

**THE PRODUCTIVE STRUCTURE OF THE JAPANESE MAQUILADORAS
LOCATED IN TIJUANA, MEXICO**

Luis A. Berlanga-Albrecht*

Tsukuba University
Graduate School of International Political Economy
Tennoudai 1-1-1
Tsukuba-shi, Ibaraki-ken 305-0005
Japan
beal@gsipe.kokusai.tsukuba.ac.jp
berlanga_luis@hotmail.com

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Summary: This is a cross-section study of the productive structure of the Japanese Maquiladora firms located in the city of Tijuana, Mexico, conducted by classifying into two matrices of parts sourcing more than 5,000 component parts of 29 firms product and by estimating a Cobb-Douglas production function of three factor inputs –capital, labor and parts. The main results of the data systematization are: 1) the total value of parts engaged in the production process was 11.95 billion US dollars in 1993; 2) the only Latin American country taking part in the sourcing structure is Mexico, but has very little participation (0.001%); and 3) the 84.88% of the raw material and component parts are imported from Japan and 11.23% from the United States. Moreover, the production function estimate shows that: 1) the average variations of “wage and salaries” are the main influence over the added-value variations; and 2) the estimated production function exhibits constant returns to scale.

Key words: Case study, Japan, maquiladora, Mexico, productive structure.

I. Introduction

A wide array of scholars has extensively documented from different perspectives the globalization process of the productive system and its impacts on economic structures.

There is a general consensus that the transnationalisation and desegmentation of the productive process increases host country's opportunities not just by augmenting its employment rate but also by developing its industrial capacity by tying-up local small and medium enterprises (SMEs) production with transnational companies (TNCs) either by meeting the transnational firms' productive process requirements of component parts and other inputs or by supplying tools and technology [see, for example, OECD (1996)].

However, to be able to engage different aspects of a successful industrial policy in order to embed local suppliers in the international production system requires a deep understanding of different sets of research agenda. On one hand, the TNCs productive structure, its industrial relations systems and the viability of its international transplantation –which in turn takes us into the analysis of what kind of institutional framework is supporting the firms overseas operations. On the other hand, it also requires empirical research into the domestic productive structure, its industrial relations systems as well as a full comprehension of the institutional forces shaping the domestic industrial organization and controlling the viability of its economic development.¹

The conceptualization of a process of industrial integration by an analytical triad “productive structures-industrial systems-governing institutions” is beyond the scope of this research. This paper presents to the scholar's community a detailed analysis of the productive structure of the Japanese maquiladoras located at the city of Tijuana, Mexico, in 1993. The aim is to contribute new and accurate information on a scientific problem which has been studied from different perspectives and could be embraced in a single question which has not been completely answered: What are the economic and social issues relevant to the maquiladora investment?

To answer these questions scholars have focused on the impact on the skill development of the domestic workforce [see, for example, Bustamante (1983), Sargent and Matthews (1997)], the profile of the labor market and labor relations [see, for example, Carrillo (1991a, 1991b)], as well as the work and production organizational forms [see Kenney and Florida (1993, 1994)].

¹ An introduction to institutions and economic development literature can be found in: Harry, John (et.al.) editors (1995), **The New Institutional Economics and Third World Development**, Routledge, London, chapters one and two. Another excellent reference is: Nabli, Mustapha K. and Jeffrey B. Nugent, editors (1989), **The New Institutional Economics and Development. Theory and Applications to Tunisia**, Elsevier Science Publishers B.V., Netherlands, chapter one. Also it is recommended to review: Coase, Ronald (1992), The Institutional Structure of Production, Alfred Nobel Memorial Prize Lecture in Economics, *American Economic Review*, Vol. 82, No. 4, pp. 713-719.

One shared conclusion in this strand of research is that since the maquiladora firms were conceived basically just like assembly plants, the production process is labor intensive and therefore one important factor driving the FDI in the maquiladora industry is the low labor cost.²

The effects on employment rates and production operations have been researched from a different perspective [Szekely (1991)]. Also, location strategies [South (1990), Coronado (1992)] and technological change [Hualde, et.al. (1994)] are insights clarifying the maquiladora's economic effects. While there is not doubt about the positive impacts of the maquiladora investment on employment rates [Vargas (1996)] and its role in globalization [Gereffi (1994)], there is still much to research in the field of productive structure.

Barraza (1990) and Kenney and Florida (1994) pioneered studies dealing with the maquiladoras sourcing structure, but their insights are lacking in exact data with which to research into the economic nature of the maquiladora industry.

This paper is organized as follows. Section II explains the methodology and data sources used in this study (with regard to the sample, data and measures). Section III presents an overview of the Japanese maquiladora industry located in Tijuana and analyzes its productive structure by estimating a production function and the systematization of the raw materials and component parts structure (RM/CP). Section IV presents the conclusions.

II. Data Sources and Methodology

Maquiladoras (also called maquilas) are firms that operate under a special set of provisions – known as the *maquila* program- that allows duty-free importation of machinery, equipment and tools as well as RM/CP into Mexico as long as 100% of production is exported [Sargent and Matthews (1997)]³. Although if firms solicit permission, the Mexican government may authorize maquiladora firms to sell part of production to domestic market.

