



Innovation for integration into supplier networks of multinational companies

*Innovación para la integración a las redes de proveeduría
de las empresas multinacionales*

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Abstract

The purpose of this work is to demonstrate that innovation promotes the probability of small companies to be a part of the supplier networks of large companies established in the local industrial parks. This is specifically demonstrated through the design of a logistic regression model, which indicates that the greater the number of innovations (product, process, administration, and commercialization) the greater the probability of a small company chosen at random to be a supplier for the multinational companies that lead global value networks. The hypothesis tests are carried out on a random sample of metal-mechanic and information technology companies of Sonora. This was based on the results of previous investigations, where it is demonstrated that this type of companies is in better conditions to participate in the supplier networks of large companies.

Keywords: Innovation; Global Value Chains; SMEs; Multinational Companies.

JEL Classification: O14, O31, C25

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Resumen

El propósito del presente trabajo es demostrar que la innovación promueve la probabilidad de que las pequeñas empresas formen parte de las redes de proveeduría de las grandes empresas asentadas en los parques industriales locales. En particular, se demuestra a través del diseño de un modelo de regresión logística que a mayor número de tipos de innovaciones (de producto, proceso, administración y comercialización), mayor es la probabilidad de que una pequeña empresa cualquiera elegida al azar sea proveedora de las empresas multinacionales que encabezan redes globales de valor. Las pruebas de hipótesis se realizan sobre la base de una muestra aleatoria de pequeñas empresas metalmecánicas y de tecnologías de la información de Sonora, basados en los resultados de investigaciones anteriores, donde se demuestra que este tipo de empresas están en mejores condiciones de participar en las redes de proveeduría de las grandes empresas.

Palabras clave: Innovación, Cadenas Globales de Valor, Pymes, empresas multinacionales.
Códigos JEL: O14, O31, C25

“There is no science without a clear and operative distinction between independent and dependent variables”.

Jon Elster (2011).

El desinterés. Critical treaty of the economic man.

Mexico, Siglo XXI

Introduction

The participation of small and medium enterprises (SMEs) in the supplier networks of transnational corporations (TNCs) located in the local markets is a topic of great interest because it invigorates and strengthens the regional economy. Particularly, it promotes the scaling of small companies through competitiveness improvements and an increase in productivity (Bueno, 2012).

This scaling takes place through various processes, but innovation is the essential element. Much has been written on the topic, but this work seeks to explain, in the particular field of the economy of Sonora, that the relation between the metal-mechanic (MM) and information technology (IT) SMEs and the global value networks is strengthened if the SMEs that supply the TNCs generate different types of innovations. In other words, if a company only produces one type of innovations—for example, products—their probabilities of belonging in the supplier networks of the TNCs are lower than those that have innovation diversification of two or more types (e.g. of product, process, administration, and commercialization).

It is true that innovation in the local industrial parks is largely due to the knowledge spill by the large TNCs (other factors, such as the entrepreneurial spirit of the local businesspeople, the applied public policies, and the existence of a strong, qualified workforce also count), but the knowledge absorption capability of the small companies and their capability to convert the explicit knowledge into implicit knowledge and then transform it into innovations is what allows them to promote themselves as candidates for the supplier networks of TNCs.

The study was done based on the information collected from 68 small and medium-sized enterprises (SMEs), of the Metal-mechanic (MM) and Information Technology (IT) branches

of Sonora at the beginning of 2015. A random sampling was carried out based on a refined census of companies, as is explained in the methodology section, and the conclusions could be generalized to similar experiences.

The document is organized into six sections, with this introduction being the first. The second section presents a summary of the debate regarding the role that small companies perform in the economy. The third exposes, in detail, the sector of the SMEs in Sonora, specially the MM and IT sectors. The fourth section presents the methodology, the investigation design, the theoretical approach that supports the investigation, and develop the models used for the hypothesis tests.

Finally, this article derives from the results of the research project called “Knowledge Transfer and Technological Learning of the local Small and Medium Enterprises (SMEs) in the context of the Global Production Networks”, financed by Promet with registration 151329.

The debate regarding the role of the SMEs

The debate regarding the role of small companies in the economy appears to have already been overcome by the facts. More than 200 years after Marx wrote the Communist Manifest, small businesses have not only not disappeared by being absorbed by the concentration of capital, but have been revealed to be essential elements in the functioning of a system ruled by imperfect competition market structures (especially oligopolistic and of monopolistic competition) (Matsuyama, 1995), where the large multinational companies play a leading role in the global value networks, fixing the working rules in highly globalized markets. It is not that they lack problems, quite the contrary as we will see further on, but SMEs have come to build the *interstice* that keeps the large companies functioning as part of the economic system.

