

# SPECIALIZATION, AGGLOMERATION AND BORDER URBAN MANUFACTURING GROWTH

Jorge Eduardo Mendoza Cota  
*Universidad Autónoma de Coahuila*

## *1. Urban Agglomeration and External Economies*

As a result of the liberalization process established in the eighties, the Mexican economy has experienced an important adjustment in its manufacturing sector. One of the most relevant changes has been the geographic restructuring of the industries of that sector. During the eighties, new determinants of manufacturing growth emerged, such as foreign investment and the opening of export markets abroad (Hanson, 1998). As a consequence of export oriented industrial growth, the northern border cities of Mexico have experienced an expansion in their manufacturing activities and population. During the nineties, the agglomeration of economic activities became one of the determinants for the manufacturing growth in that region due to the advantages provided by geographic proximity.

Therefore, Mexican industrialization and urbanization have been experiencing a different pattern of geographic localization, based on the development of new urban industrial areas, with different characteristics than the large, traditional industrial cities such as Mexico City, Monterrey and Guadalajara. These emerging cities are characterized by the existence of concentration and specialization of specific manufacturing industries. Such is the case of Tijuana, which is focused on television assembly; Ciudad Juarez, which is primarily dedicated to the production of electrical components; and Saltillo, which is specialized in automobile assembly plants. Within this context, it is relevant to investigate whether the development of agglomeration economies and the emergence of new manufacturing centers can explain the rapid manufacturing growth observed in the most important northern border cities.

Taking into account this objective, it is important to analyze the development of those urban manufacturing centers with high economic activity and population growth in the northern border of Mexico. For this purpose, the theoretical concept of agglomeration economies is useful for the study of urban manufacturing growth from the perspective of the existence of regional externalities that affect the manufacturing firms established in those cities.

The present research seeks to estimate the impact of external economies,

originated by industrial and urban agglomeration, on the manufacturing employment growth of the northern border cities of Mexico. The hypotheses of the study are the following:

1. Economic globalization and the establishment of the North American Free Trade Agreement (NAFTA) have encouraged the shift of the manufacturing production process from industrialized countries (USA) to less developed economies (Mexico). This phenomenon has intensified the industrial agglomeration and specialization in several northern border cities of Mexico (depending on the geographic proximity to the manufactures market).
2. Manufacturing and urban agglomeration generates externalities for the industries located in urban areas, due to the existence of specialized inputs.
3. The expansion of cities allows the presence of urban economies related to transportation costs and the proximity to the markets of the factors of production and final goods.

In this context, the general goal of the study is to evaluate the impact of the external economies on the manufacturing employment performance of the urban areas of the Mexican northern border region. The particular objectives of this paper are:

- i)* Estimate the impact of industrial agglomeration on employment growth in the manufacturing sector of the northern border cities of Mexico, before and after NAFTA was established.
- ii)* Explain the patterns of industrial expansion of the most important cities of the northern border.
- iii)* Determine whether the level of urbanization (measured by population size) in the larger urban areas generates the existence of urbanization economies and rapid growth of the manufacturing sector.

## *2. Urban Manufacturing Development in Mexico*

### *2.1. Changes in the Dynamics of the manufacturing industries of the Northern Border Cities*

During the nineties, the northern border cities of Mexico grew very rapidly. In particular, the larger cities along the border such as Tijuana, Ciudad Juarez and Nuevo Laredo exhibited an accelerated expansion in their manufacturing employment. From 1988 to 1993, the cities of Tijuana, Hermosillo and Nuevo Laredo showed the most rapid manufacturing employment growth. The an-

nual average rates of growth for those cities were 15.6%, 11.9% and 7.7%, respectively (Table 1). For the period from 1993 to 1998, manufacturing employment in the cities of Ciudad Juárez, Tijuana and Hermosillo increased rapidly. It is important to stress that the maquiladora share of the labor employment in the manufacturing sector of the states of Baja California, Chihuahua, and Tamaulipas in 1993 was 75.3%, 76.6% and 70.3%, respectively (Calderón and Mendoza, 2000). These results show the predominance of that type of manufacture in the urban centers of the northern border.