One of the strategies of the Mexican government to promote industrial development on the northern part of Mexico was the introduction of the maquiladora program in 1965. The goals of the program were: “(a) to attract foreign firms and stimulate employment, (b) to provide a source of foreign exchange and (c) to enhance technology transfer to Mexico and build linkages to national industry” [Kenney and Florida (1994), p.29].

² For a review of the literature about maquiladora firms location please refer to Kenney and Florida (1994).

³ Restated from note number one, p.1680.

By law, every maquiladora must submit to the Mexican Secretary of Commerce and Industrial Promotion (known as SECOFI⁴) a set of documents, composed of four different reports, that details the production process. The data set systematized for this study is derived from these official documents⁵.

Non-dollar value for any unit is presented in this study because the value of the amount can easily reveal the firm's identity. Also, these considerations about data confidentiality limited the tables' framework. For example, there are two sectors of activity – 'Other Products Made of Wood and Cork' and 'Engines and Car Accessories'- with one single firm each, these two firms were grouped together with other two firms belonging to a third sector – 'Other Manufacturing Industries'- in a column titled 'Remaining Firms' in table 5.

(a) *Sample*

The maquiladora firms identified for the sample are those listed as Japanese maquiladoras in the records of SECOFI Regional Office at the city of Tijuana in 1994, i.e. the criterion used in this research to build up the data base counts a plant, or a series of plants, as a maquiladora firm in accordance with the way the investment is officially recorded in the Mexican government's register. So, for example, Sanyo has five different plants, each one producing a different electronic good, but there is one top management office legally liable for carrying out the production process of these products. The Mexican official register counts these then as one Japanese maquiladora firm. On the other hand, Matsushita Battery and Kyushu Matsushita Electric are counted as two different maquiladora firms because the legal authorization to produce rechargeable alkaline batteries and wireless telephones was required of Mexican government by two different local top management offices –i.e. both of these plants have their own Articles of Incorporation⁶ according to the Mexican law but both are owned subsidiaries of Matsushita Electric Industries Corporation in the United States.⁷

So, according to the SECOFI records as of 1993, 32 Japanese maquiladora firms were doing operations in Tijuana⁸. However, it was not possible to analyze the whole population

⁴ SECOFI is the shortened form of *Secretaria de Comercio y Fomento Industrial*.

⁵ The Mexican government specifies the official frame document and specialized staff of the firm writes down the data. Some of it is published, the rest remains unpublished.

⁶ *Articles of Incorporation* is a document that creates a private corporation according to the general corporation laws of the State [Friedman, Jack P. (1994), **Dictionary of Business Terms**, second edition, Barron's Educational Series, United States]. The translation into Spanish is *acta constitutiva*.

⁷ In fact, their respective productive processes in Tijuana are integrated into one to produce wireless telephones for the United States market. That is, some Japanese maquiladoras operate as primary suppliers to other Japanese maquiladoras.

In order to allow for methodological comparisons the example presented in this study parallels Kenney and Florida (1994) exemplification.

⁸ The number differs from previous studies accordingly as the applied methodology. To review different methodologies for sample identification see, for example, Barraza (1990), Szekely (1991), Kenney and

because problems raised from lacunas and inconsistency in the submitted information of three companies. So, the sample for regression analysis and for the sourcing-sector matrix consists of 29 cases.

Regarding the sourcing-country matrix, although only the largest 16 firms declared the sourcing country, this sample can be considered representative because the value of the comprised RM/CP is equivalent to 86% of the total value.

(b) *Data*

Both matrices of sourcing parts are built up of data from the official document titled “Temporary Imports Authorization. Non-Transferable” (*Autorización de Importación Temporal. No Transferible*) which include very detailed information on each unit of RM/CP used to manufacture or/and assemble the final output. The data recorded in this document are the kind of RM/CP, the total quantity engaged in the production process, the price of one single unit of the part and the total price of the total quantity of each kind of part and raw material, as well as the sourcing country of each item. A total of 5,095 RM/CP were systematized into 13 chief sectors of manufacture activity.

In the same source are specified data on tools, equipment and machines, as well as their respective price per unit.

The data on value-added, gross product value, wages and salaries, total number of jobs and destination country of output were obtained from two documents. One is known as the “Certificate of Actualization of the Export Maquiladora Industry” (*Cédula de Actualización de la Industria Maquiladora de Exportación*), and the other one as “Monthly Survey of the Maquila Industry” (*Cuestionario para la Estadística Mensual de la Industria Maquiladora de Exportación*). In the case when data were not undoubtedly confident, the document “Renovation Program of the year 1993” (*Programa de Renovación 1993*) was consulted to give confirmation on the data concerned.

(c) *Measures*

The measures used in this study are as follows.

The variable ‘labor’ was measured by the total annual value of wages and salaries paid by the firm, which means there is no differentiation on the added value, either of skilled work from unskilled work or plant workers from office employees.

Florida (1994).

Since it was not possible to estimate the capital depreciation, the capital was approximated by the total monetary value of machinery, equipment and tools reported as new acquisitions for the production process in 1993.

With regards to the value-added the applied criterion relies on the assumption that this measure is accurately reported by every maquiladora to SECOFI.

The variable 'raw materials/component parts' was measured by adding up the value of raw materials and component parts of each maquiladora.

