Mexican manufacturing markups: procyclical behavior and the impact of trade liberalization

Alejandro Castañeda*

Fecha de recepción: 16 de mayo de 2002; fecha de aceptación:12 de marzo de 2003

Abstract: This paper estimates the markup for the Mexican manufacturing sector to detect the impact of trade liberalization on market power. Using Hall's proposal that states that a procyclical Solow residual is an indication of market power, this research estimates the markup for different periods to detect the change in market power after trade liberalization was implemented. We account for the potential cyclical behavior of the markup by including procyclical variables that affect the markup. The data shows a markup that moves counter-cyclically. The evidence is consistent with theoretical arguments advanced by Rotemberg and Saloner (1986). We pool four-digit industries and obtain estimates of the markup for the whole manufacturing sector. For the entire manufacturing sector, we find that trade liberalization acts as a market disciplining device that reduces the degree of market power. At the sector level, we find a significant reduction in market power in those sectors that experienced a strong liberalization process after the GATT negotiations. Also, those sectors that show a reduction in market power after the NAFTA implementation, show a liberalization process in which protection is eliminated at a faster pace than the average for the whole economy.

Keywords: market power, markups, manufacturing sector, trade liberalization, Mexico.

Resumen: Este trabajo estima el *markup* en el sector manufacturero mexicano para detectar el impacto de la liberalización comercial en el poder de mercado. Usando la propuesta de Hall, la cual establece que un residual procíclico de Solow indica la existencia de poder de mercado, el trabajo estima el *markup* en diferentes períodos para detectar el cambio en el poder de mercado después de que la liberalización comercial fue implementada. Para tomar en consideración el potencial comportamiento cíclico del *markup*, se incluyeron variables procíclicas que afectan dicho

*El Colegio de México and visiting professor at CIDE (sabbatical). Camino al Ajusco No. 20. México, D.F. C.P. 10740. Fax (55) 645-0464, Ph. 5449-3075, e-mail: acasta@colmex.mx

markup. Los datos muestran que éste se mueve de forma contracíclica. La evidencia es consistente con los argumentos teóricos presentados por Rotemberg and Saloner (1986). Se agrupan las industrias a nivel de cuatro dígitos y se obtienen estimaciones del *markup* para el sector manufacturero en su conjunto. Se encuentra que la liberalización comercial actúa como un mecanismo de disciplina en el mercado, que reduce el grado de poder de mercado. A nivel sectorial, se encuentra una reducción significativa en el poder de mercado en aquellos sectores que experimentaron un fuerte proceso de liberalización después de las negociaciones del GATT. También, aquellos sectores que muestran una reducción en el poder de mercado después de la implementación del TLCAN, presentan un proceso de liberalización en el cual la protección es eliminada a un ritmo mayor que el promedio de la economía.

Palabras clave: poder de mercado, *markup*, sector manufacturero, liberalización comercial, México.

Introduction[1]

Trade liberalization affects the behavior of an economy along several dimensions. First, the opening of the trade regime generates a reallocation of resources towards the activities in which the countries are relatively more efficient. Second, the reduction in tariffs affects the economic activity at the geographical level. Finally, the reduction in protection, changes the competitive regime of the industries. Increased competition from abroad should have an impact on price setting behavior of domestic firms. This paper analyzes this latter impact of trade liberalization. To fulfill this purpose, the paper estimates the degree of market power with the help of Solow type regression equations.

Several papers in the economic literature have measured the degree of market power in the mexican manufacturing sector. There have been two main approaches for the measurements of market power in Mexico: on one hand, Casar *et ál.* (1990) used concentration indexes to measure market power. On the other, an alternative literature estimates market power with the aid of econometric techniques. Castañeda (1998) estimates market power by using Hall's identification

[1] Thanks to David Mulato and Miguel Ángel de Jesús for data management and econometric estimates.

assumption that states that the Solow residual is not intrinsically procyclical. Thus, the finding of procyclical productivity is an implication of market power. However, the empirical studies for Mexico do not focus its analysis on the impact of trade liberalization.

This paper uses Hall's assumption to estimate market power and detects the impact of trade liberalization on mexican manufacturing measurements of market power. To check for the possibility of false inferences, due to the fact that the markup may have procyclical behavior, the paper includes procyclical dummies in the regression. Domowitz, Hubbard and Petersen (1988) have found evidence of procyclical behavior of the markup for the United States manufacturing. This paper finds that the markup behaves anticyclically in the mexican manufacturing sector.

This paper distinguishes itself from the previous literature in the data set used for the estimation. We use data at the four-digit level. This fact allows us to study the price setting behavior of firms that produce similar products.[2] In contrast, previous work (Castañeda, 1998) used data with a level of aggregation (two-digits) that pools (in some cases) rather dissimilar products.

