Global Journal of Enterprise Information System

Innovation Capacity as a Factor that Affects the Competitiveness of Software Industry Jalisco

José Guadalupe Vargas Hernández[1*] and Omar C. Vargas-González[2]

[1]*María José Calle Medrano, Centro Universitario de Ciencias económico administrativas, Universidad de Guadalajara, Núcleo Universitario Los Belenes, Zapopan, Jalisco, México; josevargas@cucea.udg.mx*
[2]*Instituto Tecnológico de Cd. Guzmán; Omarc7@hotmail.com*

Abstract

The aim of this work is to identify analyze an index to measure innovation capacity of enterprises in the software industry of Jalisco, based on a survey of the companies in the Software Center of the State, as well as evaluating the influence that has the capacity for innovation on competitiveness, seeking empirical evidence to answer the question. The main hypothesis for this research is the ability to innovate is a factor that positively affects the performance of companies in the software industry, which is reflected in the competitiveness of sector. The methods used in this research are three: innovativeness index (ICI), Linear Regression Model with OLS and Soft Computing using evolutionary algorithms: FUZZYCESAR, the latter something very new which puts us in the forefront of knowledge in methods it is still.

Keywords: Competitiveness, Software Industry, Innovation

(**Date of Acceptance:** 01-01-2015; **Plagiarism Check Date:** 15-01-2015; **Peer Reviewed by Three editors blindly:** 04-02-2015; **Reviewer's Comment send to author:** 14-02-2015; **Comment Incorporated and Revert by Author:** 23-03-2015; **Send for CRC:** 28-03-2015)

1. Introduction

The economic outlook is forcing companies to rethink their business, because the complexity of the environment is causing a progressive decline of many business models considered valid until recently. In some sectors, innovation has become an essential survival factor. However, still for some companies, especially smaller ones, innovation is synonymous with complexity and ignorance, leading to a sense that is exclusive to large companies. The ability to innovate is a resource of a company like its financial, trade and productive capacities and should be managed in the same manner with the same importance.

Moving towards service economy with high added value and an innovation oriented dynamic industry requires competitive Information and Communication Technologies (ICT) tightly integrated with other economic sectors. In a globalized economy, built by information and knowledge, software is a primary tool for solutions of problems facing industry, academia and government. This is how the software industry offers new opportunities for economic and social development of countries (Secretaria de Economía, 2012).

The Software Industry in Mexico is relatively small and of Little commercial development, based mainly on the production of custom software, standardized software adaptation to the needs of users. This lack of development of production of basic software, systems operating systems and applications, is expressed in the structure of national accounts of Mexico, which has not a section that allows socially account the magnitude of domestic production of such software[7].

In this context, this research aims to analyze the competitiveness of the software industry Jalisco depending on the capacity for innovation. It is intended to determine an index of innovation capacity to analyze and discuss the application of this indicator to a sample of 44 companies of the State of Jaliscoas part of the Center for Software (2012) and likewise interested in evaluating whether firms with greater capacity to innóvate have out performed the market, which is reflected in the sector's competitiveness.

2. Problem Delimitation

The technological advances that have occurred in recent years have generated and promoted many events and series of

*Author for correspondence

processes that many have defined as a new productive industrial revolution[2]. These events mentioned Mochi[7], are related to the emergence of a new stage of capitalist production, which is characterized by the increasing importance of technological innovation and knowledge as a major factor in generating value,a context of economic globalization.

In this context, this research aims to analyze the competitiveness of the software industry of Jalisco depending on thecapacity for innovation. It is intended to determine an index of innovation capacity to analyze and discuss the application of this indicator to a sample of 44 companies of the State of Jalisco as part of the Software Center (2012). Moreover, this research is interested in evaluating whether firms with greater capacity to innóvate have out performed the market, which is reflected in the sector's competitiveness. In this scenario, the Information and Communication Technologies (ICTs) have become very important. This is related to the development and increased use of multifunctional technology: Software. This has generated a major industry, whose keyfields are software engineering and informatic services (SIIS), which have a complex structure and require a great capacity for innovation.

The software industry in Mexico and Jalisco is going through a stage of maturity, which manifests itself in an increase in recent years. In addition, to the generation of active public policies that are aimed at encouraging entrepreneurship and development of existing businesses, the promotionof technology and infrastructure (Secretaria de Economía, 2012). As Mochi[7] argues, opportunities and challenges posed to consolidate the software industry, make clear the need to convene, in order to exploit the advantages offered by this sector, for insertion into the international economy, and development of different sectors of the national economy.

It is important to also consider that Jalisco being the leading producer of embedded software in the country, then it can be said that, as noted by the OECD to Mexico, is still competing in niches with low value added (OECD 2006), low innovation[10] and little expertise. Hence the issues that this research intends to address, which part of some work and international sources out of which it is possible to draw a number of elements to determine an index to measure the innovativeness of a representative group of the software industry in Jalisco in order to study this as afactor affecting performance companies in the sector, reflected on competitiveness.

3. Research Question

Does the ability to innóvate is a factor affecting the performance of companies in the software industry Jalisco, making the sector competitive?

4. Justification of Research

Due to the increasing international competition and the integration of technological advances, companies have had to adapt to technological changes in order to compete in the market. Likewise, they require efficient and adequate resources and therefore create capabilities as relevant to recognize the potential of innovation and adapt to the needs of companies, allowing them to differentiate themselves from their rivals and becoming more competitive. It is contradictory that despite the importance and rapid growth of the software industry worldwide, there is relatively little scholarship on the topic, although there is a lot of work studying forms of competence, the dynamics of innovation among others, in branches such as automotive, chemistry, computing, but few that do the same in the industry[7] software.

The ability to innovate today is a relatively a new concept that is considered very important when talking about competitiveness either a company, industry or country. Given this scenario and considering the paucity of literature on this subject, this research aims to analyze the innovation capacity of Jalisco´s software companies and the incidence of the competitiveness of the sector through market performance. The importance of research also lies in the methodological proposal made to analyze this situation, as it aims to define an Innovation Capability Index of business and industry, likewise to analyze the correlation between this index with recorded sales on the last period applying econometrics and soft computing. This is a totally new method to analyze such situations.

5. Research Hypothesis

To define the assumptions on which research will be addressed, then the variables are described.

5.1 Definition of Variables

Independent variable(X0): X0=Ability to innovate
Dependent variable: (Y0): Y0=Competitiveness of the software industry Jalisco (Table 1).