III. Productive Structure

(a) Overview

By 1993, the 32 firms constituting the industry (equivalent to 1.38% of the total maquiladora firms located in Mexico in 1993) were basically concentrated in three sectors of activity (see table 1). The largest one is 'Electric and Electronic Equipment and House-Hold Appliances' sector, which was comprised of 21 firms assembling refrigerators, televisions, video recorders, speakers, batteries, etc. Four firms manufacture high-precision products made of plastic (or the so-called plastic products sector) and three firms manufacture metal products.

Two out of the four remaining firms are classified in the 'Other Manufacturing Industries' sector. Another one is manufacturing seat belts and thus is classified in the 'Engines and Car Accessories' sector. The last one is manufacturing bases (where products are stored for safe keeping) made of wood.

The Japanese FDI in the maquila program at Tijuana started in 1979 (see table 1). But the most notable period of FDI was 1987-1989, which coincided with the time when Japanese TNCs were at its peak of relocating abroad due to the appreciation of the yen.⁹

The Japanese maquiladora industry posted an investment value of 154.6 million dollars in 1992, this was roughly 27% of the total Japanese FDI in Mexico for the period 1987-1992, and in 1993 accounted for 2.19% (12,110 people) of the total Mexican maquiladora industry employment.

⁹ The exchange rate in 1985 was 200.5 yen per dollar; in 1989 was 143.45 yen. In some months of 1986 the figure of flight firms reached 150 firms.

TABLE 1
YEAR OF LOCATION IN TIJUANA AND MAQUILADORA SECTOR OF ACTIVITY
 (Number of firms)
 Code of Sector of Activity

Year	30	42	50	53-54-55	57	59	Total
1979				1			1
1982				1			1
1984				1			1
1985				2			2
1986	1			1			2
1987		1	1	5			7
1988		2		4		1	7
1989				3		1	4
1990			1	1			2
1991		1			1		2
1992			1	2			3
1993							0
<i>Total</i>	<i>1</i>	<i>4</i>	<i>3</i>	<i>21</i>	<i>1</i>	<i>2</i>	32

Sector 30: Other products made of wood and cork.

Sector 42: Plastic products.

Sector 50: Other metal products but machinery.

Sectors 53-54-55: Electric and electronic equipment and household appliances.

Sector 57: Engines and car accessories.

Sector 59: Other manufacturing industries.

Note: The classification was made according as the Mexican codification system at two digits level. Refer to Instituto Nacional de Geografía e Informática (1992).

Source: Author's database.

To discern the employment structure in three categories –unskilled worker, skilled worker or technicians and office employees- is to allow us to judge as to what extent the Japanese employment structure is similar or not similar with other structures; for example, with the employment structure of the maquiladora electronic firms¹⁰ (see table 2).

The indexes' average shows that, given the technology and the management of firms' affairs, the Japanese maquiladora firms hire less workers by technician than the electronic maquiladora firms –the difference is equivalent to 1%. But on the other hand, the higher ratio for Japanese firms' laborer-office employee may be indicative of higher office employee productivity of Japanese firms. However, in order to make a definite conclusion, it is needed to go further into comparative analysis, which is beyond the reach of this paper.

¹⁰ It was compared with a stratified sample of maquiladora firms located in Tijuana and manufacturing electronic goods. The sample comprises 29 cases, including one Japanese maquiladora firm. See Salinas (1994).

TABLE 2
EMPLOYMENT STRUCTURE INDEXES

Index	Japanese maquiladora firms	Electronic maquiladora firms
Laborers/Technicians	10.46	10.56
Variance	101.05	115.27
Max	73	84
Min	0.13	Non technician
Laborers/Office employees	16.89	14.42
Variance	187.34	122.79
Max	76.96	69.80
Min	0.01	Non office employee ^{1}

{1} This can be the case of a maquiladora completely managed in U.S.

The source for electronic firms is Salinas' database.

The source for Japanese firms is the author's database.

So, according to the aim of this investigation, it can be said that the employment structure of the Japanese maquiladora industry located in Tijuana in 1993 was composed of 85.64% laborers, 7.58% office employees and 6.78% technicians.

The Japanese maquiladoras located in Tijuana in 1993, paid the laborers, technicians and office employees 39.6 million U.S. dollars, the quantity of which is equivalent to 53.18% of these Japanese firms value-added (74.51 million dollars), which in turn is equivalent to 1.5% of the whole of Mexican maquiladora industry's value-added.

(b) *Raw Materials/Component Parts Sourcing Structure*

Tables 3 and 4 give us a first glance on the structure of the RM/CP demand. The total dollar value of raw materials and component parts is 11.95 billion U.S. dollars. These items were categorized into 13 different manufacturing sectors plus one group to arrange those lacking the necessary information to be identified. The Japanese maquiladora industry considered as a whole sourced mostly from five different sectors of industrial activity (see table 3).

Since the largest and most of the firms produce electric and electronic equipment and household appliances, it is not surprising to find that 75.23% of the total parts and raw materials are sourced by the 'Electric and Electronic Equipment and Components' sector. The second largest sourcing sector is 'Chemical Products' (10.03%) and the third one is the 'Rubber and Plastic' sector (4.33%). 'Paper and Cardboard' and 'Other Metal Products' sectors were the source of 3.26% and 2.60% of all RM/CP respectively.