In 1985, the Mexican government implemented a trade liberalization program. In that year, the average tariff was 23.5 percent and 92.2 percent of national production was protected by import license requirements. By the end of 1987, the average tariff was reduced to 11.8 percent and the import license requirements covered only 25.4 percent of national production with a maximum rate of 20 percent. By 1994, the average import duty for the whole economy was 18.59. The NAFTA agreement generated a second round of liberalization.

As expected, the paper finds that trade liberalization works as a market-disciplining device that reduces the market power of the industry. Grether (1996) found similar evidence. He used traditional measurements of price-cost margins. He runs regressions by making the price-cost margin a function of the Herfindahl concentration index, the import penetration rate, and the industry level of capital-output ratio. He uses panel data and estimates with fixed effects. As Domowitz, Hubbard and Petersen (1986) have suggested: in contrast with traditional industrial organization cross-section studies, "the longitudinal nature of the data allows these kind of approaches to

[2] The previous literature made its findings at the two-digit level.

control for unobservable individual industry effects in the empirical analysis" (p.14).

This paper distinguishes from traditional industrial organization approaches (Grether, 1996) in the measurement of market power. In the paper is not calculated the markup with the use of traditional formulas that pretend to approximate the markup. Instead, it obtains an estimate of this from Solow type regression equations. The advantage of the econometric approach lies in that it has sound basic principles. In contrast, the method that calculates the margin from industry data assumes that variable cost is an appropriate surrogate for marginal cost. Hoekman Looi and Olarreaga (2001) estimate markups by using a similar technique to the one used in this paper. However, they focus their analysis on a cross-country comparison on how regulation, trade and country size affect the markup.

We investigate the changing patterns of the price-cost margins in relation with trade liberalization by running panel regressions with fixed effects over several periods. We have data from 1975 to 1998 and we split the time series in two sample periods. First, the period before Mexico joined the GATT (1975-1985) and then the period after Mexico joined the GATT (1986-1998). We also study the changing pattern of the markup for the period before NAFTA (1975-1993) and the period after NAFTA (1994-1998).[3]

Although Mexico initiated a substantial liberalization program in 1985 with an average tariff that went down from 38.6 percent in 1985 to 14.9 percent in 1990 for the manufacturing sector, the average import duty for the whole economy was still 18.59 in 1994. Thus, the NAFTA negotiation implied a new round of liberalization. This study accounts for these two rounds of liberalization**.**

Unfortunately, the information that we have for the time span after NAFTA is relatively short and the period between NAFTA and GATT is not very long. This fact has implications for the efficiency of the estimation process, especially at the sector level where we have, in some cases, a relatively few number of industries. Besides, it is important to have a long period of estimation due to the evidence that the markup shows evidence of cyclical fluctuations.[4] Thus, to gain efficiency, we split the estimation period only in two sample periods

[3] Other studies that use this methodology for the mexican manufacturing sector use data from national accounts, Castañeda (1998).

[4] See Domowitz, Hubbard and Petersen (1988).

(either before GATT and after GATT and before NAFTA and after NAFTA). However, to gain more insight on the impact of these two rounds, we present a table for the entire manufacturing sector with the sample period divided in three. We also account for the cyclical behavior of the markup by including procyclical variables in the regression. Hence, we deal with the potential cyclical behavior of the markup in two ways, by extending the period of estimation and by including procyclical dummies in the regression.

I. Methodology

Let the technology be given by constant returns to scale production function with no intermediate inputs:[5]

$$Y(t) = F(L(t), K(t)A(t)). \tag{1}$$

$A(t)$ represents technical progress, $L(t)$ represents labor input, $K(t)$ is the stock of capital and $Y(t)$ is value added. Differentiating with respect to time the last equation and rearranging:

$$\frac{\dot{Y}}{Y} = \left(\frac{F_K K}{Y}\right)\frac{\dot{K}}{K} + \left(\frac{F_L L}{Y}\right)\frac{\dot{L}}{L} + \left(\frac{F_A A}{Y}\right)\frac{\dot{A}}{A}. \tag{2}$$

The dots over the variables denote derivatives with respect to time and the subindexes express partial derivatives. Using Euler's theorem for homogenous functions and assuming homogeneity of degree 1 in technical progress[6], the last expression can be written in the following form:

$$\frac{\dot{Y}}{Y} - \frac{\dot{K}}{K} = \left(\frac{F_L L}{Y}\right)\left(\frac{\dot{L}}{L} - \frac{\dot{K}}{K}\right) + \frac{\dot{A}}{A}. \tag{3}$$

[5] The assumption of constant returns to scale is not very restrictive, if we have a situation in which increasing returns are present, the procedure would detect the presence of market power. The reason lies in that an industry with increasing returns to scale must have a price above marginal cost to remain viable.

[6] This is just a normalization, which is very common in the literature.

