery being used in processes
- X5: Percentage of machinery that is "Spell".
- X6: Percentage of machinery less than three years old
- X7: Percentage of machines that are automated
- X8: Percentage of all products returned that are dispatched.
- X9: Percentage of raw material imported
- X10: Average inventory for the month
- X11: Monthly inventory rotation
- X12: Average percentage of invoices generated monthly with inconsistencies
- X13: Percentage of skilled workers within the enterprise
- X14: Average amount of money invested in trainings for your employees
- X15: Percentage of employees for provision of services
- X16: Percentage of direct contract workers
- X17: Percentage of productivity
- X18: Percentage of monthly absences
- X19: Average number of accidents at work per month
- X20: Annual investment in research and development
- X21: Association with another company
- X22: Days of accounts receivable held by the company
- X23: Percentage of indebtedness
- X24: Percentage of raw material recycled
- X25: Percentage of organic products
- X26: SGA Account
- X27: Account with SGC

With these variables a survey was constructed that was applied to 80 companies of different industrial sectors of the Department of Atlántico, where 31 are currently exporters and 49 non-exporters. After carrying out the information survey and processing it through SPSS software using an F-Fisher test, it was found that not all the selected variables are significant, this reduced the number of study variables to 14 that they are:
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Table 1: Significant variables for research

<table>
<thead>
<tr>
<th>Variables</th>
<th>X3</th>
<th>X4</th>
<th>X5</th>
<th>X7</th>
<th>X9</th>
<th>X10</th>
<th>X12</th>
<th>X13</th>
<th>X14</th>
<th>X19</th>
<th>X20</th>
<th>X25</th>
<th>X26</th>
<th>X27</th>
</tr>
</thead>
</table>

Continuing with the analysis of the results, the Box Test for equality of variance-covariance matrices among the populations studied was carried out. The results are presented below:

Table 2: Results of the Box Test for equality of variance-covariance matrices

<table>
<thead>
<tr>
<th>M de Box</th>
<th>447,397</th>
</tr>
</thead>
<tbody>
<tr>
<td>F Aprox.</td>
<td>3,379</td>
</tr>
<tr>
<td>gl1</td>
<td>105</td>
</tr>
<tr>
<td>gl2</td>
<td>12895,810</td>
</tr>
<tr>
<td>Sig.</td>
<td>.000</td>
</tr>
</tbody>
</table>

According to these results, by the value of the $p$-value, it can be inferred that the variance-covariance matrices of the two populations studied are not equal, that is to say that there are significant differences between them. Bearing in mind that if there are significant differences between the two populations studied and that the selected variables have an impact on these differences, a Linear Discriminant Function was constructed for these populations (exporting and non-exporting companies), which is presented below:

$$f(X_i) = 3,918 - 6,569X_1 + 1.188X_4 - 1,610X_5 - 0.140X_7 + 0.506X_9 + 0.000X_{10} + 0.047X_{12} + 0.449X_{13} + 0.000X_{14} + 0.150X_{19} + 0.000X_{20} - 0.190X_{25} + 0.360X_{26} + 1.681X_{27}$$

(1)

Function 1: Linear discriminant function

Analyzing the coefficients of function 1, the following inferences can be made regarding the relationship of the variables used with the populations studied:

The variables use of machinery (X4), percentage of imported raw material (X9), percentage of invoices generated with inconsistencies (X12), percentage of workers trained within the company (X13), work accidents (X19), presence of SGC and SGA, are more related to exporting companies (population 1). And the variables fulfillment of demand (X3), percentage of bewitched machinery (X5), percentage of automated machines (X7), percentage of ecological products (X25), are more related to non-exporting companies (population 2). The variables Average inventory for the month (X10), money invested in employee training (X14) and annual investment in research and development (X20) have a zero coefficient, which
does not support any population despite being significant. However, according to the operation of the Linear Discriminant Rule, if the variable does not help to increase the value of the function, it is supporting the classification in population 2, i.e. non-exporting companies, in this case.