**Table 1. Northern Border Cities:  
Average Annual Rates of Growth.**

<i>Cities</i>	<i>1988-1993</i>		
	<i>Manufacturing Employment</i>	<i>Manufacturing Employment</i>	<i>Annual Average Rate of Growth</i>
	<i>1988</i>	<i>1993</i>	
Tijuana	41,872	91,419	15.62%
Hermosillo	11,294	20,441	11.87%
Nuevo Laredo	12,368	18,190	7.72%
Cd. Juárez	108,172	143,723	5.68%
Saltillo	33,330	42,982	5.09%
Torreón	41,791	52,361	4.51%
Chihuahua	42,340	50,776	3.63%
Monterrey	184,031	218,741	3.46%
Matamoros	35,951	41,620	2.93%

  

<i>Cities</i>	<i>1993-1998</i>		
	<i>Manufacturing Employment</i>	<i>Manufacturing Employment</i>	<i>Annual Average Rate of Growth</i>
	<i>1988</i>	<i>1993</i>	
Cd. Juárez	143,723	235,768	9.90%
Tijuana	91,419	146,634	9.45%
Hermosillo	20,441	32,717	9.41%
Torreón	52,361	80,974	8.72%
Matamoros	41,620	56,841	6.23%
Chihuahua	50,776	68,132	5.88%
Nuevo Laredo	18,190	23,924	5.48%
Monterrey	218,741	284,112	5.23%
Saltillo	42,982	54,244	4.65%

Source: Own elaboration with data from: 1989 and 1999 Censo Industriales. INEGI.

The industries leading the manufacturing expansion in the urban areas included in this study were largely related to the maquiladora tariff regime, or export oriented assembly plants. In the case of the manufacturing industries under the maquiladora system, the industries of electronics and television assembly and electric materials stood out as the main industrial activities for the cities of Tijuana, Chihuahua and Matamoros. In the case of the assembly manufactures produced by multinationals, the automobile industry was preponderant in the city of Saltillo (Table 2).

**Table 2. Northern Border: Industries with the Largest Share in the Cities' Manufacturing Sector, 1999.**

<i>City</i>	<i>Industry</i>	<i>Description</i>	<i>City employment</i>	<i>Percentage share</i>
Monterrey	3831	Electric machinery, equipment and accessories	25398	8.94%
Tijuana	3832	Electronic equipment, radio and television	44038	30.03%
Nuevo Laredo	3841	Automobile industry	5063	21.16%
Matamoros	3220	Clothing	5421	16.57%
Chihuahua	3831	Electric machinery, equipment and accessories	20325	29.83%
Hermosillo	3220	Clothing	5421	16.57%
Torreón	3220	Clothing	36543	45.13%
Ciudad Juárez	3220	Clothing	5421	16.57%
Chihuahua	3831	Electric machinery, equipment and accessories	20,325	6.90%
Saltillo	3841	Automobile industry	8507	15.68%

Source: Own elaboration with data from: 1989 and 1999 Censos Industriales. INEGI.

Given the outstanding dynamism of the manufacturing activities in the larger cities of the northern border region (Tijuana, Ciudad Juarez and Monterrey), it is convenient to briefly analyze their structure and trends. The urban area of Ciudad Juarez constituted 4.74% of the national manufacturing employment in 1988, which increased to 5.6% in 1998. The 3 most important industries during the period were electric machinery, equipment and accessories, electronic equipment, radio and television assembly and textiles. These industries accounted for more than 70% of the employment in that urban area. It is also worth mentioning that the industry of electronic equipment, radio and television assembly increased its share, both in the city manufacturing employment and in the specific industry employment at the national level. In 1988, the shares of that industry accounted for 10.0% and 13.8%, respectively; whereas, in 1998 the shares of that industry accounted for 20.3% and 21.2%, respectively (Table 3).

Table 3. Ciudad Juárez: Manufacturing employment share, 1988-1998.

<i>Industry</i>	<i>Description</i>	<i>Employ- ment</i>	<i>Industry share in the urban area</i>	<i>Industry employment at a nation- al level</i>	<i>Share in the national industry</i>
<i>Total</i>	<i>1988</i>	<i>108,172</i>	<i>100.00%</i>	<i>2284133</i>	<i>4.74%</i>
3831	Electric machinery, equipment and accessories	54,760	50.62%	149,627	36.60%
3832	Electronic equipment, radio and television	10,852	10.03%	78,667	13.79%
3213	Textiles	5,317	4.92%	21,709	24.49%
3900	Other manufacturing industries	3,743	3.46%	35,200	10.63%
3833	Domestic appliances	3,436	3.18%	21,947	15.66%
3822	Machinery and equipment	3,338	3.09%	63,090	5.29%
3823	Computer Industry	3,244	3.00%	16,999	19.08%
<i>Total</i>	<i>1998</i>	<i>235,768</i>	<i>100.00%</i>	<i>4213,566</i>	<i>5.60%</i>
3831	Electric machinery, equipment and accessories	180,130	33.99%	294,452	27.21%
3832	Electronic equipment, radio and television	47,908	20.32%	225,905	21.21%
3213	Textiles	23,589	10.01%	86,954	27.13%
3841	Automobile Industry	15,322	6.50%	190,783	8.03%
3823	Computer Industry	8,920	3.78%	48,719	18.31%
3833	Domestic appliances	7,488	3.18%	47,518	15.76%
3220	Apparel	5,597	2.37%	453,414	1.23%