TABLE 3
RAW MATERIALS/COMPONENT PARTS SOURCING-SECTOR
 Résumé
 (U.S. dollars and percentages)

<i>Sourcing Sector</i>	<i>Value</i>	<i>Participation</i>
Electric and Electronic Equipment and Components	8,990,492,750	75.23%
Chemical Products	1,198,480,388	10.03%
Rubber and Plastic Products	517,614,605	4.33%
Paper and Cardboard	389,857,697	3.26%
Other Metal Products	310,903,760	2.60%
Basic Industries of Non Ferroses Metals	85,498,045	0.72%
Wood Products	66,425,368	0.56%
Products Made of Non Metal Minerals	64,153,162	0.54%
Auxiliary Materials	42,508,714	0.36%
Printing and Publishing Industry	40,286,722	0.34%
Basic Industries of Iron and Steel	26,175,632	0.22%
Textile Industry	2,619,104	0.02%
Other Manufacturing Industries	114,143,625	0.96%
Other Sourcing Sectors	11,302,674	0.09%
Unidentified Items	90,698,054	0.76
Total Value	11,951,160,300	100%

Source: Author's database.

The Japanese maquiladoras as a whole source from 13 different countries (see table four) as follows: 1) three North American countries (Canada, Mexico and United States); 2) eight Asian countries (China, Hong Kong, Japan, Malaysia, Singapore, South Korea, Taiwan and Thailand); and 3) two European countries (England and France).

Primary suppliers located in Japan source the bulk of RM/CP (84.88%), and the second sourcing-country is United States (11.22%). Regarding the remainder 3.89%, it is supplied mainly from other Asian countries like Taiwan (2.48%), South Korea (0.77%) and Malaysia (0.48%).

These findings are indicative of an almost complete lack of linkages between Japanese maquiladoras and domestic as well as European suppliers. RM/CP from Mexico are equivalent to 0.001% (mostly cardboard boxes). England and France's RM/CP participation is 0.003%.

Table 5 shows the sourcing-country of each maquiladora by sector of activity. Firms belonging to both sectors -'Metal Products Excluding Machinery' and 'Electric and Electronic Equipment and House-Hold Appliances'- source mainly from Japan (61.14% and 84.39% respectively). The sector 'High-Precision Plastic Products' has its primary suppliers mostly in the United States (from whom get an equivalent to 88.35% of the total RM/CP dollar value).

TABLE 4
RAW MATERIALS/COMPONENT PARTS SOURCING-COUNTRY
LARGEST 16 JAPANESE MAQUILADORAS
 Résumé
 (U.S. dollars and percentages)

<i>Sourcing Country</i>	<i>Value</i>	<i>Participation</i>
Japan	8,732,143,833	84.88%
United States	1,155,421,115	11.23%
Taiwan	255,383,937	2.48%
South Korea	68,507,785	0.67%
Malaysia	48,931,992	0.48%
China	5,651,856	0.05%
Others ^{1}	21,849,581	0.21%
Total	10,287,890,099	100%

{1} Canada, England, France, Hong Kong, Mexico, Singapore and Thailand.
 Source: Author's database.

TABLE 5
PARTS SOURCING-COUNTRY
LARGEST 16 JAPANESE MAQUILADORAS
 (percentages)

Sourcing Country	MAQUILADORA SECTOR OF ACTIVITY			
	High-Precision Plastic Products	Metal Products Excluding Machinery	Electric and Electronic Equipment and Household Appliances	Remaining Firms ^{1}
South Korea	0.00	0.00	0.74	7.58
United States	88.35	35.12	11.91	92.42
Japan	11.65	61.14	84.39	0.00
Malaysia	0.00	0.00	0.24	0.00
Taiwan	0.00	0.00	2.53	0.00
Other Countries ^{2}	0.00	3.74	0.18	0.00
TOTAL	100%	100%	100%	100%

{1} Four firms distributed among sectors 30, 57 and 59.

{2} Canada, England, France, Hong Kong, Singapore and Thailand.

Source: Author's database.

The sourcing-sector matrix (see table 6) singles out the separate firms of Japanese maquiladora industry. This matrix shows a strong level of concentration, a single firm (firm X) demands the overwhelming bulk of items (70.75% of the total dollar value). Two firms together ask for 12.31% of the items (firm I plus firm M). If we add firms –which participation in the total RM/CP demanded is between one and two percent- together, it is found that a total of six firms require 10.38% of the RM/CP (firms A, G, J, K, N and V). The remaining 20 firms ask for the rest 6.56%.

Also, from table 6 we can classify industrial sectors attending its occurrence among the top three sourcing-sectors of each firm. According to this sourcing-sectoral standing criterion:

TABLE 6
SOURCING-SECTOR MATRIX BY FIRM
(percentages)