The performance of those companies (and their participation in employment, national production, and the stability of the markets) supports the thesis of the so-called dynamic approach that states that most SMEs play a crucial role in the functioning of the markets (Acs and Audretsch, 1993; Berger and Piore, 1980).

This approach recognizes at least two functions of small companies: first, the production (as is the case for most of them) of intermediate goods to meet the demand (under the subcontracting scheme) of large corporations; and second, the introduction into the economy of advance products (OCDE, 2010) thus boosting the innovation of the regional and national systems (Armenteros, Medina, Ballesteros and Molina, 2012). This second function is achieved by generating new or improved—sometimes even radical—products and processes that drive the economy towards a technology frontier.

Those who support the dynamic approach argue that these small productive organizations (and the entrepreneurial spirit) have played a much more important role in the economy than how it was initially considered. According to this approximation, there are four specific contributions from this type of businesses to the industrial markets. First, the role they play in the technological change process; Nelson and Winter (1982) argue that small industrial businesses make a significant business contribution in the sense that they are a source of considerable innovative activity. Second, the turbulence they generate in the markets; which not only creates an additional dimension to the competence not recorded by the static vision of the market structure, but also generates regeneration mechanisms that serve as agents of change (Beesley

and Hamilton, 1984)¹. Third, related to the second, is promoting international competitiveness through the creation of new market niches (Brock and Evans, 1989). The fourth contribution is their prevailing participation in the newly developed jobs (Storey, 1994)². It must also be added that small companies are the base for the subcontracting networks on which the global corporations in the local markets rely.

The metal-mechanic and information technology sectors

Small companies have been thoroughly studied. The aim has been to understand their nature (Brok and Evans, 1989; Coase, 1937³; Storey, 1994) by analyzing their influence in the emergence of new companies (Beesley and Hamilton, 1984); tracing the coordinates of the debate to which they are subject (Acs and Audretsch, 1993); promoting institutional studies in order to derive recommendations and public policies (OCDE, 2010); investigating the influence of intangible factors, such as trust, in their innovation processes (Valenzuela, 2012); and exposed the multiple problems they face (Escalera, 2007).

It is worth emphasizing this last line, since the problems presented by these companies tend to stop their development (that is, for the increase of their productivity, the improvement of competitiveness and their innovation processes) and make them vulnerable to changes in the economic environment, and to macroeconomic instability. SMEs face problems regarding a lack of credit, scarce information on financing sources, rudimentary administrative processes, reduced profit margins, the use of obsolete technologies in production, and deficient quality controls. Furthermore, small companies develop amid the poor productive infrastructure suffered by the country.

Innovation and link with the CGV

As Sonora has become a seat for multinational companies in various activity branches (automotive, aerospace, medical industry, etc.), the demand for local goods and services has become a market where the competition for contracts has become fierce. For the SMEs of Sonora, becoming a supplier for a transnational company is no easy task; the technological and organizational requirements or the production and innovation capabilities demanded by large firms, in addition to the collaboration agreements, regularly present power asymmetries that favor the TNCs. This can cause serious problems with the compliance of the commitments undertaken by the local companies (Arias and Solari 2008; Bueno, 2012).

As it can be assumed, there are activity branches that make companies more inclined to participate in supplier networks. This is the case for the metal-mechanic and information technology sectors. The type of goods and services they produce turn them into players of the

¹ “The important role of small independent companies, as is often said, is the function of being a seedbed for new companies capable of challenging already established companies.” (Beesley and Hamilton, 1984).

² Menkveld and Thurik (1999) found—by applying a model that measures the relation between the size of the company and growth—that an industry with a low presence of large firms (in comparison with the same industries in other countries) behaves better in terms of product growth. In this sense, not restructuring the industry (promoting competition and the elimination of monopolies) comes at a price in terms of growth.

³ The classic book by Ronald Coase does not explicitly address small companies, but it is clear that it also does address large corporations. It is very probable that the model that the author had in mind was the medium industrial company.

local development type promoted by the TNCs (Contreras, 2005). However, only a minority of companies (37.9%) have managed to incorporate themselves into the value chains, with the MM companies being the ones that more frequently proportionally establish a relationship of this type when compared to IT companies (see Table 1).