Table 1. Overview of research variables

VARIABLES	DESCRIPTION	INDICATORS
X_0	Innovationcapacity	X_1: Innovation Capacity Index (ICI)
Y_0	Competitiveness	Y_1: Sales

Source: Own elaboration.

GJEIS | Print ISSN: 0975-153X | Online ISSN: 0975-1432

5.2 General Hypothesis

H0: X0 → Y0

H0: The ability to innovate is one factor that positively affects the performance of companies in the software industry, which is reflected in the sector's competitiveness. Whereas Innovation Capacity Index is composed of three factors as described in Table 2.

5.3 Secondary Hypotheses

$$H_1: X_{F1} \rightarrow Y_1$$

$$H_2: X_{F2} \rightarrow Y_1$$

$$H_3: X_{F3} \rightarrow Y_1$$

1) H1: The ability to innovate in terms of capacity positively affects sales.
2) H2: The ability to innovate in terms of product innovation positively affects sales.
3) H3: The ability to innovate in terms of knowledge circulation positively affects sales.

6. Research Objectives

Raised in the directions described above, the objectives are described below.

6.1 General Purpose

To analyze the competitiveness of the software industry Jalisco depending on the innovativeness of the companies that comprise it.

6.2 Specific Objectives

Determine the Innovation Index of Jalisco software industry.

Analyze sales companies in the software industry of Jalisco, according to the Innovation Index.

Analyze sales companies in the software industry Jalisco, depending on the factors of the Innovation Index.

7. Scope

This research is a descriptive type, which intends to describe the behavior of sales, depending on the innovativeness of software companies Jalisco during the last period for which it has been used secondary sources.

8. Research Methods

8.1 Description of the Investigation

According to the objectives, the methodological procedure proposed is aimed at determining an index of innovation capacity to assess the situation of the sector taking a sample of 44 companies. Subsequently, it is analyzed as an independent variable in a model that seeks to find its relation to sales, using for this three methods:

1) Innovation Capacity Index (ICI)
2) Regression econometric.
3) Fuzzy logic and evolutionary algorithms.

To determine the Index of Capacity for Innovation (ICI), factors differentiating between those associated with the development of skills, the innovative product and circulation of knowledge, some primary sources were used by an instrument applied to 44 companies Software Center of Jalisco, see Annex A.

8.2 Type of Research

Following the methodology of Hernández, Fernández & Bapista[6], there are exploratory descriptive, correlational and explanatory studies.

This research is a descriptive with a quantitative approach because data is collected or components on different indicators that measure the ability to innovate and their impact on competitiveness and performance of companies that make up the sector to be studied. To explain the behavior of the sector, it is considered the sales of the last period. The descriptive research seeks to specify properties, characteristics and important features of any phenomenon to be analyzed (Hernandez et al., 2003, p. 119). Descriptive studies measure more independently rather concepts or variables to which they relate and focus on measure as

Table 2. Factors of independent variable

VARIABLES	DESCRIPCIÓN	INDICADORES	DIMENSIONES
X_0	Innovationcapacity	X1:InnovationCapacityIndex	X_{F1}:Capacity development X_{F2}: Product innovation X_{F3}:Knowledgecirculation

Source: Own elaboration base on Yoguel y Boscherini[14].
Three secondary hypotheses are also proposed:

accurately as possible (Hernandez et al, 2003).Also, the study has a quantitative approach, since it is necessary to analyze the results and to use the proposed methods.

8.3 Research Design

Through research, it will be obtained the necessary and required information to accept or reject the hypothesis. This research is non-experimental, transactional and of a descriptive type. It is not experimental also because the variables cannot be manipulated and data gathering will be obtained from primary sources. Since in a non-experimental study builds no situation but existing situations are observed not intentionally provoked (Hernandez et al., 2003). Descriptive transactional designs aim to investigate the incidence and values that are manifested one or more variables within the quantitative approach. The procedure is to measure or locate a group of people, objects, situations, contexts, and phenomena in a variable or concept and provide a description (Hernandez et al., 2003).

The methods to be used in this research are described.

8.3.1 Index Innovativeness

To test the hypotheses, it will apply the proposed Yoguel and Boscherini[14] model, with a total of three factors of the innovation capacity index:

a. Capacity building
b. Innovative product
c. Circulation of knowledge

Getting information through a detailed survey of enterprises of Software Center and a wide range of internal and external factorshas contributed to the research.

8.3.2 Multiple Regression Analysis

The technique of multiple regression analysis is more suitable for a ceteris paribus analysis because it allows explicit control many other factors that affect the dependent variable. This is important both to test economic theories as to evaluate the effects of a policy when it is necessary to rely on non-experimental data. Because multiple regression models can accept several explanatory variables that may be correlated, can be expected to infer causality in cases where the simple regression could not give good results[12].

8.3.3 Fuzzy Logic and Evolutionary Algorithms (FuzzyCsar)

Current technology has enabled the industry to collect and store large amounts of information. This information is a key factor for company processes and is invaluable for making business decisions. This need for modeling the behavior of the variables can be formalized with a database of transactions T that contains a set of transactions{t1, t2,. .., Tn} where each transaction tk contains a set of ítems (which is commonly known as a set of elements), and is a collection of elements{i1, i2,. .,Im}. The overall objectiveis to find interesting patterns, associations, correlations or causal structures among sets of items.

These relationships are put in terms of association rules. An association rule is an affirmation X→ Y, where X and Y are disjoint sets of elements. This type of modeling, using rules, has the advantage of being readable without losing generalization[11].

8.4 Knowledge Representation

Fuzzy-Csar evolves a population of association rules, generally referred to as classifiers. At the end of the learning process, the population is expected to capture the strongest and most relevant associations between variables. The user sets the maximum size of the population. This maximum sets an upper limit on the number of relevant associations that can be found, i.e. the maximum, the system will be able to discover as many relevant relationships as the number of classifiers in the population.

Each classifier is a fuzzy rule association and a set of parameters. The fuzzy association rule is represented as: if xi is Ai and... and Xj is Aj then xc is Ac, where the antecedent contains Là input variables xi, ..., xj and the result is a single variable xc is not present in the antecedent. In presenting this study, each variable is represented by a linguistic term or label Ai, which can be user defined. This structure allows a number of variables to be background, but requires only one variable as a result. With this strategy, the researcher can search for sets of variables with certain values that make other variable to occur. Rules therefore can be interpreted as a causal relationship between certain values of the variables in antecedent (s) and certain values of the consequent variable.