Source: Own elaboration with data from: 1989 and 1999 Censo Industriales. INEGI.

As it has been pointed out, the majority of the firms localized in Ciudad Juárez have the legal status of maquiladora, which allows them to import all the inputs they require in the manufacturing process duty free and export practically all output back to the country of origin. In that sense, the dynamics of that urban center is largely determined by the strategies of the multinational firms located in that city.

The second large urban manufacturing center is located in Tijuana, Baja California. In 1988 the number of employees in the manufacturing sector of Tijuana was 41,872, which represented 1.8% of the total national manufacturing sector employment. However, in 1998 that number increased to 146,634 and its share of national manufacturing employment reached 3.5%. With respect to the structure of the manufacturing sector in that urban area, the industry of electronic equipment, radio and television assembly was predominant during the period. In 1988 that industry represented 18% of the total employment of the city, but by 1998 the share increased to 30%, with 44,038 employ-

ees. Other important industries in that city area were: electric machinery, equipment and accessories and plastic products (Table 4).

Table 4. Tijuana: Manufacturing employment share, 1988-1998.

<i>Industry</i>	<i>Description</i>	<i>Employment</i>	<i>Industry share in the urban area</i>	<i>Industry employment at a national level</i>	<i>Share in the national industry</i>
3832	Electronic equipment, radio and television	7,523	17.97%	78,667	9.56%
3831	Electric machinery, equipment and accessories	5,517	13.18%	149,627	3.69%
3320	Non-metallic furniture manufacturing	4,144	9.90%	58,597	7.07%
3833	Domestic appliances	2,216	5.29%	21,947	10.10%
3822	Machinery and equipment	2,168	5.18%	63,090	3.44%
3115	Bakery products	1,760	4.20%	89,573	1.96%
3220	Apparel	1,701	4.06%	121,715	1.40%
<i>Total</i>		<i>41,872</i>	<i>100.00%</i>	<i>2,284,133</i>	<i>1.83%</i>
	<i>1998</i>				
3832	Electronic equipment, radio and television	44,038	30.03%	225,905	19.49%
3560	Plastic products	13,156	8.97%	166,884	7.88%
3831	Electric machinery, equipment and accessories	10,955	7.47%	294,452	3.72%
3320	Non-metallic furniture manufacturing	10,828	7.38%	134,401	8.06%
3900	Other manufacturing industries	7,029	4.79%	66,969	10.50%
3823	Computer Industry	6,987	4.76%	48,719	14.34%
3850	Precision instrument equipment manufacturing	6,449	4.40%	33,178	19.44%
<i>Total</i>		<i>146,634</i>	<i>100.00%</i>	<i>4,213,566</i>	<i>3.48%</i>

Source: Own elaboration with data from: 1989 and 1999 Censo Industriales. INEGI.

Once again, the manufacturing employment dynamics were related to firms operating under the maquiladora regime. In particular, the dynamics of the urban manufacturing area of Tijuana is related to the Asian maquiladoras oriented towards television assembly. When analyzing the northern border cities, it is important to include the city of Monterrey, located in the northern border state of Nuevo Leon. Although it is not a border city, an important part of its manufacturing activities are oriented toward the export market. However, between 1988 and 1998, the share of its manufacturing employment in the national manufacturing sector decreased from 8.06% to 6.74%. Nevertheless, the share of the most important urban industries of Monterrey (metallic products, electric machinery, equipment and accessories, automobiles and the glass industry) remained constant over the period (Table 5). It is worthwhile to mention that the manufacturing industry of the City of Monterrey has been encouraged, in a large extent, by the strategies of

local firms facing the process of globalization. This is the case of the Vitro and Alfa companies. Additionally, production chain-links have been developed in the auto parts industry, with the aim of providing parts for the automobile industry, this is the case of firms such as Metalsa, Nematik and Axa-Yazaki (Pozas, 1999).