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<i>Sourcing-Sector</i>	<i>A</i>	<i>B</i>	<i>C</i>	<i>D</i>	<i>E</i>	<i>F</i>
Electrical & Electronic Equipment and Components	58.41%	85.59%	9.59%	42.55%	31.66%	5.89%
Chemical Products	3.79%	0.13%	1.44%	1.10%	4.96%	1.19%
Rubber and Plastic Products	24.43%	0.38%	3.88%	32.89%	47.18%	20.75%
Paper and Cardboard	0.80%	0.00%	0.00%	0.12%	4.16%	10.46%
Other Metal Products	2.51%	10.98%	52.88%	0.77%	9.77%	30.93%
Basic Industries of non Ferrous Metals	0.00%	0.14%	0.03%	3.35%	0.82%	0.06%
Wood Products	4.75%	0.00%	0.00%	0.00%	0.00%	4.17%
Products Made of Minerals Non Metal	0.00%	0.23%	1.01%	15.13%	0.00%	0.00%
Auxiliary Materials	1.39%	0.87%	1.88%	3.40%	0.00%	0.00%
Printing and Publishing Industry	0.70%	0.54%	0.25%	0.02%	0.94%	0.10%
Basic Industries of Iron and Steel	0.00%	0.00%	25.76%	0.00%	0.00%	20.73%
Textile Industry	0.18%	0.00%	0.00%	0.00%	0.31%	1.88%
Other Manufacturing Industries	2.26%	0.00%	0.05%	0.04%	0.00%	0.00%
Other Sourcing-Sectors {1}	0.71%	1.00%	0.00%	0.00%	0.03%	0.00%
Unidentified Items	0.08%	0.14%	3.23%	0.63%	0.17%	3.83%
Total (%)	100%	100%	100%	100%	100%	100%
Firms Participation in the RM/CP Total Value	1.13%	0.67%	0.24%	2.43%	0.22%	0.39%

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<i>Sourcing-Sector</i>	<i>G</i>	<i>H</i>	<i>I</i>	<i>J</i>	<i>K</i>	<i>L</i>
Electrical & Electronic Equipment and Components	45.14%	2.00%	14.10%	61.45%	31.28%	51.00%
Chemical Products	0.22%	0.00%	21.44%	1.73%	0.03%	2.90%
Rubber and Plastic Products	18.45%	43.20%	4.92%	22.12%	28.08%	4.72%
Paper and Cardboard	1.83%	1.52%	38.44%	0.57%	35.26%	0.86%
Other Metal Products	2.48%	1.03%	16.40%	5.58%	0.75%	18.91%
Basic Industries of non Ferrous Metals	3.56%	0.00%	0.64%	0.54%	0.00%	0.18%
Wood Products	0.07%	0.00%	0.08%	0.01%	0.03%	0.00%
Products Made of Minerals Non Metal	0.00%	0.00%	0.00%	0.00%	0.00%	18.60%
Auxiliary Materials	0.06%	10.59%	0.00%	0.02%	0.00%	0.01%
Printing and Publishing Industry	1.92%	41.26%	0.09%	0.64%	0.03%	0.99%
Basic Industries of Iron and Steel	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%

Textile Industry	0.00%	0.36%	0.05%	0.03%	0.00%	0.00%
Other Manufacturing Industries	0.15%	0.01%	3.14%	2.23%	0.53%	0.73%
Other Sourcing-Sectors {1}	0.02%	0.00%	0.18%	3.07%	0.00%	0.21%
Unidentified Items	26.11%	0.02%	0.52%	2.00%	4.03%	0.90%
Total (%)	100%	100%	100%	100%	100%	100%
Firms Participation in the RM/CP Total Value	1.78%	0.24%	6.00%	1.63%	1.02%	0.38%

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<i>Sourcing-Sector</i>	<i>M</i>	<i>N</i>	<i>O</i>	<i>P</i>	<i>Q</i>	<i>R</i>
Electrical & Electronic Equipment and Components	74.87%	86.54%	0.00%	0.33%	0.00%	0.00%
Chemical Products	0.70%	0.03%	2.77%	5.28%	50.34%	0.00%
Rubber and Plastic Products	13.46%	4.51%	0.09%	0.00%	46.55%	0.00%
Paper and Cardboard	0.26%	4.68%	0.05%	0.02%	1.17%	92.42%
Other Metal Products	1.33%	0.20%	5.78%	1.10%	0.00%	7.58%
Basic Industries of non Ferrous Metals	0.09%	0.00%	91.17%	10.71%	0.00%	0.00%
Wood Products	5.58%	0.00%	0.00%	0.00%	0.00%	0.00%
Products Made of Minerals Non Metal	0.40%	0.00%	0.00%	0.00%	0.00%	0.00%
Auxiliary Materials	1.55%	0.00%	0.00%	0.00%	0.00%	0.00%
Printing and Publishing Industry	0.15%	0.96%	0.00%	0.00%	0.81%	0.00%
Basic Industries of Iron and Steel	0.00%	0.00%	0.00%	82.44%	0.00%	0.00%
Textile Industry	0.00%	0.12%	0.00%	0.00%	0.00%	0.00%
Other Manufacturing Industries	1.42%	2.81%	0.00%	0.00%	0.00%	0.00%
Other Sourcing-Sectors {1}	0.03%	0.00%	0.00%	0.00%	0.00%	0.00%
Unidentified Items	0.18%	0.15%	0.14%	0.13%	1.13%	0.00%
Total (%)	100%	100%	100%	100%	100%	100%
Firms Participation in the RM/CP Total Value	6.31%	2.38%	0.03%	0.05%	0.14%	0.00%

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<i>Sourcing-Sector</i>	<i>S</i>	<i>T</i>	<i>U</i>	<i>V</i>	<i>W</i>	<i>X</i>
Electrical & Electronic Equipment and Components	0.00%	0.87%	27.04%	80.24%	0.12%	85.64%
Chemical Products	99.48%	55.32%	0.61%	2.66%	11.56%	11.14%
Rubber and Plastic Products	0.52%	1.68%	31.53%	8.73%	1.89%	0.47%
Paper and Cardboard	0.00%	1.74%	1.93%	0.88%	0.57%	0.43%
Other Metal Products	0.00%	4.57%	38.64%	2.00%	14.04%	0.98%
Basic Industries of non Ferrous Metals	0.00%	0.97%	0.03%	0.66%	6.79%	0.62%
Wood Products	0.00%	0.00%	0.00%	0.04%	0.15%	0.03%
Products Made of Minerals Non Metal	0.00%	0.00%	0.00%	0.03%	0.00%	0.10%
Auxiliary Materials	0.00%	1.87%	0.11%	2.06%	0.08%	0.07%