Table 1. SMEs per activity of the company, according to transnational clients.

| Transnational Clients | Activity of the Company | | Total |
|-----------------------|-------------------------|-------|-------|
| | TI | MM | |
| No | 75.0 | 50.0 | 60.3 |
| Yes | 25.0 | 50.0 | 39.7 |
| Total | 100.0 | 100.0 | 100.0 |

Source: Knowledge Transfer and Technological Learning of local Small and Medium Enterprises (SMEs) in the context of Global Production Networks. UNISON, project PRODEP No. 151329.

That difference is explained by the fact that the TNCs mainly use software provided by their matrices or from international suppliers, leaving to the local companies only collateral activities such as maintenance and, in some cases, the adaptation of the programs to the local conditions.

In the case of MM companies, they have another context phenomenon; the TNCs find it preferable, in terms of cost, to locally substitute the worn metallic pieces or to construct metallic structures whose transportation would be more expensive.

Despite most of the companies not having a relation with the TNCs, the studies that analyze this intersection between the small companies and the global value chains have been plentiful (Contreras, Carrillo and Olea, 2012; Jurowetzki, Lundvall and Lema, 2015; Navarrete, Olea and Taddei, 2015; Olea, 2014). Particularly, the aspects that ought to be highlighted in this intersection are those regarding learning processes and technological innovation.

However, what makes the study of those topics interesting is that the impacts of the global production networks are both direct as well as indirect. The economic restructuring of the 1980s, which led to Sonora entering the new model as a manufacturing affiliate in the global production chains, modified the productive structure, giving it a clearer direction towards the exterior and broadened the field of action for a new generation of businesspeople who adapted to the new economic conditions and became protagonists in the local economic development (Bracamonte and Contreras, 2008).

The opening of the markets brought an acceleration to the innovating tendencies of the local companies, overcoming the old belief that innovations occurred in industrialized countries, leaving the imitation and adaptation of the new developments to other countries. In this sense, the local SMEs that entered the supplier networks of the transnationals absorb the knowledge disseminated by the same and increase their capabilities, generating product, process, organizational, and marketing innovations.

Perhaps due to the indirect effects of the global value networks, a high portion of the local SMEs state having implemented product (76.5%), process (69.1%), organizational (48.5%), and marketing (48.5%) innovations. Furthermore, the small companies that supply the TNCs

report a greater number of innovations and types of innovation than non-supplier companies (Table 2).

An aspect that seems logical (and in line with the proposed hypotheses) is that the companies tied to the TNCs are more innovating than those that have no supplying relation, given that the transnational companies demand high quality and operation standards from the local companies, forcing them to implement a constant learning that translates into innovations.

Table 2. Innovating SMEs by activity and supplying towards transnational companies

| Is supplier to a TNC | Activity of the company | | | | | | | | |
|-------------------------|--|-------|-------|------|-------|-------|-------|-------|-------|
| | IT | | | MM | | | Total | | |
| | Made product or process innovations | | | | | | | | |
| | No | Yes | Total | No | Yes | Total | No | Yes | Total |
| No | 33.3 | 66.7 | 100.0 | 35.0 | 65.0 | 100.0 | 34.1 | 65.9 | 100.0 |
| Yes | 0.0 | 100.0 | 100.0 | 0.0 | 100.0 | 100.0 | 0.0 | 100.0 | 100.0 |
| Total | 25.0 | 75.0 | 100.0 | 17.5 | 82.5 | 100.0 | 20.6 | 79.4 | 100.0 |
| | Made organizational or marketing innovations | | | | | | | | |
| No | 52.4 | 47.6 | 100.0 | 55.0 | 45.0 | 100.0 | 53.7 | 46.3 | 100.0 |
| Yes | 0.0 | 100.0 | 100.0 | 25.0 | 75.0 | 100.0 | 18.5 | 81.5 | 100.0 |
| Total | 39.3 | 60.7 | 100.0 | 40.0 | 60.0 | 100.0 | 39.7 | 60.3 | 100.0 |
| | Made some type of innovation | | | | | | | | |
| No | 33.3 | 66.7 | 100.0 | 35.0 | 65.0 | 100.0 | 34.1 | 65.9 | 100.0 |
| Yes | 0.0 | 100.0 | 100.0 | 0.0 | 100.0 | 100.0 | 0.0 | 100.0 | 100.0 |
| Total | 25.0 | 75.0 | 100.0 | 17.5 | 82.5 | 100.0 | 20.6 | 79.4 | 100.0 |

Source: Knowledge Transfer and Technological Learning of local Small and Medium Enterprises (SMEs) in the context of Global Production Networks. UNISON, project PRODEP No. 151329.