In general, the urban manufacturing dynamics were closely related to the expansion of export oriented firms, in particular under the maquiladora regime (Calderón and Mendoza, 2000), and to the development of local industries which have been able to integrate themselves as suppliers to multinational firms or for the domestic market.

Table 5. Monterrey: Manufacturing employment share, 1988-1998.

<i>Industry</i>	<i>Description</i>	<i>Employment</i>	<i>Industry share in the urban area</i>	<i>Industry employment at a national level</i>	<i>Share in the national industry</i>
<i>Total 1988</i>		<i>184,031</i>	<i>100.00%</i>	<i>2,284,133</i>	<i>8.06%</i>
3831	Electric machinery, equipment and accessories	16,241	8.83%	149,627	10.85%
3822	Machinery and equipment	12,970	7.05%	63,090	20.56%
3620	Glass	12,374	6.72%	26,243	47.15%
3814	Other metallic products	11,150	6.06%	66,790	16.69%
3710	Iron and Steel Industry	9,982	5.42%	69,860	14.29%
3841	Automobile Industry	8,201	4.46%	101,689	8.06%
3220	Clothing	8,011	4.35%	121,715	6.58%
<i>Total 1998</i>		<i>284,112</i>	<i>100.00%</i>	<i>4,213,566</i>	<i>6.74%</i>
3831	Electric machinery, equipment and accessories	25,398	8.94%	294,452	8.63%
3814	Other metallic products	18,303	6.44%	136,391	13.42%
3822	Machinery and equipment	17,893	6.30%	83,895	21.33%
3560	Plastic products	17,500	6.16%	166,884	10.49%
3220	Clothing	14,203	5.00%	453,414	3.13%
3620	Glass	13,890	4.89%	46,185	30.07%
3841	Automobile Industry	13,854	4.88%	190,783	7.26%

Source: Own elaboration with data from: 1989 and 1999 Censos Industriales. INEGI.

### 3. Econometric Specification to Estimate the Impact of Agglomeration

To empirically test the effects of urban manufacturing agglomeration, two log-linear econometric specifications were developed as follows:

I. The first econometric model considers the following variables:

$$\Delta \ln(L_{irt}/L_{it}) = \alpha + \beta_1 \ln(RT_{irt}) + \beta_2 \ln(AI_{irt}) + \beta_3 \ln(A2_{irt}) \\ + \beta_4 \ln(DI_{irt}) + \beta_5 \ln(T_{irt}) + \beta_6 \ln(PD_{irt}) + \beta_7 \ln E + \beta_8 \ln r + e_{irt}$$

- The dependent variable is the relative employment growth in the urban manufacturing sector:

$$\Delta \ln(L_{irt}/L_{it}) = [\ln(L_{irs}) - \ln(L_{irt})] - [\ln(L_{is}) - \ln(L_{it})],$$

where  $i$  and  $r$  represent the manufacturing industry and the urban region, respectively, and  $s$  is the final period and  $t$  is the initial period.

- $RT$  is the annual remuneration per worker in the industry  $i$  for the urban areas  $j$  during the period  $t$ , weighted by the annual remuneration for the industry at a national level  $j$  during the period  $t$ :

$$RT_{ijt} = (R_{ijt}/L_{ijt}) / (R_{it}/L_{it})$$

- $A1$  is the index of industry specialization and is defined at a 4 digit level according to the Mexican Classification of Products and Activities (CMAP). The index is constructed as follows:

$$AI_{irt} = (L_{irt}/L_{it}) / (L_{it}/L_t)$$

This index measures the level of specialization of an industry within a city, relative to that industry specialization at the national level.

- $A2$  represents the agglomeration of related industries. These industries share the classification at the 2 digit level, according to CMAP.

$$A2_{irt} = (L_{ikt}/L_{irt}) / (L_{kt}/L_{it}),$$

where  $k$  represents the aggregated industry at two digits.

This variable is a proxy to estimate the relationship between suppliers and buyers of inputs of the industries at the 4 digit level.

- $DI$  is the diversification index of the manufacturing industry  $i$  in the urban area  $r$  during the period  $t$ . It also constructed at the 4 digit level. This index of diversification is given by  $\sum_{i \neq r} (L_{ikt}/L_{it})^2$ , but in this econometric specification is weighted by the same index at national level aggregation:

$$DI_{irt} = \sum_{i \neq r} (L_{irt}/L_{it})^2 / \sum_{i \neq r} (L_{it}/L_t)^2$$

This index is used to measure the degree of concentration or diversity within industries at the 4 digit level.