Besides its own association rule, each classifier has two main parameters, the support and confidence.

i. Support:is an indicator of thefrequency of the rule.
ii. Confidence indicates the strength of the association

The Fuzzy-CSAR system is designed to find rules with high support (i.e., rules that indicates relationship that can be found frequently), and high confidence(i.e., the rules under which the values of the variables in the antecedent determine the value of the variable in the consequent).

Caesar Fuzzy learning scheme continues to evolve a population of highly relevant standards, from a population of vacuum and learning new training examples as shown. More specifically, the system receives a new training example at each iteration of learning, and then takes a series of measures. First, the system

creates a whole party[M] with all classifiers in the population that match the input example with greater than 0. If [M] does not contain sufficient classifiers, covering the operator is activated to create new classifiers. So classifiers[M] are organized together the candidates of the association.

Each set of candidates association is given a selection probability proportional to the confidence of the average of classifiers that belong to this set of associations. The selected set of association [A] goes through a process of subsumption that aims to reduce the number of rules that express similar relationships between variables. Then, the parameters of all the classifiers in [M] are updated according to information provided by the current instance. At the end of the iteration, a genetic algorithm is applied to [A] to discover promising new rules. This process is repeatedly applied to update the parameters of existing classifiers and create new promising rules[9].

8.5 Model Specification

In this section it is described the model and the methodology used in research, in order to validate the hypotheses that will be described in detail:

1) H0: The ability to innovate is one factor that positively affects the performance of companies in the software industry, which is reflected in the sector's competitiveness.
2) H1: The ability to innovate in terms of capacity positively affects sales.
3) H2: The ability to innovate in terms of product innovation positively affects sales.
4) H3: The ability to innovate in terms of knowledge circulation positively impact on sales.

8.5.1 Hypothetical Model

With the assumptions and the revised theory it was posed a hypothetical model to be validated in this chapter. So it is important to consider the composition of the variables under analysis that it was developed:

a. Dependent variable: Competitiveness
b. Independent variable: Innovation Capacity

The indicators of both variables are:

a. Competitiveness sales
b. Capacity for innovation: Innovation Capacity Index

It is very important to note that the Innovation Capacity Index is composed of three factors:

a. Capacity building
b. Innovative product
c. Circulation of knowledge

Out of these factors, the following hypothetical model is developed, where it can be seen graphically in Figure 1 the relationship between the variables and hypotheses:

8.6 Operationalization of Variables

Depending on the hypothetical model described, with the purpose to meet the objectives and contrasting hypotheses, then the operationalization of variables, which is the starting point to use the methodology proposed research, is presented in Table 3.

8.6.1 Independent Variable

The variable used in this study as described in Table 3 is the ability to innóvate in the sector, a variable that is measured by an index of innovative capacity, which depends on three factors(Capacity Development, Product Innovation and Circulation of Knowledge) that were operationalized as shown in Table 3. Data obtained from the survey applied to the sample, basically covering eight questions to be described later, all this for the rate of innovation capacity of the sector.

8.6.2 Dependent Variable

The data obtained in the survey competitiveness applied to the sample basically encompass a question that relates to the sales recorded last period. This indicator of competitiveness and performance of the sector is key to analyze the influence of the Capacity to Innovate on them.

8.7 Methodological Instrument

The methodological instrument used for this research is a survey that is part of the research project of Francisco Raul Leonel de Cervantes Orozco of the Master of Business and Economic

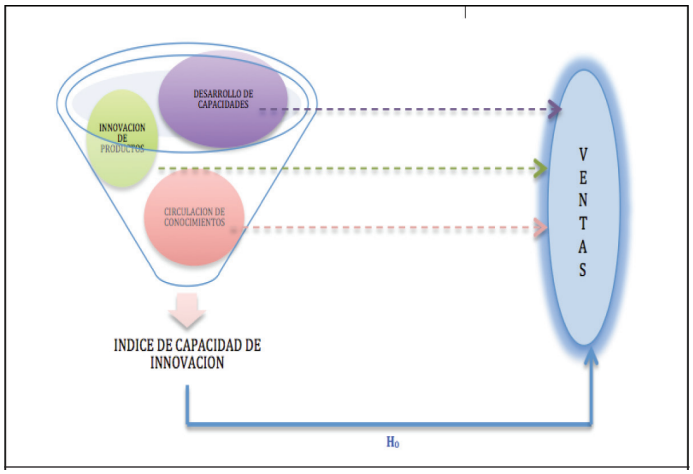


Figure 1. Hyphotetical model proposal.
Source: Authors.

Table 3. Operationalizing variables

VARIABLES	DESCRIPTION	INDICATORS	DIMENSIONS	OPERACIONALIzZATION
X_0	Abilitytoinnovate	X_1: Innovation Capacity Index (ICI)	X_{F1}:Capacitybuilding	Capacity
				Quality
				Linking
				Development
			X_{F2}:Productinnovation	Productdevelopment
				Modifications
				Tecnologicalconversion
			X_{F3}:Circulation of knowledge	Sharing
				Training
Y_0	Competitiveness	Y_1: Sales	Y_1: Sales	Annual sales

Source: Authors.

Studies through support from Institute Jalisciencie of Information Technology (IJALTI) in collaboration with the IDIT SMEs. It was applied during the first half of 2012 to 44 of 52 companies that make up the Software Center of the central state of Jalisco.

The survey consists of ten sections:

1) Data respondent
2) Company Information
3) Information of company founder
4) Type of business
5) Park services where it is located
6) The company in the Cluster Software
7) Learning Activities Company
8) Innovation
9) Quality
10) Interactions with other local associations

It is therefore very important to clarify that for purposes of this research, it is based on this instrument and the information gathered. Thus, it could be said that it is working with secondary sources.

8.7.1 Innovation Capacity Index

As part of the research design and to fulfill the objectives and validate the hypotheses, the first section of the methodology is to estimate an index for obtaining a proxy value of the ability to innovate. The applied model was proposed by Yoguel G, et al[14]. This model was described in the theoretical framework in detail. To apply the model, it was revised and selected information obtained in the database that was used for research. The questions used to measure the variables of the factors that make up the index of ability to innovate, are described below and will have the same assigned weights proposed by Yoguel G, et al[14].

On Table 5, it is shown how the information obtained from the database for purposes of the investigation will be treated. It is important to mention that to implement the proposed model and to quantify the variables to be studied, an adjustment was made to the responses.It passed from a Likert scale to binary, as for the calculation in this research is not relevant,the intensity of the answers, just the affirmation or denial of these.For example in question 23 of the questionnaire it asks: "Assess the importance of governmental and public factors for business location in the cluster (training and research programs)".