Printing and Publishing Industry	0.00%	3.66%	0.00%	0.20%	0.00%	0.15%
Basic Industries of Iron and Steel	0.00%	0.00%	0.00%	0.04%	59.20%	0.03%
Textile Industry	0.00%	0.00%	0.00%	0.12%	0.00%	0.00%
Other Manufacturing Industries	0.00%	25.54%	0.10%	0.67%	0.00%	0.29%
Other Sourcing-Sectors {1}	0.00%	1.73%	0.00%	0.02%	5.20%	0.00%
Unidentified Items	0.00%	2.05%	0.02%	1.68%	0.41%	0.07%
Total (%)	100%	100%	100%	100%	100%	100%
Firms Participation in the RM/CP Total Value	0.02%	0.71%	0.20%	2.44%	0.02%	70.75%

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<i>Sourcing-Sector</i>	<i>Y</i>	<i>Z</i>	<i>AA</i>	<i>AB</i>	<i>AC</i>	<i>TOTAL</i>
Electrical and Electronic Equipment and Components	13.38%	6.48%	59.67%	0.40%	92.91%	75.22%
Chemical Products	19.98%	46.14%	11.61%	14.56%	2.14%	10.03%
Rubber and Plastic Products	2.75%	1.08%	1.91%	8.36%	1.36%	4.33%
Paper and Cardboard	0.12%	2.13%	0.16%	4.94%	0.21%	3.26%
Other Metal Products	1.95%	41.93%	4.33%	14.86%	0.78%	2.60%
Basic Industries of non Ferrous Metals	2.96%	1.57%	2.54%	0.00%	0.38%	0.72%
Wood Products	0.00%	0.07%	0.00%	53.99%	0.00%	0.56%
Products Made of Minerals Non Metal	0.00%	0.00%	0.00%	0.00%	0.00%	0.54%
Auxiliary Materials	0.08%	0.00%	3.65%	0.51%	0.00%	0.36%
Printing and Publishing Industry	0.00%	0.00%	0.09%	0.97%	0.00%	0.34%
Basic Industries of Iron and Steel	0.00%	0.04%	0.40%	0.00%	0.00%	0.22%
Textile Industry	0.00%	0.21%	0.00%	0.33%	0.00%	0.02%
Other Manufacturing Industries	56.46%	0.01%	8.61%	1.05%	0.40%	0.96%
Other Sourcing-Sectors {1}	0.00%	0.00%	0.00%	0.02%	0.00%	0.10%
Unidentified Items	2.33%	0.35%	7.03%	0.01%	1.82%	0.76%
Total (%)	100%	100%	100%	100%	100%	100%
Firms Participation in the RM/CP Total Value	0.19%	0.04%	0.28%	0.20%	0.08%	100.00%

{1} Cattle Raising, Sugar, Oil and its Derivations, Coal and Graphite Extraction and its Derivations, Minerals Non Metals, Basic Chemistry, Other Textiles, Glass and Glass Products, Cement.

Source: Author's database.

- 1) 'Electrical and Electronic Equipment and Components' sector is the main sourcing-sector of 12 firms (A, B, D, G, J, L, M, N, V, X, AA and AC). Also this sector is the second more important sourcing one of firms E and K, and is the third largest sourcing-sector of firms C, U, Y and Z.
- 2) The second most remarkable sectors are 'Chemical Products' and 'Other Metal Products'. Each sector is one of the three top sourcing-sectors of 15 firms.

For four Japanese maquiladoras the main RM/CP are chemical products (firms Q, S, T and Z); for five firms (I, X, Y, AA and AC) this sector is the second source of RM/CP

and for six firms (A, O, P, V, W and AB) chemical products are the third range of sourcing sector.

Regarding metal products, the maquiladoras C, F and U mainly source from this sector; for firms B, L, O, R, W, Z and AB the second largest set of parts engaged in their production process are component parts made of metal; and for five maquiladoras (E, I, J, T and X) the 'Other Metal Products' is the third source of RM/CP.

- 3) Also, this sourcing-sector standing indicates that 13 firms have a production process such that the 'Rubber and Plastic' sector is one of the three top three main sourcing sectors. The final output of two maquiladoras (E and H) is mostly made of rubber and/or plastic parts; for eight firms this sector is the second largest source of RM/CP and for three firms (G, K and N) rubber and/or plastic intermediate goods are the third main component of their final product.

(c) *Technology*

It is assumed that the relation among labor, capital, RM/CP and output can be explained by a functional form¹¹, like the Cobb-Douglas production function, of three components because: 1) the sample is relatively small (29 cases), thus the functional form proposed by Cobb and Douglas¹² allows the higher number of degrees of freedom, and 2) there is a consensus that this functional form has property to the value of cross-section studies.¹³

The functional form specification is:

$$Y = AK^\alpha L^\beta I^\gamma \quad (1)$$

Where: - Y represents the value-added produced;
- K is the total value of new capital stock acquired in 1993;
- L represents the labor services used to produce Y;

¹¹ A basic reference to functional forms is: Fuss, Melvyn et.al. (1987), A Survey of Functional Forms in the Economic Analysis of Production, in Melvyn Fuss and Daniel McFadden, editors, **Production Economics: A Dual Approach to the Theory and Applications**, North-Holland, London.