- The econometric model also includes the average size of the manufacturing plant  $T = (L_{irt}/N_{irt})/(L_{it}/N_{it})$ , which is a proxy of the existing market structure at the 4 digit level and the average relative productivity of manufacturing industries at 4 digits  $PD = (VA_{irt}/L_{irt})/(VA_{it}/L_{it})$ . These variables are introduced because the manufacturing firms do not operate with the same level of efficiency and technology.

- Finally, the total level of employment  $E$ , and the total amount of earned wages  $R$ , for the manufacturing industries in the base year, represents the control variables. In the case of the first variable, it is assumed that if external economies are located in the urban areas, a greater level of initial employment (labor agglomeration) in the urban industries would result in a higher rate of growth in the manufacturing industries at the 4 digit level. On the other hand, the model considers that the demand for manufacturing workers will shift from the higher wage urban areas to the areas with lower wages, thereby increasing the manufacturing employment growth of the northern border cities.

- $e_{irt}$  is the error term, and it is assumed to present the following form:

$$e_{irt} = c_i + \gamma_t + \eta_i$$

where  $c_i$  is the fixed effect by urban area  $i$ ,  $\gamma_t$  is the fixed effect for year  $t$  and  $\eta_i$  is the independent and random variable with mean zero and a variance  $\sigma^2$ .

II. The second model incorporates a variable representing the externalities derived from urban agglomeration. The objective is to find out whether or not urban agglomeration economies are present in the manufacturing sector of the northern border cities. The proxy of urban agglomeration used in the study is the urban population. The model is set up as follows:

$$\begin{aligned} \Delta \ln(L_{irt}/L_{it}) = & \alpha + \beta_1 \ln(RT_{irt}) + \beta_2 \ln(AI_{irt}) + \beta_3 \ln(A2_{irt}) \\ & + \beta_4 \ln(DI_{irt}) + \beta_5 \ln(T_{irt}) + \beta_6 \ln(PD_{irt}) + \beta_7 \ln E + \beta_8 \ln r + \beta_8 \ln EU + e_{irt} \end{aligned}$$

- $EU$  are the urban economies, which imply a more efficient use of available resources in the cities, due to the existence of pooled labor markets, and a larger service sector.

#### 4. *Econometric Results*

The first econometric model was applied to a cross section data base for the period of 1988-1993. The empirical findings derived from the different regressions that were estimated show that, for this period, the statistically significant coefficients were the ones related to the variables of specialization within the industry (4 digits), the specialization among industries (sharing the classification at 2 digits) and the industrial diversity. The coefficients of specialization within the industry and industrial diversity showed an inverse effect with respect to manufacturing employment growth. On the other hand, the coefficient of the specialization among industries exhibited a positive sign (Table 6). The regressions were based on a heteroskedasticity-consistent standard errors and covariance matrix, developed by White (1980).

**Table 6. Northern Border Cities. Dependent Variable:  
Relative Employment Growth (1988-1993).**

<i>Variable</i>	<i>Coef.</i>	<i>t-Stat.</i>	<i>Coef.</i>	<i>t-Stat.</i>	<i>Coef.</i>	<i>t-Stat.</i>	<i>Coef.</i>	<i>t-Stat.</i>	<i>Coef.</i>	<i>t-Stat.</i>	<i>Coef.</i>	<i>t-Stat.</i>	<i>Coef.</i>	<i>t-Stat.</i>	<i>Coef.</i>	<i>t-Stat.</i>
Agglomeration 1	-0.22	-5.10	-0.13	-2.49	-0.20	-3.77	-0.22	-4.11	-0.22	-4.05	-0.22	-3.74	-0.22	-3.72	-0.22	-3.72
Agglomeration 2			0.14	2.07	0.12	1.73	0.10	1.57	0.10	1.62	0.11	1.64	0.10	1.63	0.10	1.61
Diversity					0.14	-4.75	-0.12	-3.98	-0.12	-3.83	-0.11	-3.29	-0.12	-3.35	-0.12	-3.35
Productivity							0.09	1.56	0.08	1.26	0.08	1.26	0.08	1.26	0.08	1.26
Relative Wages									0.06	0.45	0.06	0.47	0.06	0.47	0.06	0.45
Plant Size											-0.02	-0.30	-0.03	-0.33	-0.03	-0.33
Employment 1989													0.00	0.45	0.00	-0.57
Total Wages 1989															0.00	0.77
R <sup>2</sup>	0.12		0.13		0.16		0.17		0.17		0.17		0.17		0.17	
Adjusted R <sup>2</sup>	0.12		0.13		0.15		0.16		0.16		0.16		0.16		0.16	
Durbin-Watson	1.83		1.84		1.89		1.88		1.87		1.88		1.88		1.88	

\* White Heteroskedasticity-Consistent Standard Errors & Covariance.