The types of innovation considered in Table 2 can be classified, in turn, into the following categories: 1) incremental, which refers to the creation of value added to an already existing product by making certain improvements, and 2) radical, which is known as the change or introduction of a new product, service or process not known before (OCDE, 2005).

Small MM and IT companies in Sonora⁴

According to data from the 2014 Economic Census, there are 117,289 economic units in Sonora that provide employment for 827,542 people, and small companies (with up to 100 workers) represent 99.8% of the total and demand 72.8% of employment. The portions of these numbers in Sonora are very similar to the national figures according to the same source.

⁴ The information for this section is primarily taken from the doctoral thesis of Alejandro Valenzuela (2012) done within the framework of *Project No. 133596 of the National Council for Science and Technology (CONACYT for its acronym in Spanish): Global production networks and local learning: technological spill of the transnational and absorption capability in technologically based SMEs in the Northeast of Mexico, jointly directed by researchers from El Colegio de la Frontera Norte and El Colegio de Sonora.*

According to Contreras (2005), the metal-mechanic sector (grouped in the 1.5% of the economic units and which employs 2.01% of the occupied personnel) is comprised by a group of companies that produce metallic pieces and structures up to the manufacture of machinery and equipment that involve technology which can be considered “sophisticated” (precision tools, digital lathes, robotics, etc.).

Fifty-six percent of MMs dedicate themselves to industrial and technical equipment maintenance. Among the MMs, the main activity is the production of metallic pieces for the industry.

IT companies are broadly located in professional, scientific and technical services, although the software and computer systems developing companies (more related to the objectives of this research) represent only 72 companies that hire 962 employees. This is a more specialized sector which “presents a higher technological and entrepreneurial profile and a competitiveness strategy that is more focused towards quality” (Contreras, 2005).

The software industry has suffered a radical change in the last twenty years due to two processes: first, the generalization of the use of information and communication technologies and, second, the continuous fall in price of the tangible part of this technology (hardware) and the increase in the price of the software due to its growing sophistication.

Furthermore, the level of required knowledge by the personnel of these companies is so specialized that “they are the ones that report the most difficulties in finding the employees they need” (Contreras and Olea, 2006).

The average age of the MM plants is of 17 years with a standard deviation of 13.7. The oldest MM is 64 years old. This information is important to understand the entrenchment of the industry in the state, but for the purpose of this investigation a more important indicator is the average age of the machinery and equipment. According to the information collected in the field, the average age of both activities (MM and IT) is of approximately 5 years. The minimum age is of zero years and the maximum is of 20. However, in accordance with the datum of the age of the companies, the age of the machinery and equipment ranges from 0 to 8 years with an average of 2.29 years in the IT sector, whereas in the MM the range goes from 0 to 20 years with an average of 7.7. This relates to a shorter useful life cycle of the information technology equipment and to the lower age of the companies: 17 years with a standard deviation of 6.5, with the foundation of the first company of this type 30 years ago.

Even though 86.5% of the companies affirm having made innovations, their own qualification of the technology they use is moderately conservative given that around half of the companies guarantee that their technology is in the average, and a third-part places it on the technology frontier⁵. It must be said, however, that the portion that is on the technology frontier is much greater in the IT than in the MM companies, which is explained by the fact that in the metal

⁵ The economic theory presumes that companies operate with the standard technology shown by the production function. All the sub-standard productive techniques would be, in a general equilibrium model, below the limit of production possibilities and would be using non-optimal combinations of inputs in the sense of Pareto. This single fact would be enough to advance towards the efficient equilibrium or to leave the market (Gravelle and Rees, 1996). However, this neoclassic hypothesis is not verified in the market that we are analyzing because the companies with technology below the technological limit continue to operate perhaps due to the sacrifice of short-term profit plans for the sake of competitiveness through innovation, which is referenced in the first section of this chapter. It must be said that the classification is not a product of a technological typology, but rather of the knowledge that the businessperson has on the context of their activity and of the comparison of their equipment with the existing one in the medium and in countries with further development in the field.

industry it is not strictly necessary to have the latest generation technology to remain in the market, whereas obsolescence is a growing characteristic of computer equipment and software.

Another relevant factor for the study of innovation in this type of companies is the analysis of the human capital⁶. Two variables are considered in this regard. On the one hand, the education level of the personnel and, on the other, the professional training and experience of the businessperson.

Despite dealing with companies that are, on average, very small (19 workers in the MM and 13 in the IT companies), the education level is relatively high. The percentages of workers that have at least a Bachelor's degree are: 52% in IT and 15% in MM companies. To scale this information, let us observe that the economically active population that has that level of education is of only 13% at a national level and of 14% in Sonora. It is therefore observed that IT companies in particular stand apart from the average by a considerable amount.