The possible answers are:

a) Very important
b) Important
c) Unimportant
d) Nothing important
e) No answer

As mentioned, the Likert scale for purposes of this investigation is irrelevant. Therefore all those options that represent an affirmation, in this case about the importance of factors of governmental and public for the location of the company in the cluster, will be taken as a positive response. So the value of 1 is assigned as shown in Table 5 where 1 is assigned to the first three options: Very Important, Important and Unimportant. Under the same criterion is assigned a value of zero to the latter two options: Nothing important and unresponsive, since for purposes of this investigation will be assumed as a denial to the question (Table 4).

For the other two dimensions, it was used the same described criteria, in Table 6 and 7, it is observed the details of questions, responses and weighting assigned. With everything described in this section can be applied when calculating the Innovation Capacity Index(ICI), using the following formula:

$$ICI = \frac{\sum_{i=1}^{i=k} fi * \alpha i}{\sum_{i=1}^{i=k} fi}$$

Table 4. Weights assigned to factors that make ICI

No. question	Question	Variable	Weight
SKILLS DEVELOPMENT			0.77
23	Evaluate the importance of governmental and public factors for business location in the cluster[training and research programs]	Training	0.25
34	Do you have any quality certification?	Quality	0.25
23	Evaluate the importance of governmental and public of factors for business location in the cluster[Linking with universities and research centers]	Bonding	0.2
7	Weight of project leaders	Development	0.07
INNOVATIVE PRODUCT			0.08
28	Innovation Product/ Service[Development of new products/services]	Product development	0.027
28	Innovation of product / service [Amendments product design / existing services]	Modifications	0.027
28	Innovation of product / service [Conversion technology products / services (versions for new platforms)]	Conversion Technology	0.027
KNOWLEDGE CIRCULATION			0.15
37	Did you do any of the following activities with others in the industry? [Share training]	Share Training	0.15

Source: Author.

Table 5. Questions to assess skills development

SKILLS DEVELOPMENT		
TRAINING		
23. Evaluate the importance of governmental and public factors for business location in the cluster [training and research programs]		
VARIABLE	ANSWER	WEIGHT
Very important	1	0.25
Important	1	
Unimportant	1	
Nothing important	0	
No answer	0	
QUALITY		
34. Do you have any quality certification?		
VARIABLE	RESPUESTA	PONDERACION
yES	1	0.25
No	0	
No answer	0	
LINKING		
23. Evaluate the importance of governmental and public factors for business location in the cluster [Linking with universities and research centers].		
VARIABLE	RESPUESTA	PONDERACION
Veryimportant	1	0.2
Important	1	
Unimportant	1	
Nothing important	0	
No answer	0	
7.Weight Project leaders		
VARIABLE	RESPONSE	WEIGHTING
Yes	1	0.07
No	0	
No answer	0	

Source: Author.

Where:

ICI=Innovation Capacity Index

αi=weighting assigned to each other

fi=Factors components of the ICI

It is very important to mention that with this model, it is possible to obtain an ICI factor and for the enterprise, which facilitates the analysis. Therefore one should consider that:

$$ICI_{TOTAL} = ICI_{DC} + ICI_{INN} + ICI_{CC}$$

Where:

ICI_{TOTAL}=Total capacity innovation index

ICI_{DC}= Innovation capacity index Development

ICI_{INN}= Innovation capacity index of product innovation

ICI_{CC}= Innovation capacity index pf knowledge circulation

8.8 Econometric Model

Through multivariate linear regression (MRLS) to explain the behavior of sales, endogenous variable or dependent variable, (and shown with VTAS) based on the total capacity index innovation through linear dependence relation:

Table 6. Questions to evaluate innovative product

INNOVATIVE PRODUCT		
PRODUCT DEVELOPMENT		
28. Poduct innovation / service [Development of new products / services]		
VARIABLE	RESPONSE	WEIGHTING
Very important	1	0.03
Important	1	
Unimportant	1	
Nothing important	0	
No answer	0	
MODIFICATIONS		
28.Innovation of product / service [Modifications of product development / services already existing]		
VARIABLE	RESPUESTA	PONDERACION
Very important	1	0.03
Important	1	
Unimportant	1	
Nothing important	0	
No answer	0	
TECNOLOGY CONVERSION		
28. Product to innovation / service [Technology on version of products / services (versions for new platforms)]		
VARIABLE	RESPUESTA	PONDERACION
Very Important	1	0.03
Important	1	
Unimportante	1	
Nothing Important	0	
No answer	0	

Source: Author

Table 7. Questions to evaluate knowledge circulation

KNOWLEDGE CIRCULATION		
SHARE TRAINING		
37. Did you do any of the following activities with others in the industry? [Share training]		
VARIABLE	RESPONSE	WEIGHTING
Yes	1	0.15
No	0	
No answer	0	

Source: Author.

$$VTAS = \beta_! + \beta_2 ICI + \mu$$

Being the term of disturbance or error.

The goal is to assign numerical values to the parameters. That is, estimating the model so that the fitted values of the endogenous variable result as close to the actually observed values as possible, all with the purpose of validating the General Hypothesis raised in the investigation. A model of multiple linear regression (MRLM) is also raised to explain the behavior of sales, endogenous variable or dependent variable,(and shown with VTAS) depending on the rate of innovation capacity of the factors to be analyzed (Development capacity, Product Innovation and Knowledge Circulation) which together are equal to the total ICI.

$$VTAS = \beta_! + \beta_2 CI_{DC} + \beta_3 ICI_{INN} + \beta_4 ICI_{CC} + \mu$$

μ being the term of disturbance or error.

This model is proposed in order to test the secondary hypotheses proposed on the research.

8.9 Fuzzy Csar

Fuzzy-Csaris an evolutionary method of unsupervised learning, and aims to uncover information patterns of interest that besides are reliable. Fuzzy-Csarisable to work without a priori information abou tthe relationships between variables processing. Thus, the search process is not driven by a relational reference structure (e.g. a model), and this feature provides clear benefits when Fuzzy Caesar applies to new, unusual scenarios decision, such as the research to have a database of low quality[9]. It was applied the method to the results of the composition of ICI shown in Table 8, obtaining 34 rules that were selected according to their level of confidence filtering rules that have utmost confidence, i.e.1.0 (or 100%) discarding the rest. This means that the rules have great quality.

9. Analysis of Results

In this section it is also shown and discussed the results of the research tools used for hypothesis testing.