¹² Cobb, C. and P.H. Douglas (1928), A theory of Production, *American Economy Review*, Vol. 18, pp. 136-165.

¹³ See, for example: Caves, Richard E. and David R. Barton (1990), **Efficiency in U.S. Manufacturing Industries**, MIT Press, U.S. Also you can see: Sinha, Rajeeva (1993) Foreign Participation and Technical Efficiency in Indian Industry, *Applied Economics*, Vol. 25, pp. 583-588. Also, a comparative analysis of different functional forms can be found in: Corbo, V. and J. de Melo (1986), Measuring Technical Efficiency, a Comparison of Alternative Methodologies with Census Data, in A. Dogramaci, editor, **Measurement Issues and Behaviour of Productivity Variables**, Studies in Productivity Analysis, No. 7, Kluber Academic Pub., pp. 188-223.

- I represents the raw materials and the component parts used to produce Y;
- A captures shifts in the production function due to, for example, technological change.

One by one, the coefficients of equation (1) are the estimates of the respective elasticities of the value-added and by adding the coefficients together we get the information about the degrees of returns to scale.

Estimation results

The estimated regression measures the variables of equation (1) in natural logarithms

$$\ln Y_i = \ln A + \alpha \ln K_i + \beta \ln L_i + \gamma \ln I_i + e_i \quad (2)$$

The subscript 'i' refers to the ith-firm and 'e' is an error term.

The coefficients of equation (2) were estimated by Ordinary Least Squares (OLS) method using a sample of 29 firms. The equation estimated is:

$$\ln Y_i = 0.568 + 0.0301 \ln K_i + 0.947 \ln L_i + 0.0219 \ln I_i + e_i \quad (3)$$

(1.2035) (0.0855) (0.1113) (0.0950)

Degrees of freedom = 25

The numbers in parentheses are the estimated standard errors.¹⁴

The results make known a regression line satisfactorily adjusted since: 1) an 82.22% of value-added variation are attributed to the (logarithm of) machinery value, wage and salaries and raw materials/component parts value variations; and 2) the estimated parameters have the expected signs.¹⁵

The elasticity 'wages and salaries' is the most important source of variation of the value-

¹⁴ Since the aim of this study is not to make projections but to analyze the economic nature of the Japanese maquiladora firms located in Tijuana in 1993, the statistic 't' is not presented. However, it is of worth to mention that the 't' statistics are (0.4722), (0.3522), (8.5036) and (0.233) respectively. Only the 'wages and salaries' elasticity is significantly different from zero.

¹⁵ However, as it could be expected from cross-section data, multicollinearity problems raised between the logarithm of capital and logarithm of labor as well as between logarithm of capital and logarithm of RM/CP. This is because, given the technology, as more machinery is used to increase the output, the number of employees and the quantity of RM/CP engaged in the production will also increase. To resolve this problem it is recommended to make variable transformations, but in turn interpretation problems about the new variables arise.

On the other hand, neither heteroskedasticity nor autocorrelation problems were detected.

The statistic 'F' was used to test multicollinearity; the White test was applied to test heteroskedasticity; and the statistic Durbin-Watson was used to test autocorrelation.

added. In other words, *ceteris paribus*, a 1% change in ‘wages and salaries’ would, according to this estimate, increase value-added by 0.94%.

Furthermore, the addition of the three estimated coefficients of elasticity is indicative of constant returns to scale (the value is 0.999).

IV) Conclusions

This study is a step to broaden our knowledge about maquiladora industry facts. Based on a documentary research and analysis, this paper clarifies the exact economic nature of the production process of the Japanese maquiladora firms located at the city of Tijuana in 1993.

The global sourcing structure of the Japanese maquiladora firms is described by using a matrix of sourcing-sector and another one of sourcing-country. Also, its productive structure is examined by applying a statistical approach which estimates the value-added elasticities of a Cobb-Douglas production function of three components.

Perhaps the main contribution of this study is the rigorous systematization of every raw material and component part engaged in the production process. The finding that the sourcing structure is worth 11,951,160,300 U.S. dollars –roughly equivalent to 10% of the Mexican foreign debt in 1993- could be of importance in helping policy makers to determine policies related to industrial affairs of the Mexican government.

The picture of the sourcing structure shows a serious bias toward the ‘Electric and Electronic Equipment and House-Hold Appliances’ sector. This is the most important sector in terms of number of firms, value-added, number of jobs and dollar value of raw materials and component parts.

A sourcing-sector standing analysis makes known that ‘Chemical Products’, ‘Other Metal Products’ and ‘Rubber and Plastic Products’ are also remarkable sectors in terms of most frequent or habitual sourcing-sectors. A straight industrial policy recommendation derived from this finding could be that the strength of domestic SMEs operating in these four sectors would be a strategic step toward the implementation of an industrial development policy pursuing links with TNCs.