Regarding the businesspeople of the analyzed sectors, most of them (68% in MM and 93% of those in IT) have a Bachelor's degree or higher education (At the state level, only a third has this level of education according to Covarrubias, 2000).

Education in this sector is not due to the "ancestry" of the businesspeople, which does not exist, but rather to the need to establish a place among the local businesspeople, given that 80% of them have been qualified employees in other companies before being businesspeople. This can be interpreted as gaining experience in activities related to their current role, which has helped them found a company with a certain level of success. The fact that most of them worked as production, maintenance, and project managers points towards this hypothesis. Let us say that previous experience was a knowledge acquisition process and a useful learning experience for a business with certain advantages (see Table 3).

Table 3. SMEs by company activity and supplying to a transnational company, according to the work experience of the owner.

| The owner worked in some other company or institution | Activity of the Company | | | | | | | | |
|---|--|-------|-------|-------|-------|-------|-------|-------|-------|
| | IT | | | MM | | | Total | | |
| | Is a supplier to a transnational company | | | | | | | | |
| | No | Yes | Total | No | Yes | Total | No | Yes | Total |
| Yes | 90.5 | 85.7 | 89.3 | 75.0 | 90.0 | 82.5 | 82.9 | 88.9 | 85.3 |
| No | 9.5 | 14.3 | 10.7 | 25.0 | 10.0 | 17.5 | 17.1 | 11.1 | 14.7 |
| Total | 100.0 | 100.0 | 100.0 | 100.0 | 100.0 | 100.0 | 100.0 | 100.0 | 100.0 |

Source: Knowledge Transfer and Technological Learning of local Small and Medium Enterprises (SMEs) in the context of Global Production Networks. UNISON, project PRODEP No. 151329.

⁶ In his influential 1961 article on human capital, Theodore W. Schultz states: "It has been widely observed that the increases in national product have been large compared to the increases in land, working hours, and reproducible physical capital. The investment in human capital has been the main explanation for this difference". For his part, Gary Backer, in his note on human capital for *The Concise Encyclopedia or Economic*, states that capital is not only that tangible form already known: "education, computer training courses, medical expenses, learning regarding punctuality and honesty are also capital. This is because these factors increase incomes... They are called human capital because people cannot be separated from their knowledge, abilities, health or values as they can be separated from their physical and financial assets."

Methodology

The theoretical principles of this investigation are: First, the innovation systems and the corresponding discussion on the role of knowledge and learning in local development (Lundval, 2007); second, the proposal of global value chains, which highlight the global productive articulation of the TNCs and local companies (Gereffi, Humphrey and Sturgeon, 2005; Pietrobelli and Rabellotti, 2009), and which offers an analytical framework of the technological learning mechanisms that allow local companies to participate in the supplier networks of the transnationals (Bracamonte and Contreras, 2008); and third, the discussion regarding technological learning that goes from being explicit to implicit according to the cognitive distance (Nooteboom, 2000), and potential and real learning capabilities (Zahara and George, 2002). It must be noted, regarding this last point, that learning and the absorption capabilities do not “detonate” in a spontaneous manner, but rather by the presence of a set of factors (such as competitiveness) that brings the presence of some agent, generally external, which prompts businesspeople to think about the need for new knowledge that will allow them to introduce changes to improve their processes, increase their production capacity, reduce costs, and improve or innovate their technology (Arechavala, 1998; González-Campo and Hurtado, 2014; Olea, 2014) to become a supplier to the TNCs and thus improve their likelihood to remain in the market (Hauschild, Licht and Stein, 2001; Orr, 2008).

It must be considered that this is a cross-sectional study and as such, we are not in conditions to analyze the historical behavior of the relation between the MM and IT SMEs, on the one hand, and the TNCs on the other, in the issue of innovation. In this sense, we must adhere to the findings of the researches that have been carried out regarding the local setting of the industry of Sonora (Bracamonte and Contreras, 2008; Contreras, 2005 and 2008; Contreras and Olea, 2006) and to the results of the questionnaire applied in which the age of the company, machinery and the working trajectory of the businessperson are reported.

The sample and the indicators

The results of the research are based on the tests of a logistic regression model in which the information derived from the application of a questionnaire⁷ structured to a sample of companies from the MM and IT branches established in four municipalities of the state of Sonora was used. It is a cross-sectional and non-experimental research where the aim is to establish the structural relation between the dependent variable “participation probability of the company in the supplier networks of transnational companies” and the components of the different types of innovation generated by the companies.