For the period which encompasses the years from 1993 to 1998, which includes the NAFTA period, the econometric model showed the same relationship between manufacturing employment and the variables representing industrial agglomeration. However, two important changes in the relationship between the dependent and the explanatory variables occurred during this period (Table 7). The first difference, with respect to the previous period, has to do with the coefficient of the initial total employment in 1988. According to the results, the manufacturing employment growth was positively related to the coefficient of this variable (0.19), and it was also statistically significant at a 95% confidence level. According to the assumptions of the econometric research, when there is a large level of manufacturing employment in an urban area, the manufacturing employment might increase due to the effects of agglomeration of labor. Therefore, for this period, the existence of large manufacturing employment is an important factor for the development of pooled labor markets.

Table 7. Northern Border Cities. Dependent Variable:  
Relative Employment Growth (1993-1998).

Variable	Coef.*	t-Stat.	Coef.	t-Stat.	Coef.	t-Stat.	Coef.	t-Stat.	Coef.	t-Stat.	Coef.	t-Stat.	Coef.	t-Stat.	Coef.	t-Stat.	
Agglomeration 1	-0.22	-5.23	-0.08	-1.36	-0.11	-1.80	-0.11	-1.81	-0.12	-1.85	-0.12	-1.80	-0.14	-1.98	-0.13	-1.88	
Agglomeration 2			0.18	2.76	0.17	2.55	0.17	2.63	0.18	2.83	0.18	2.83	0.18	2.70	0.18	2.71	
Diversity					-0.06	-2.13	-0.06	-1.82	-0.06	-1.83	-0.06	-1.72	-0.11	-1.62	-0.04	-0.62	
Productivity							0.02	0.32	-0.01	-0.17	-0.01	-0.16	-0.02	-0.21	0.03	0.32	
Relative Wages									0.11	0.81	0.11	0.74	0.11	0.72	0.08	0.53	
Plant Size											0.00	0.04	0.01	0.10	-0.01	-0.26	
Employment 1994													0.01	0.77	0.19	2.13	
Total Wages 1994																-0.13	-2.04
R <sup>2</sup>	0.15		0.17		0.17		0.17		0.18		0.18		0.18		0.15		
Adjusted R <sup>2</sup>	0.15		0.17		0.17		0.17		0.17		0.17		0.16		0.14		
Durbin-Watson	1.98		2.00		2.01		2.01		2.01		2.01		1.95		1.97		

\* White Heteroskedasticity-Consistent Standard Errors & Covariance.

On the other hand, the coefficient of total wages exhibited a negative relationship with manufacturing employment growth (-0.13), also statistically significant at a 95% level of confidence. Since this variable was not significant in the period 1988-1993, the results suggest that, once the export oriented manufacturing growth was set up, wage differentials became an important factor for urban manufacturing localization.

A Chow breakpoint was calculated to evaluate the possibility of structural change in the relationship of the explanatory and dependent variables for the 2 periods studied. The results reject the hypothesis of stability. Therefore, the effects of agglomeration economies, represented by the specialization among industries parameter, should be estimated separately in order to capture the differences in the 2 periods considered.<sup>1</sup>

Table 8. Northern Border Cities: Urban Agglomeration  
and Relative Employment Growth (1993-1998).

Variable	Coef.	t-Stat.	Coef.	t-Stat.	Coef.	t-Stat.	Coef.	t-Stat.	Coef.	t-Stat.	Coef.	t-Stat.	Coef.	t-Stat.	Coef.	t-Stat.
Agglomeration 1	-0.13	-1.97	-0.13	-1.97	-0.13	-1.97	-0.14	-2.03	-0.13	-2.00	-0.13	-1.98	-0.11	-1.79	-0.08	-1.38
Agglomeration 2	0.17	2.60	0.17	2.69	0.17	2.67	0.17	2.67	0.16	2.47	0.16	2.39	0.17	2.54	0.18	2.74
Diversity	-0.02	-0.68	-0.07	-2.02	-0.07	-1.99	-0.07	-2.15	-0.07	-2.15	-0.07	-2.47	-0.06	-2.02		
Population	0.00	0.47	0.00	-0.23	0.00	3.12	0.00	2.90	0.00	2.99	0.00	2.99				
Productivity	-0.02	-0.19	-0.01	-0.13	-0.01	-0.114	-0.01	-0.11	0.03	0.39						
Relative Wages	0.12	0.84	0.13	0.85	0.12	0.81	0.11	0.81								
Plant Size	-0.02	-0.30	-0.02	-0.42	-0.02	-0.35										
Employment 1994	0.00	1.25	0.00	1.60												
Total Wages 1994	-0.01	-1.71														
R <sup>2</sup>	0.18		0.18		0.18		0.18		0.18		0.18		0.17		0.17	
Adjusted R <sup>2</sup>	0.17		0.17		0.17		0.17		0.17		0.17		0.17		0.17	
Durbin-Watson	2.04		2.03		2.03		2.03		2.03		2.03		2.03		2.01	