In spite of the fact that 84.88% of the RM/CP are imported from Japan and 11.23% from the United States, table five makes known that we can not characterized every Japanese maquiladora firm as acquiring most of the RM/CP from Japan. The conformation of the sourcing structure relies on the firm’s industrial activity.

Other results of data systematization are:

- 1) After Japan and the United States, RM/CP are imported from other Asian countries, mainly from Taiwan (2.48%);
- 2) Mexico has very little participation in the global sourcing structure (0.001%); and
- 3) Other Latin American countries have no participation.

To find that labor cost variations is the foremost influential variable on added value variations is not an unexpected result but statistically provides empirical evidence on what has been assumed in studies clarifying labor relations and characteristics of the maquiladora labor market.

Also, the estimated production function indicates that, in average, the production process of the Japanese maquiladora industry located in Tijuana in 1993 was characterized by constant returns of scale. This finding suggests that as the Japanese maquiladora industry expands, the cost per unit of output remains constant.

References

- Barraza Montoya, Cesar, et.al. (1990), **Estudio de Insumos en la Industria Maquiladora de Exportación en el Estado de Baja California** (A Study of the Inputs of the Maquiladora Industry of the State of Baja California), a joint publication by Centro de Enseñanza Técnica y Superior, Banco Nacional de México, Asociación Mexicana de Parques Industriales Privados A.C. and Gobierno del Estado de Baja California, Baja California, Mexico.
- Bustamante, J. (1983), Maquiladoras: A New Face of International Capitalism on Mexico's Northern Frontier, in J. Nash and M.P. Fernandez Kelly, **Women, Men and the International Division of Labor**, State University of New York Press, Albany, N.Y., pp. 224-256.
- Carrillo, J. et.al. (1991a), **Mercados de Trabajo en la Industria Maquiladora de Exportación, Síntesis del Reporte de Investigación** (Labor Markets of the Maquiladora Industry, A Research Report Summary), a joint publication by The Mexican Secretary of Labor and El Colegio de la Frontera Norte, Tijuana, Mexico.
- Carrillo, J. (1991b), The Evolution of the Maquiladora Industry: Labor Relations in a New Context, in Keven Middlebrook (Ed.), **Unions, Workers, and the State in Mexico**, Center for U.S.-Mexican Studies, University of California, San Diego.
- Coronado Yu, Blanca E. (1992), La Localización como estrategia de Competitividad de las Firmas Japonesas. El Caso de la Rama Electrónica en Tijuana (Location as Strategy of Competition of the Japanese Firms. The Case of the Electronic Sector in Tijuana), El Colegio de la Frontera Norte, Master Thesis, Tijuana, Mexico.
- Gereffi, Gary (1994), Mexico's Maquiladoras in the Context of Economic Globalization, paper for delivery at the conference "Las maquiladoras en México, presente y futuro del desarrollo industrial" (Maquiladoras in Mexico. Present and Future of Industrial Development), of El Colegio de la Frontera Norte, Tijuana, Mexico, May 23-25.
- Hualde, Alfredo, Alfonso Mercado and Eduardo Zepeda (1994), Industrialización y Cambio Tecnológico en la Maquiladora Fronteriza (Industrialization and Technological Change in the Bordering Maquiladora), paper for delivery at the conference "Las maquiladoras en México, presente y futuro del desarrollo industrial" (Maquiladoras in Mexico. Present and Future of Industrial Development), of El Colegio de la Frontera Norte, Tijuana, Mexico, May 23-25.

- Instituto Nacional de Geografía e Informática (1992), **Sistema de Cuentas Nacionales de México, 1988-1991** (National Accounting System of Mexico, 1988-1991), Vol. 1, Mexico.
- Kamiyama, Kunio (1994), Comparative Study of Japanese Maquiladoras with the Plants in the U.S. and Asean Countries, paper for delivery at the conference “Las maquiladoras en México, presente y futuro del desarrollo industrial” (Maquiladoras in Mexico. Present and Future of Industrial Development) of El Colegio de la Frontera Norte, Tijuana, Mexico, May 23-25.
- Kenney, M. and Florida, R. (1993), **Beyond Mass Production. The Japanese System and Its Transfer to the U.S.**, Oxford University Press.
- Kenney, M. and Florida, R. (1994), Japanese Maquiladoras: Production Organization and Global Commodity Chains, *World Development*, Vol. 22, No. 1, pp. 27-44.
- OECD (1996), **Globalisation of Industry. Overview and Sector Reports**, Paris, France.
- Salinas Romero, Enrique (1994), Medición de la Eficiencia en la Industria Maquiladora Electrónica en Tijuana (Measurement of the Efficiency in the Electronic Maquiladora Industry), Master Thesis, El Colegio de la Frontera Norte, Tijuana, Mexico.
- Sargent, J. and Matthews, L. (1997), Skill development and Integrated Manufacturing in Mexico, *World development*, Vol. 25, No. 10, pp. 1669-1681.
- South, Robert (1990), Transnational Maquiladora Location, *Annals of the Association of American Geographers*, Vol. 80, No. 4, pp.549-570.
- Szekely, Gabriel (1991), In Search of Globalization: Japanese Manufacturing in Mexico and the United States, in Gabriel Szekely (Ed.), **Manufacturing Across Border and Oceans**, Center for U.S. Mexican Studies, University of California, San Diego.
- Vargas, L. (1996), The Maquiladora Industry: Still Going Strong, *Business Frontier*, No. 3, pp. 1-4.