9.1 Innovativeness Index

The ICI is a value between 0 and 1, which can be interpreted in percentage terms, with the main assumption that 1 would mean to meet all the factors that theoretically enhance the innovation capacity of an enterprise; conversely 0 would mean not having any element that encourages innovation capacity of the company. In Table 8 below, the composition of the ICI sector is observed, being the average value 0.53, indicating that companies representing the industry in this investigation are in average levels of innovativeness.

Table 8. Composition of Innovation Capacity Index

VARIABLE	DESARROLLO DE COMPETENCIAS				PRODUCTO INNOVATIVO			CIRCULACION DE CONOCIMIENTO	ICI
	CAPACITACION	CALIDAD	VINCULACION	DESARROLLO	DESARROLLO DE PRODUCTOS	MODIFICACIONES	CONVERSION TECNOLÓGICA	COMPARTIR CAPACITACION	
PROMEDIO	0.61	0.20	0.52	0.93	0.93	0.91	0.89	0.55	0.53

Source: Authors.

It is shown in Table 9, that the factor value training in skills development is above average, i.e. 0.61, indicating that companies in the sector have a skill level above the average regarded as ideal, i.e. that the company gives some importance to training, which is reflected in the ability to innovate, as this is one of the factors with greater weight given by the authors of the model, due to its importance. Also the value of the quality factor obtained an ICI is well below average with 0.20, which means that only 20% of companies have a quality certification, showing the great potential for improvement in this aspect, since the quality represents a very important factor to compete and find a good market performance factor.

The third factor in which consist the skills development is the linking that refers to the importance of governmental and public factors for business location in the Cluster referring to the links with universities and research centers. The value obtained is 0.52, indicating that more than half of the companies give importance to the cluster as this creates ties linking the company with academia and research centers. Finally, among the factors that make up skills development is development that refers to the number of employees assigned to be project leaders, obtaining a value of 0.93 that is near perfect as almost all companies have staff trained to lead projects.

As regards innovative products, three aspects were considered: product development, modification and conversion technologies, evaluating three questions to the instrument and obtaining an average value of 0.91, indicating that it is a sector with great propensity to innovate but that is probably not reflected on its ability to innovate by factors such as lack of quality standards or linkage with other agents of the ecosystem. The value obtained in the circulation of knowledge factor was 0.55, which reflects that over 50% of companies have shared some activity where knowledge is shared, e.g. personnel training, which in the case of the sample to which it was applied the survey at the business of the SoftwareCenter, it can guess that this bonding most prone occurs when companies are physically located in one place, with all this positive innovation capacity.

In Table 10, it is observed the breakdown of the results of both the ICI total and of its components and the sales reported by each ofthe noted surveyed companies. This information is the starting point for the application and analysis of the other two tolos proposals.

9.2 Econometric Model

Consistent with the research questions and hypotheses, an econometric model of cross-sectional Ordinary Least Squares (OLS) was used to analyze the incidence of ICI and its components sales of the last period, the latter as an indicator of competitiveness. In Table 10, the results of the first regression performed are observed, considering only the total ICI.

The modelis simplified in the following equation:

$$VTAS = 3.51 + 10.15\,ICI + \mu$$

There is a positive relationship between ICI and total sales for the period, in Annex A where it is observed evidenceof validity of the model. It is also identified that the models are not statistically significant because of the absence of control variables are detailed, but for purposes of research and objectives, it is enough to see the positive relationship between these variables. So it can be deduced that the ICI overall is related to a positive impact on sales. In Table 11, the multiple regression model between the components of the total ICI and sales, where a positive relationship ICI capacity, circulation of knowledge and sales is observed, but a negative relationship with ICI of innovative product explains why most companies have made a breakthrough in the pastperiod, which means they are still in a learning stage that has not been capitalized at all, and it would be interesting to track this behavior.

10. Fuzzy Csar

As part of the proposed methodology and to test the hypotheses, a relatively new method in this type of research is applied: soft computing, the algorithm FUZZY CSAR, the most interesting thing about this, is the processing of data, they do not need comply with any predetermined structure, which makes it very useful for working database of low quality, as in the case of the database that was used in this research, as the instrument from which the information was obtained, it was not designed for the purposes of this investigation.

This is one of the main problems that was detected when analyzing the econometric regressions described in the previous section, since the lack of control variables, the models are biased and not statistically significant.

The algorithm FUZZY CSAR was processed with the data of Table 11, obtaining rules with different levels of trust and support.

Table 9. Results of Innovation Capacity Index

ID	ANNUAL SALES	ICI CAPABILITIES DEVELOPMENT	ICI PRODUCT INNOVATION	ICI KNOWLEDGE INNOVATION	ICI TOTAL
1	$500,001 a $1,000,000	0.32	0.08	0.00	0.40
2	$1,000,001 a $5,000,000	0.07	0.08	0.00	0.15
3	$10,000,001 a $20,000,000	0.52	0.08	0.00	0.60
4	$500,001 a $1,000,000	0.32	0.08	0.15	0.55
5	$1,000,001 a $5,000,000	0.52	0.08	0.15	0.75
6	$500,001 a $1,000,000	0.52	0.08	0.00	0.60
7	Menos de $500,000	0.77	0.08	0.00	0.85
8	$10,000,001 a $20,000,000	0.07	0.08	0.15	0.30
9	$10,000,001 a $20,000,000	0.77	0.08	0.15	1.00
10	$20,000,001 a $40,000,000	0.77	0.08	0.15	1.00
11	$10,000,001 a $20,000,000	0.77	0.08	0.15	1.00
12	$10,000,001 a $20,000,000	0.32	0.08	0.15	0.55
13	$1,000,001 a $5,000,000	0.52	0.08	0.15	0.75
14	Menos de $500,000	0.07	0.00	0.00	0.07
15	$1,000,001 a $5,000,000	0.07	0.08	0.00	0.15
16	$1,000,001 a $5,000,000	0.07	0.08	0.00	0.15
17	$5,000,001 a $10,000,000	0.32	0.08	0.15	0.55
18	No sabe	0.52	0.08	0.15	0.75
19	$1,000,001 a $5,000,000	0.07	0.05	0.00	0.12
20	$20,000,001 a $40,000,000	0.52	0.08	0.15	0.75
21	$5,000,001 a $10,000,000	0.52	0.08	0.00	0.60
22	$5,000,001 a $10,000,000	0.00	0.00	0.00	0.00
23	$1,000,001 a $5,000,000	0.52	0.08	0.15	0.75
24	$10,000,001 a $20,000,000	0.07	0.05	0.15	0.27
25	$10,000,001 a $20,000,000	0.52	0.08	0.15	0.75
26	$5,000,001 a $10,000,000	0.77	0.08	0.15	1.00
27	$1,000,001 a $5,000,000	0.07	0.08	0.15	0.30
28	No sabe	0.00	0.05	0.00	0.05
29	$1,000,001 a $5,000,000	0.52	0.08	0.00	0.60
30	No sabe	0.07	0.08	0.00	0.15
31	$500,001 a $1,000,000	0.52	0.08	0.15	0.75
32	$20,000,001 a $40,000,000	0.07	0.08	0.00	0.15
33	$5,000,001 a $10,000,000	0.52	0.08	0.15	0.75
34	$10,000,001 a $20,000,000	0.52	0.08	0.15	0.75
35	$1,000,001 a $5,000,000	0.25	0.00	0.00	0.25
36	Menos de $500,000	0.52	0.08	0.00	0.60
37	$500,001 a $1,000,000	0.07	0.08	0.15	0.30
38	$5,000,001 a $10,000,000	0.07	0.08	0.15	0.30
39	$1,000,001 a $5,000,000	0.52	0.08	0.00	0.60
40	$1,000,001 a $5,000,000	0.52	0.08	0.15	0.75
41	$1,000,001 a $5,000,000	0.57	0.08	0.00	0.65
42	$5,000,001 a $10,000,000	0.07	0.08	0.15	0.30
43	Más de $40,000,000	0.77	0.08	0.15	1.00
44	No sabe	0.52	0.08	0.00	0.60
		0.37	0.07	0.08	0.53