\* White Heteroskedasticity-Consistent Standard Errors & Covariance.

<sup>1</sup> The null hypothesis of stability was rejected. The F-Test exhibited an F-statistic of 2.95 while the critical values of the F-distribution were 1.83 at a 5% significance level and 2.41 at a 1% significance level.

Finally, a regression model, including the urban population of the northern border cities, was estimated. The econometric findings showed a very low value of the population coefficient, which showed a positive and statistically significant relationship between this coefficient and employment growth (Table 8). This empirical evidence suggests that urban agglomeration, measured by the proxy of population, has a positive impact on manufacturing employment growth.

### *Concluding Remarks*

The research presented intended to empirically test the effect of manufacturing agglomeration for the most important northern border cities of Mexico. The econometric specification included two control variables, total employment and total wages, for the initial year of the periods analyzed. It also incorporated the level of population of the cities as a proxy of urban agglomeration, in order to evaluate the impact of this type of agglomeration on urban manufacturing growth.

The analysis of the cities within the northern border region shows that, by the end of the eighties, Tijuana and Ciudad Juarez developed industries with a large share of the national manufacturing employment. During the nineties, rapid employment growth is experienced not only in Tijuana and Ciudad Juarez, but also in medium sized northern border region cities such as: Nuevo Laredo, Saltillo, Matamoros and Hermosillo, among others. As a result, those urban areas experienced urban and industrial agglomeration. According to the model developed in this paper, the effects of such agglomeration were the following:

- The firms with the fastest growth in the most important northern border cities were located within the following industries: electric machinery, equipment and accessories, electronic equipment, radio and television assembly, and textiles. For the case of Monterrey, the most dynamic industries were: metallic products, electric machinery, equipment and accessories, automobiles and the glass industry.
- The econometric findings showed that the coefficient of the specialization among industries partially explained manufacturing employment growth in the northern border cities during the two periods analyzed. It is important to stress that, in the period 1993-1998 the dependent variable was positively affected by the level of total employment in 1994, and by the level of the total wages received in those urban areas in 1994.
- According to the results, manufacturing employment growth was positively related to the coefficient of total employment (0.19), which was also statistically significant at a 95% confidence level. This finding suggests that the agglomeration of labor has had a positive effect on em-

ployment growth. It is considered that the existence of a high level of manufacturing employment is an important factor for the development of pooled labor markets.

Therefore, the empirical results suggest that trade liberalization and the integration of the Mexican economy with the U.S. economy has shifted the manufacturing employment dynamics from the large cities of Central Mexico towards cities of the northern border states. The expansion of the manufacturing industry in the northern region has been accompanied by the rapid development of manufacturing firms under the maquiladora regime. This type of industry was predominantly developed by foreign investors and, as a result, developed manufacturing and urban agglomeration in the urban centers of that region.

The econometric results exhibited evidence of the impact of manufacturing and urban agglomeration economies on manufacturing employment growth. The industry agglomeration is related to the backward-forward linkages between firms and factors of production within the urban centers. The impact of agglomeration was very small but positive, showing that the urban expansion is probably developing pooled labor markets in some of the cities of the northern border.