The selection of companies was done based on the reasons presented in section b of point 3. The complete listing of companies for both activity branches comes from the databases of the National Chamber of Electronics, Telecommunications and Information Technologies Industry, from the listings of companies from the industrial parks of Sonora, from the Secretariat of Economy, from the registers of the National Chamber of Industry and Transformation,

⁷The questionnaire (titled “Knowledge Transfer and Technological Learning of local Small and Medium Enterprises in the context of Global Production Networks”) contains 40 questions divided into three sections: I. General data, II. Innovation capabilities, and III. Relation of the innovations with transnational companies. Before the formal collecting of the information, pilot tests were carried out to validate the instrument.

and from the Yellow Pages website. The selection was carried out in the municipalities of Hermosillo, Guaymas and Empalme for the reasons presented in section c of point 3) following the filtering of the listings to eliminate companies that did not comply with the requirements of size (small companies), that produced metallic pieces, machines and tools for the industry (excluding smithies), that developed computer systems and software (excluding internet cafés, broadcasters, and workshops for the sale and repair of equipment). In the end, from 410 companies, only 68 were selected (28 from IT and 40 from MM) according to a stratified random sampling.

Once the sample was selected, the application of the model makes sense only based on clearly defined indicators, these being the summary of multidimensional concepts, and measurement scales that clearly reflect the nominal, ordinal or interval measurements used in the analysis (Schuschny and Soto, 2009; Venkatraman and Grant, 1986).

There are different techniques for the construction of indicators. Here, factors were built through the simple sum of previously standardized variables so that their measurement scales are comparable and can be aggregated.

The first step consisted on selecting and standardizing the variables to comprise the factors according to each type of innovation: product, process, organizational, and marketing. Two indices were built with these factors: one for the innovations grouped into two large categories, one for product and process and another for administrative and marketing innovations.

Statistical techniques and models

Given that this is a quantitative type research, the objectives of using the statistical models are: 1) to understand the characteristics of the variables, and 2) to make predictions on the dependence relations between them, validating the results (Hair, Bush and Ortinau, 2010).

An appropriate means to verify the hypothesis that the greater the innovation of different types the greater the probability that small companies have a supplier relation with transnational companies and the global value chains to which they belong is the regression line that establishes a relation of causality between variables. Specifically, and given the fact that the dependent variable is a dichotomous variable (whether the company participates in the supplier networks of the TNCs), which in the end determines the *probability* of that occurring based on another variable—innovation, in this case—, the logistic regression model is the appropriate one. This model does not require the assumptions of normality, it is a linear probability model, it allows the use of continuous and categorical independent variables, it has the capability to incorporate non-linear effects, and it is useful in making predictions and diagnostics (Alderete, 2006; Calderón and De los Godos, 2009; García, Alvarado and Jiménez, 2000; Hair, Anderson, Taham and Black, 1999; Llaugel and Fernández, 2011; Nava and Pradad, 2008).

If Y is the dependent variable and if X ($X_1, X_2, X_3, \dots, X_k$) are the explicative variables, the model can be presented as follows⁸:

$$\Pr(Y = 1) = \frac{1}{1+e^{-x}} \quad (1)$$

⁸ For a brief summary of the logistic regression model, see chapter 15 of the book *Econometría de Damodar N. Gujarati and Dawn C. Porter* (2009). See also Gail, Krickeberg, Samet and Tsiatis (2010).

Where

$$\text{Where } X = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \dots + \beta_k X_k$$

It should be mentioned that the value of the β_i coefficients (assuming that all the statistical tests that validate the model are covered) has a specific weight in the interpretation of the results: if it is positive, it indicates that the probability of to be a supplier to a TNC increases whenever the innovation capabilities increase, and vice versa.

Analysis and discussion of the results

In this section, the components and structure of the proposed analysis are presented in a disaggregated manner, in addition to its results for the contrast and validation of the research hypotheses. The tabulated calculations and estimations shown throughout this chapter use the database of the proposed questionnaire as their source.

Construction of the model

Given that the aim of this research is to analyze the probability of occurrence of a local company of the MM and IT branches having a transnational company as a client, a likelihood that depends on the number of types of innovations they develop and apply, the most appropriate model to carry out this prediction is a logistic regression model (Gail, 2010).

The dependent variable (whether the MM or IT SME is a supplier for a transnational company) is dichotomous: if the event occurs then $Y = 1$, otherwise $Y = 0$.