Source: Author.

Table 10. Results simple regression

View | Proc | Object | Print | Name | Freeze | Estimate | Forecast | Stats | Resids

Dependent Variable: VTAS
Method: Least Squares
Date: 01/14/13 Time: 14:06
Sample: 1 40
Included observations: 40

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	3.159274	3.115578	1.014025	0.3170
ICI	10.15104	5.065863	2.003812	0.0523

R-squared	0.095567	Mean dependent var	8.668750
Adjusted R-squared	0.071766	S.D. dependent var	9.618923
S.E. of regression	9.267342	Akaike info criterion	7.339577
Sum squared resid	3263.578	Schwarz criterion	7.424021
Log likelihood	-144.7915	F-statistic	4.015263
Durbin-Watson stat	1.820361	Prob(F-statistic)	0.052257

Source: Authors.

Table 11. Results of multiple regression

View | Proc | Object | Print | Name | Freeze | Estimate | Forecast | Stats | Resids

Dependent Variable: VTAS
Method: Least Squares
Date: 01/14/13 Time: 14:09
Sample: 1 40
Included observations: 40

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	3.576597	5.150791	0.694378	0.4919
ICI_CAP	7.322074	6.327346	1.157211	0.2548
ICI_CON	37.01114	21.13474	1.751199	0.0884
ICI_INN	-12.57564	76.73376	-0.163887	0.8707

R-squared	0.136928	Mean dependent var	8.668750
Adjusted R-squared	0.065005	S.D. dependent var	9.618923
S.E. of regression	9.301030	Akaike info criterion	7.392767
Sum squared resid	3114.330	Schwarz criterion	7.561655
Log likelihood	-143.8553	F-statistic	1.903819
Durbin-Watson stat	1.912232	Prob(F-statistic)	0.146427

Source: Authors.

There were selected 34 filtering out those that had a maximum level of confidence. To precede the analysis of these rules, are considered only those that include all the variables studied in the research. In Table 12 are observed the rules that were selected for analysis of the behavior of the variables.

To evaluate the behavior of the variables, they were assigned labels with eight different fuzzy values {Tiny, Very Small, Small, Medium-Small, Medium-large, large, very large, Immense}. It is very important to mention that the algorithm considers the behavior of the variables as antecedents and consequents, which is very interesting because it allows analyzing their behavior from different perspectives. Following is the interpretation of the rules to be analyzed, considering those that besides having high expectations have the greatest support. It was the last filter applied to the results, leaving only the 4 rules of Table 12, rules 1, 2, 3and 6:

1) If ICI Capacity Development is{VerySmall} and{ICI_ CirculationKnowledgeis {Tiny} and ICI_Innovación Product is {Tiny} ->{Annual sales are less than 500,000}
2) If annual sales are {less than 500,000 and ICI Capacity develop-mentis {very small} and ICI_Knowledge Circulation is {Tiny} ->and ICI_Innovation Productis {Tiny}
3) If annual sales are {5,000.001 to 10,000,000} and ICI_ Capacity Development is{VerySmall} and ICI Product innovation is{Immense} ICI_ Knowledge Circulation is{Immense}
4) If annual sales are {1,000,001 to 5,000,000} and ICI Capacity development is {Large} ->ICI Product innovation is{Immense}ICI_KnowledgeCirculation} is {Immense}

These results it can be contrasted the hypotheses, since it is evident that there is a direct and also positive relationship between the variables that make up the ICI and total sales for the period, as it is observed that when ICI's are "Very small "or" tiny "less sales and vice versa are recorded, so the hypotheses are tested.

Table 12. Rules FUZZY CSAR

NO.	SALES	ICI_DES_CAP	ICI_CIR_CON	ICI_INN	Support	Trust
1	menos de 500,000	Verysmall	Tiny	Tiny	0.014	1
2	menos de 500,000	Verysmall	Tiny	Tiny	0.014	1
3	5,000,001 a 10,000,000	Verysmall	Inmense	Inmense	0.029	1
4	5,000,001 a 10,000,000	Tiny	Tiny	Tiny	0.023	1
5	5,000,001 a 10,000,000	Medium-small	Inmense	Inmense	0.021	1
6	1,000,001 a 5,000,000	Large	Inmense	Inmense	0.066	1
7	1,000,001 a 5,000,000	Large	Tiny	Inmense-medium	0.052	1
8	1,000,001 a 5,000,000	Tiny	Tiny	Large	0.005	1

Source: Authors

11. Conclusions

The existence of a positive association between the development of innovation capacity of agents and sales reported last period (2011) of the same can be confirmed from the panel of firms analyzed. From this, it became clear to make and implement the proposed two methods, the econometric model and the evolutionary algorithm. Also, it can be concluded that the sector has a Capacity Index of 0.53 which means that about half this, having a great potential to improve especially in terms of quality and circulation of knowledge at the time when linked as it is where they had the lowest values to apply the model to calculate the ICI values. Without this, innovation is not given; hence its ability to innovate is low and the sector less competitive, to have a lower market performance.