### *Bibliography*

- Calderón, C. and Eduardo Mendoza (2000). "Demanda regional de trabajo de la industria maquiladora de exportación en los estados de la frontera norte." *Frontera Norte*, no. 24, El Colegio de la Frontera Norte, July-December.
- Dumais, Ellison and Glaeser (1997). "Geographic Concentration as a Dynamic Process." NBER, Working Paper, no. 6270.
- Fujita, Masashita *et al.* (2000). *The Spatial Economy*, The MIT Press.
- Glaeser, E., H. D. Kallal, J.A. Scheinkman y A. Shleifer (1992), "Growth in Cities." *Journal of Political Economy*, no. 100, pp. 1126-1152.
- Graizbord, Boris and Crecencio, Ruiz (1999). "Reestructuración Regional Sectorial en México, 1980-1993: una evaluación." *Comercio Exterior*, vol. 49, no. 4, pp. 321-330.
- Hanson, Gordon (1994), "Regional Adjustment to Trade Liberalization." NBER, Working Paper, no. 4713.
- (1998). "North American Economic Integration and Industry Location." NBER, Working Paper, no. 6587.
- (1996), "Localization Economies, Vertical Organization, and Trade." *The American Economic Review*, vol. 86, no. 5, pp. 1226-1278.
- Hanson, Gordon (1998). "North American Economic Integration and Industry Location." National Bureau of Economic Research (NBER), Working Paper, no. 6587.

- Head, Ries and Swenson (1999). "Attracting Foreign Manufacturing: Investment Promotion and Agglomeration." *Regional Science and Urban Economics*, vol. 29, no. 2.
- Henderson, Vernon (1974). "The Sizes and Types of Cities." *The American Economic Review*, vol. LXIV, no. 4, pp. 640-656.
- (1982). "Systems of in Closed and Open Economies." *Regional Science and Urban Economics*, no. 12, pp. 325-350.
- (1999). "Marshall's Scale Economies." NBER, Working Paper, 7358.
- Henderson, Kuncoro, Turner (1995). "Industrial Development in the Cities." *Journal of Political Economy*, vol. 103, no. 5.
- INEGI (1989, 1994 y 1999). *Censos Industriales*. México.
- (1990). *XI Censo de Población y Vivienda*. Mexico.
- Jacobs, Jane (1984). *Cities and Wealth of Nations*. Vintage Books, Random House, New York.
- Krugman, Paul (1992a). *Geografía y Comercio*. Antoni Bosh Editor, Barcelona.
- (1995a). "Urban Concentration: The Role of Increasing Returns and Transport Costs." Proceeding of the World Bank Annual Conference on Development Economics, 1994
- (1995b). *Development, Geography and Economic Theory*. The MIT Press.
- Krugman, P. and A. Venables (1993). "Integration, Specialization, and Adjustment." NBER, Working Paper, no. 4559
- Krugman, P. and Livas E., R. (1992b). "Trade Policy and the Third World Metropolis." NBER, Working Paper, no. 4238, Cambridge, Mass. December.
- Lucio H., Herce J. and Goicolea A. (1998). "The Effects of Externalities on Value Added and Productivity Growth in Spanish Industry." FEDEA, documento de trabajo 98-05.
- Marshall, Alfred (1920). *Principles of Economics*, 8th edition. Reprinted Macmillan.
- Morrison, Catherine and Siegel, Donald (1996). "External Capital Factors and Increasing Returns in U.S. Manufacturing." *The Review of Economics and Statistics*, pp. 647-654.
- Mendoza, Eduardo and Martínez, Gerardo (1999a). "Globalización y Dinámica Industrial en la Frontera Norte de México." *Comercio Exterior*, vol. 49, no. 9, September.
- (1999b). "Un Modelo de Externalidades para el Crecimiento Manufacturero Regional." *Estudios Económicos*, vol. 14, no. 2, El Colegio de México, pp. 231-263.
- Moomaw, R.L. (1998). "Agglomeration Economies: are They Exaggerated by Industry Aggregation?" *Regional Science and Urban Economics*, no. 28, pp. 199-211.
- Nakamura, Ryohei (1985). "Agglomeration Economies in Urban Manufacturing Industries: a Case of Japanese Cities." *Journal of Urban Economics*, no. 17, pp. 08-124.

- Pozas, María de los Angeles (1999). "Estrategias de Globalización y Encadenamientos Productivos: El Caso de Monterrey," in Garza Gutiérrez Esthela, editor, *La globalización en Nuevo León*.
- Richardson, H. (1973). *Regional Growth Theory*, Macmillan & Company.
- Rivera-Bátiz, Luis and Romer, Paul (1992). "Economic Integration and Endogenous Growth," in Grossman Gene, editor, *Imperfect competition and international trade*. MIT Press.
- White, Halbert (1980). "A Heteroskedasticity-Consistent Covariance Matrix and a Direct Test for Heteroskedasticity." *Econometrica*, 48, pp. 817-838.
- Wilson, Patricia (1996). *Las nuevas maquiladoras de México*. Universidad de Guadalajara.