The independent or predictive variables are comprised by the innovation indices built with the four recognized types: product, processes, organizational and marketing.

As it is known, this type of regression models has a *confounding variable* that in this case is the company activity (the codification of which is 1 for MM and 0 for IT). This is an independent variable that externally affects the main relation (types of innovation® be a supplier to a transnational company) because the production and administration activities of the analyzed companies are different.

The model estimation is the following

Table 4. Statistical results of the logistic regression a,b

| | | B | E.T. | Wald | gl | Sig. | Exp(B) | I.C. 95% for EXP(B) | |
|---------|--------------|--------|-------|--------|----|------|---------|---------------------|----------|
| | | | | | | | | Lower | Higher |
| Step 1a | IOC | 4.733 | 2.046 | 5.353 | 1 | .021 | 113.638 | 2.062 | 6263.386 |
| | IPP | 4.825 | 1.567 | 9.479 | 1 | .002 | 124.592 | 5.774 | 2688.494 |
| | Activity (1) | -2.101 | .892 | 5.545 | 1 | .019 | .122 | .021 | .703 |
| | Constant | -2.663 | .782 | 11.610 | 1 | .001 | .070 | | |

^a The cutoff point is 0,500

^b The positive sign in the exponent indicates an increase in the probability of occurrence of the event; a negative sign reduces it and a coefficient close to zero results in a value near the unit that practically does not influence the probability of occurrence of the event (Ibarra and Michalus, 2010).

The model shown in Equation 1, substituting the results shown in Table 4, is the following:

$$\Pr(Y = 1) = \frac{1}{1+e^{-x}} \quad (2)$$

Where:

$\Pr(Y=1)$ = Probability for the SME to be a supplier for a transnational company

$$X = -2.663 + 4.733IOC + 4.825IPP - 2.101A$$

IOC = Types of organizational and marketing innovations

IPP = Types of product and process innovations

A= Main activity of the SME (MM or IT)

The data presented can be interpreted in the following manner. The value of the constant (β_0) does not have an interpretation of its own, and is considered an adjustment value that must be included in the model. The values of the constants $\beta_1=4.773$ y $\beta_2=4.825$ are both positive, indicating that the probability of being a supplier to a TNC increases as the values of the variables increase; in this case, it refers to the types of production (IPP = product and process) and administration (IOC = organizational and marketing) innovations carried out by the local SMEs. The value of the constant β_3 refers to the main activity of the SMEs. But being a dichotomous variable and having a negative value (-2.101), indicates that the probability to be a supplier to a TNC decreases depending on the type of activity. Thus, a MM company (which had an assigned value of 1) has lower probabilities to be a supplier than an IT company (which had an assigned code of 0).

Furthermore, the parameter estimators of the three independent variables are statistically significant, since the level of significance associated to Wald index is, in all cases, less than 0.03. The signs of the coefficients allow inferring that the IOC and IPP variables positively affect the probability for the SMEs to be suppliers to a TNC.

Equation 2 allows us to predict the probability for a SME to be a supplier to a TNC based on the types of product, process, organizational and marketing innovations it has carried out and its economic activity. This logistic regression provides the calculation of probability of occurrence for a SME to be a supplier to a TNC among all the SMEs in the sample. If the adjustment is good, it is expected that the presence of different types of innovations instituted will associate with high probability values for the company to be a supplier to a TNC.

Table 5 presents the probabilities for the IT and MM SMEs to be suppliers for a transnational company according to the types of innovation implemented. Based on these results, we can infer that the probability for a small company to be a supplier to a transnational is related to the number of types of innovations that it has implemented and the type of economic activity.

The innovation capabilities developed by local SMEs can be a fundamental factor for these to be in the position to comply with the parameters imposed by transnational companies to be accepted as suppliers. However, these demands are not always the only factor that play in favor (or against) the participation of the SMEs. There are also contingent factors; in face-to-face interviews with small local businesspeople it becomes evident that the presence of an unexpected problem (mechanical failures, jams in the production line, etc.) force large companies to look for immediate solutions with local companies, which places them on the road to being a supplier and encourages them to seek to institute innovations on their own performance.