On the other handit can be concluded that there is a direct relationship between total ICI and its components with sales, which accepts the hypotheses development. Therefore, it states that the ability to innóvate is one factor that positively affects the performance of companies in the software industry, which is reflected in the sector's competitiveness. In addition to the ability to innóvate in terms of capacity, circulation of knowledge and product innovation positively affects sales but often because of product innovationdoes not reflect an increase in immediate sales due to the stage in which the product lifecycle is found.

It is important to compare the obtained results with empiricalwork done before, where it coincides with the incidence of ICI on competitiveness, this being positive. This relationship was obtained in samples of companies from different countries in different situations, which gives a pattern behavior that can be the starting point for future research. Among the main findings is the lack of attention from companies in the industry in quality, being one of the most important factors when measuring the ability to innóvate and seek competitiveness. On the other hand it was identified that the circulation of knowledge is regular so to speak as the value obtained was around average, despite being companies that are locatedin the same place geographically which should encourage this and not is occurring.

On the otherside, it was evident that mostcompanies have innovated in the last period, which when related to sales was a negative impact, which is explained by the stage of the life cycle of the product and sounds logical that's not generating sales growth if it is in early stages. This point is important so that it can modify or propose public policies that encourage innovation. The contributions of this research are divided into two aspects: First from the perspective of the results and findings described, it becomes evident that factors such as innovation increasingly are gaining importance in the new global competitive scheme, which is important to consider when raising or proposing business strategies in search of a good market performance in the software industry.

On the other hand, the second aspect is from the perspective of academic contribution it intends to apply new methods for the treatment of data from low quality sources, especially when not relying on primary sources such is the case of this research. Where sofa was used, it was computed by evolutionary computing algorithms to assess behavior variables supported by pure statistics and obtaining interesting results.Among the major implications, the results may be grounds for creating or modifying public policies that encourage innovation in this type of technology-based sectors, as well as promoting the involvement of industry, academia and government to achieve levels best competitiveness.

Likewise future research that can define more specifically the behavior of external factors regarding the ability to innóvate in different sectors to establish patterns of behavior are proposed. Among the main limitations of this research it was Access to information so they had to rely ons econdary sources from an instrument that was not designed for the specific purposes of research, which gives some uncertainty as to the accuracy results. Another limitation was thetime and resources available.

12. References

1. Centro de Software. Somos. Recuperado de. 2012. Available from http://www.centrodelsoftware.com.mx/somos.aspx
2. Dabat A. Globalización, capitalismo actual y nueva configuración espacial del mundo. Citado en: Basave, J., Globalización y alternativas incluyentes para el siglo XXI. México, Instituto de Investigaciones Económicas, UNAM, Porrúa. 2002.
3. Gujarati D. Econometría. McGraw-Hill; México: 2003.
4. Hamel G, Prahalad C. Competing for the future. Harvard Business Review. 1994; 72(4):112–28.
5. Hedberg G. How Organizations Learn and Unlearn. Handbook of Organizational Design. Oxford University Press; 1981.
6. Hernández, F, Baptista. Metodología de la Investigación. 3rd ed. Mc Graw-Hill; México: 2003.
7. Mochi P. La industria del software en México en el contexto internacional y latinoamericano. UNAM; México: 2006.
8. OCDE. Organization for Economic Cooperation and Development. The IT Industry: Recent developments and Outlook, en Information Technology Outlook, OCDE. 2006.
9. Orriols, Martínez, Casillas, Nick. 2012. A soft-computing-based method for the automatic discovery of fuzzy rules in databases: Uses for academic research and management support in marketing. Journal of Business Research. 2006; JBR-07502:1–6.
10. Rodríguez OA. La capacidad exportadora de las PYMES de software en la ZMG, Tesis para obtener el grado de Maestro en Negocios y Estudios Económicos. Universidad de Guadalajara. 2010.

11. Sancho A. Association Rules, Universidad Ramon LLull. 2011.
12. Wooldridge J. Introducción a la Econometría: un Enfoque Moderno. 4th ed. Estados Unidos de América, Ed. Cengage Learning; 2009.
13. World Economic Forum (WEF). Global Competitiveness Report 2011-2012. 2012. Available from http://www3.weforum.org/docs/WEF_GlobalCompetitivenessReport_2012-13.pdf
14. Yoguel G, Boscherini F. La capacidad innovativa y el fortalecimiento de la competitividad de las firmas: el caso de las Pymes exportadoras argentinas, CEPAL, Documento de Trabajo n. 71, Buenos Aires. 1996.

Citation:
José Guadalupe Vargas Hernández and Omar C. Vargas-González "Innovation Capacity as a Factor that affects the Competitiveness of Software Industry Jalisco", Global Journal of Enterprise Information System. Volume-7, Issue-2, April-June, 2015. (www.gjeis.org)

Conflict of Interest:
Author of a Paper had no conflict neither financially nor academically.

ANNEXA

VALIDITY OFECONOMETRIC MODEL

1. Test for Normality of Residuals

The classical normal línea rregression on the assumption that each u_i, is normally distributed with:

Media: $E($

Variance: $E[u_i - E(u_i)]^2 = E(u_I^2$

Cov: $E\{[u_I - E(u_i)[u_i - E(u_j)]\}^2 = E(u_I, u_j) =$

Generally, ther eare not made contrasts of normality, since most of the time there are available significant samples. Such is the case of this research. Therefore, to determine whether these assumptions are met, you can use any of the following tests.

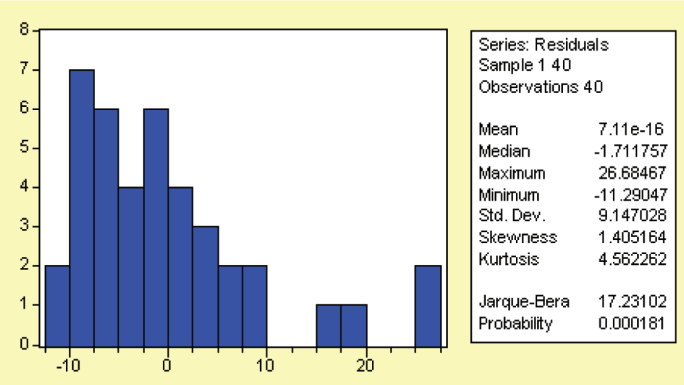
2. Jarque Bera Test

Jarque Bera test is based on the residuals obtained by OLS. Through this test for normality, two properties of the distribution of residuals are determined: Skewness and kurtosis (or shoring). Thus, to accept the null hypothesis of normality of residuals, the probability value must be greater than 0.05.