There is statistical evidence to infer that the constructed discriminant rule can be applied to classify companies as exporting or non-exporting, according to the following results:

**Table 3**: Autovalue and Canonical Correlation of the discriminant function

<table>
<thead>
<tr>
<th>Function</th>
<th>Autovalue</th>
<th>% variance</th>
<th>% cumulative</th>
<th>Canonical correlation</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>1,823</td>
<td>100,0</td>
<td>100,0</td>
<td>0.804</td>
</tr>
</tbody>
</table>

**Table 4**: Wilks lambda and chi-square test for discriminant function

<table>
<thead>
<tr>
<th>Contrast of functions</th>
<th>Lambda of Wilks</th>
<th>Chi-square</th>
<th>gl</th>
<th>Sig. p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>0.354</td>
<td>73,682</td>
<td>14</td>
<td>0.000</td>
</tr>
</tbody>
</table>

The canonical correlation of 0.804 indicates that, on average, out of every 100 companies that are classified with the constructed discriminate function, between 80 and 81 of them will be classified correctly, which is good since it can be said that the rule is reliable. Wilks' lambda gives us an idea of how much our rule discriminates can actually discriminate between the two study populations; the closer to zero, the more discrimination power. Our value of 0.354 indicates that our discriminant function is valid. Another indicator of this is the p-value, which must be less than 0.05 for there to be statistical evidence that our function is valid. As you can see our function has a p-value equal to zero.

The summary of this classification is presented below and the summary of the cross validation is included:
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Table 5: Summary of the validation of the original and cross classification of Mahalanobis and Bayes.

<table>
<thead>
<tr>
<th>Group</th>
<th>Predicted membership group</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>Original</td>
<td>1</td>
<td>29</td>
</tr>
<tr>
<td></td>
<td>2</td>
<td>6</td>
</tr>
<tr>
<td>%</td>
<td>1</td>
<td>93,5</td>
</tr>
<tr>
<td></td>
<td>2</td>
<td>12,2</td>
</tr>
<tr>
<td>Cross validation</td>
<td>1</td>
<td>27</td>
</tr>
<tr>
<td></td>
<td>2</td>
<td>8</td>
</tr>
<tr>
<td>%</td>
<td>1</td>
<td>87,1</td>
</tr>
<tr>
<td></td>
<td>2</td>
<td>16,3</td>
</tr>
</tbody>
</table>

2.2 Classification, In Each Of The Categories, Of Experimental Units Using The Classification Functions Obtained

In order to verify the reliability of the results obtained, the discriminant function was validated by resubstitution. Summarizing the results of the validation of the function, we have the following:

Table 6: Summary of discriminant function validation

<table>
<thead>
<tr>
<th>League Table</th>
</tr>
</thead>
<tbody>
<tr>
<td>Corrent Category</td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td>1</td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td>2</td>
</tr>
<tr>
<td></td>
</tr>
</tbody>
</table>

Source: Own construction Based on the results the allocation achieved by the discriminant function

In other words, these functions in general correctly classified 88.75% of the companies surveyed, which indicates that their results are highly reliable and that they can be used to classify companies according to their productive profile as exporters and non-exporters. Or better, and that is the objective of this research, this
function serves us to identify the main differences in the productive profile of the exporting and non-exporting companies of the Department of Atlántico.

3. Conclusions

After concluding the previous investigation and analyzing its results, a series of general conclusions can be reached:

1. The industrial sector of the Department of Atlántico is made up of an important number of companies (more than 4000), mostly SMEs.
2. The subsectors that contribute the most to the department's exports are food, metalworking and petrochemicals, within which plastic is found.
3. In spite of the exporting dynamics of the department that places it in a good position in the Caribbean Region and in the Country, less than 25% of the total of companies participate in these exports.
4. International markets are an attractive source of sales revenue for any company in any industrial sub-sector.
5. In the department there are many attractive products in international markets and exports would expand the markets of industries requiring expansion, which would result in more employment, greater competitiveness of the region and the country and better quality of life for its inhabitants.
6. The country has made an important effort to promote the internationalization of industries in all sectors.
7. The Atlantic is a department in a privileged geographical position that would allow it to take better advantage of the international agreements and treaties signed by Colombia with other countries.
8. There are significant differences between the productive profiles of the few exporting companies and the many non-exporting companies of the Department of Atlántico.
9. The Multivariate Statistical Analysis, specifically the Discriminant Analysis, is a tool that allows the identification of these main differences between the mentioned profiles, with a high reliability in the results.

From the constructed discriminant function, as such it can be concluded that if a currently non-exporting company wanted to become an exporter it should:

1. Implement quality and environmental management systems. This could reduce your errors in procedures, improving the quality of your products and reducing returns. In addition, it could represent cost reductions if an
adequate raw material recycling policy is implemented. Among others, there are many international markets, such as the European one for example, that open more doors to companies that guarantee a minimum environmental impact.

2. Have a policy of investment and technology updating, which could increase productivity, reduce non-conforming products and reduce maintenance costs.

3. Implement, as far as possible, business associativity models with other companies in your sector. This strategy can be important when acquiring bargaining power in the purchase of raw materials. In addition, it is possible to gain greater production capacity and therefore demand fulfillment.

References


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