Table 5. Probability for a SME to be a supplier to a TNC according to the types of innovation implemented

| Innovation | | Activity of the company | |
|------------|-----|-------------------------|-------|
| OC | PP | TI | MM |
| 0.0 | 0.0 | 0.065 | 0.012 |
| 0.1 | 0.1 | 0.153 | 0.028 |
| 0.2 | 0.2 | 0.320 | 0.093 |
| 0.3 | 0.3 | 0.551 | 0.335 |
| 0.4 | 0.4 | 0.761 | 0.690 |
| 0.5 | 0.5 | 0.892 | 0.871 |
| 0.6 | 0.6 | 0.956 | 0.936 |
| 0.7 | 0.7 | 0.982 | 0.964 |
| 0.8 | 0.8 | 0.993 | 0.978 |
| 0.9 | 0.9 | 0.997 | 0.987 |
| 1.0 | 1.0 | 0.999 | 0.992 |

Source: Knowledge Transfer and Technological Learning of local Small and Medium Enterprises (SMEs) in the context of Global Production Networks. UNISON, project PRODEP No. 151329.

Conclusions

According to the studies cited in this work, there are many advantages for a small local company to enter to the supplier networks of multinational firms. The probability of achieving it, as has been shown, increases if the local SME generates innovations of various types, because this increases their competitiveness and places it in conditions to comply with the quality and time standards demanded by the TNCs.

However, succeeding in improving the capability of innovation of a SME is a complicated process due to various reasons. First, for a SME to be able to develop innovating activities it needs to overcome a series of internal obstacles, such as deficient production systems, obsolete technology, poor training, and poor educational level of both workers and owners, among others. These deficiencies impede or delay the acquisition processes of knowledge that could come from the environment or that is transmitted by the leading firms of the value chains. Second, it is common for the companies that undertake innovating efforts to concentrate on achieving product or process innovations. The aim of this investigation was to demonstrate that for a local SME to be considered a supplier for a TNC it requires developing and implementing various types of product, process, marketing and organizational innovation.

The results of this study demonstrate that the SMEs from Sonora of the MM and IT branches that presented innovation activities in the broadest range increased their probability to be accepted in the supplier network of the large transnationals established in the region. Furthermore, it was observed that the IT SMEs have greater probabilities to incorporate themselves into the global value chains.

We coincide with the affirmation by Lall (1992) when he says that, for most SMEs, doing business outside the markets that comprise their immediate geographical areas is a great challenge. The internationalization of the company is considered an evolutionary process, which is regularly slow and grows as its capabilities develop. If a company seeks to sale their products or services outside their local area, they must design a marketing strategy in national or international markets, because the level of competitiveness has been affected by globalization.

We find that the SMEs that employ marketing innovations to foray into the global market are few; their concerns are more in line with making improvements to their products, processes or services that will allow them to remain or survive in the local market. The incorporation process into the global markets is particularly difficult for these SMEs due to the lack of knowledge and resources that would allow them to export their products or services outside their area. For this type of companies, internationalization lies in having transnational companies that incorporate their production to the value chain as clients or, to a lesser extent, having that large companies marketing their products in geographical areas that would be difficult to access for them.

The opportunities to become a supplier to a TNC are scarce for the local SMEs. However, opportunities present themselves from the very strategies of these large companies. For example, to minimize costs or to solve immediate problems, they seek local companies that possess the necessary capabilities to meet their needs.

An important finding that demonstrates the results of the logistic regression model is that the MM SMEs of Sonora proportionally affiliate themselves more than those of IT, but the latter have greater probabilities of being chosen as suppliers for transnational companies, a

phenomenon that can be explained based on the type of innovations implemented, the activities of the companies themselves, and the needs of the TNCs.

The capabilities that the transnational companies request from the local SMEs are a powerful barrier for them to desist in the attempt to become suppliers. However, sometimes there are problems in the production lines, related to mechanical failures, that force the transnationals to look for immediate solutions with local metal-mechanic companies. On the other hand, the geographical context of the empirical study where this research develops has the characteristic of being close to the American market, where most of the head offices of the transnationals are found with branches established in the region. This situation favors the MM companies more than the IT companies, because the branches of the large companies adhere to the requirements of their main office regarding information systems, where their implementation and maintenance depend for the most part on the companies affiliated with the main office, thus it is difficult for a TNC established in the region to request the services of a local IT company.

In summary, the logistic regression model allows differentiating three basic conditions: 1) the probability for a local company to be chosen as supplier for a transnational is directly related to the types of innovation that this company has implemented; 2) the MM SMEs are proportionally affiliated more than the IT companies; and 3) the IT companies have greater probabilities than the MM companies to be chosen as suppliers for large companies.

Without a doubt, the pursuit for the development of national small and medium enterprises must be imperative in the agenda of the governmental decision makers, since it is necessary to promote public policies that prompt the improvement of the SMEs through a greater affiliation with higher education institutions and to promote the chaining of the local industry with transnational companies.

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