Applying this test to the models, it is obtained:

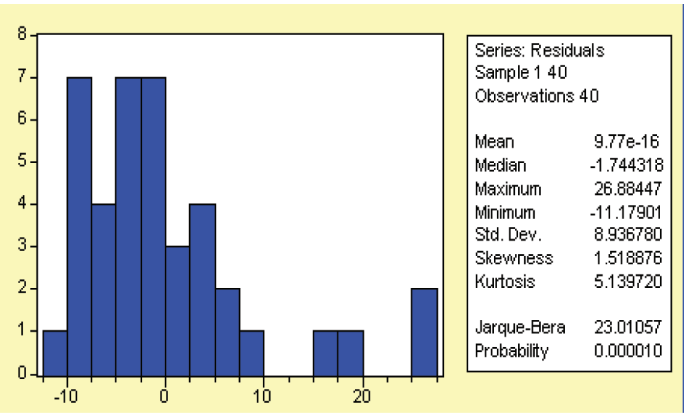
It is found that the graphic representation of residuals throughits histogram presents a number of observations in the tails that are not consistent with the low probability that these areas have a normal distribution. Furthermore, the coefficient of sample asymmetry(1.40 and 1.51) respectively, it is not opened close to zero as expected, and the coefficient of kurtos is pointing

Table 13. Jarque-Bera test for a simple regression model



Source: Own elaboration.

Table 14. Jarque-Bera test for multiple regression model



Source: Authors.

or sample(4.56and 5.13) respectively, far excedes the value 3. Finally, statistical Jarque-Bera rejects the null hypothesis of normality, since its value (17.23102 and23.01057) respectively, generates a probability of rejecting this hypothesis being true very small and less tan 0.05.

The solution to the lack of normality of the disturbances requires a study of possible causes. In general, this normally cannot be due to the existence of outliers'distributions generating lack of a symmetry. So you can mention that situations in which the model specification is deficient, as the omission of relevant variables or nonlinearity, aiming for greater distribution of residues can be detected than normal or strong asymmetries. In these cases, the solution is to introduce dummy variables in the model.

3. Test Heteroskedasticity

The basic linear regression model requires as a primary hypothesis that the varianceof the random perturbations, conditional on the values of the regressors X, is constant. In other words,

the conditional variance of Yi (which isequal toui), conditional onX,remains the same regardless of the values taken by the variable X. Algebraically this is expressed as:

$$E(u_I^2) = \sigma_u^2$$

There are basically two methods for detecting the presence of heteroskedasticity, graphical methods and numerical contrasts. Within the numerical contrasts among others Parktest, Goldfeld-Quantand White. Whitecontrast, despite being similar to the other evidence in its category, seems to be more robust, not requiring prior assumptions such as the normality of residuals[3].

4. White Test

Is a general way to identify the presence of heteroskedasticity, without making assumptions about the impact of a particular variable or on the distribution of residues. The following assumptions are considered:

$H_0 : \sigma_1^2 = \sigma^2$ *para todo i.*

H_1 :*nos e verifique* H_0

The way to make the contrast is based on the regression of least squares errors squared, which are indicative of the variance of shocks to an independent term, the regressors, their squares and cross products two to two (or second order). For example, based on the following model:

$$Y_i = \beta_0 + \beta_1 x_{1i} + \beta_2 x_{2i} + \varepsilon \qquad i = 1.....N$$

The auxiliary regression for this contrast would be:

$$e_i^2 = \delta_0 + \delta_1 X_{1i} + \delta_2 X_{2i} + \delta_{11} X_{1i}^2 + \delta_{22} X_{2i}^2 + \delta_{12} X_{1i} X_{2i} + vi \qquad i = 1 \ldots \ldots N$$

The following Table 15 and 16 show the results of the White test applied to the two models used as shown below:

As shown in the Table 15 and 16, heteroskedasticity is confirmed, to the linearized model, through statistical F and Obs * R-square, since both statistical null hypothesis of homoscedasticity has a p value> 0.05. In the linear and quadratic models the probability values exceed a level of significance of 5% therefore must assume the presence of heteroskedasticity in these models. Therefore, it is concluded that the model is not statistically significant, and is biased. To fix this it is necessary to include more control variables, which is not possible in this research because the database used.

Table 15. White test for simple regression

White Heteroskedasticity Test:

F-statistic	2.138199	Prob. F(2,37)	0.132205
Obs*R-squared	4.144158	Prob. Chi-Square(2)	0.125924

Test Equation:
Dependent Variable: RESID^2
Method: Least Squares
Date: 01/29/13 Time: 23:11
Sample: 1 40
Included observations: 40

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	117.5571	77.18444	1.523067	0.1362
ICI	-4.053384	3.267410	-1.240550	0.2226
ICI^2	0.048660	0.030041	1.619777	0.1138

R-squared	0.103604	Mean dependent var	81.57642
Adjusted R-squared	0.055150	S.D. dependent var	155.9284
S.E. of regression	151.5677	Akaike info criterion	12.95198
Sum squared resid	849992.6	Schwarz criterion	13.07865
Log likelihood	-256.0396	F-statistic	2.138199
Durbin-Watson stat	1.884576	Prob(F-statistic)	0.132205

Source: Own elaboration.

Table 16. White test for multiple regression

White Heteroskedasticity Test:

F-statistic	0.658887	Prob. F(5,34)	0.656933
Obs*R-squared	3.533434	Prob. Chi-Square(5)	0.618335

Test Equation:
Dependent Variable: RESID^2
Method: Least Squares
Date: 01/29/13 Time: 23:13
Sample: 1 40
Included observations: 40
Collinear test regressors dropped from specification

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	47.02804	100.0404	0.470091	0.6413
ICI_CAP	-4.852279	4.009424	-1.210218	0.2345
ICI_CAP^2	0.071131	0.050040	1.421472	0.1643
ICI_INN	-19.07928	73.59054	-0.259263	0.7970
ICI_INN^2	3.484959	8.855858	0.393520	0.6964
ICI_CON	0.590427	3.754279	0.157268	0.8760

R-squared	0.088336	Mean dependent var	77.86938
Adjusted R-squared	-0.045732	S.D. dependent var	160.4538
S.E. of regression	164.0817	Akaike info criterion	13.17609
Sum squared resid	915375.5	Schwarz criterion	13.42942
Log likelihood	-257.5217	F-statistic	0.658887
Durbin-Watson stat	1.767419	Prob(F-statistic)	0.656933

Source: Own elaboration.