Define *c*, *p* and *w* as marginal cost, price and wages, respectively. The first order conditions of a profit-maximizing firm that has some degree of market power can be expressed in the following way:

$$F_L = \beta\,(w/p),$$

where β represents the markup (i.e. the ratio of price to marginal cost). By using the last expression, condition (3) can be written in the following way:

$$\frac{\dot{Y}}{Y} - \frac{\dot{K}}{K} = \beta\,\frac{wL}{pY}\left(\frac{\dot{L}}{L} - \frac{\dot{K}}{K}\right) + \frac{\dot{A}}{A}. \qquad (4)$$

Solow assumed that $\beta = 1$ and used the last equation to calculate the so-called Solow residual ($\dot{A}/A$). Hall, whom we follow, assumed that technical progress (A) followed a random walk with drift and that β is a constant that can be estimated. He uses instruments correlated with business cycles to estimate β. In the first stage of the procedure, the rate of growth of the labor-capital ratio weighted by the share of wages in the value of output is projected in the space spanned by the instruments. In the second stage, he finds the level of β that makes the estimated error of the regression in (4) orthogonal to business cycle fluctuations.

II. Data

The data was obtained from the *Encuesta Industrial Anual* from 1975 to 1998. The breakup point that divides the preGATT-postGATT period is 1986-1987 and for NAFTA is 1993-1994.

The data give the level of investment at nominal prices and there is no information for capital assets. Thus, we calculated the capital assets by following the perpetual inventory model. We follow the methodology suggested in Nadiri and Prucha (1996), to calculate the initial stock of capital. In that paper, they define the initial stock of capital as the level of investment divided by the rate of growth of the stock of capital and the average rate of growth of depreciation for the whole period. From that date on, we calculate the stock by using the

investment series at constant prices and the depreciation series (also at constant prices).

To calculate the level of investment at constant prices, we deflated with an index obtained from the input-output matrix for various years. For each year we looked at the input-output matrix for that year (or the one for the closest year) and we trace, for each industry, the purchases of durables. We calculated the percentage share for each industry over the total purchases of durables made by the industry. With this information we constructed a weighted average price index by using the weights obtained from the input-output matrix, and the price indexes obtained from the national accounts information. All this procedure is done at the two-digit level (since the input-output matrix is usually calculated at this level). For each four-digit level industry, we look at the corresponding two-digit price index and we deflate the investment series with that index. For depreciation, we use the same index to obtain real depreciation.

To calculate the average, *w*, we took the ratio of labor income (remuneraciones) to yearly hours. We calculated yearly hours from employment data by assuming that each worker would work 40 hours per week with two weeks of vacations per year. Output corresponds to value added reported in the Encuesta. The industrial price deflator, *p*, was obtained from INEGI at the four-digit level.

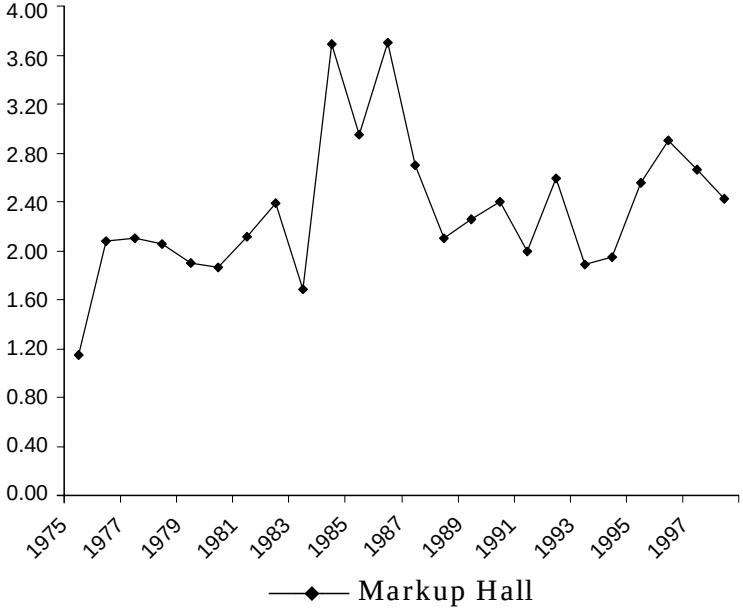
We illustrate in the following graph an estimate of the markup, using equation (4) in a cross-section fashion.[7]

After viewing figure 1, we can see that after the GATT went into effect, the markups start to decrease. This decrease is interrupted by the increase in the 1995 period which corresponds to a period in which the economy was in sharp recession. As we will see later in the paper, the explanation for this behavior lies in the fact that the markup behaves anticyclically. Thus, the recession of 1995 affected dramatically the behavior of the markup. Domowitz, Hubbard, and Petersen (1986) observe similar variations in the markups (or the equivalent price cost margins)[8] across time, and run regressions across sub-samples of the whole period to observe the changing behavior of price cost margins and the determinants.

[7] Strictly speaking, Hall´s suggestions require the use of a certain span of time and the projection of the right-hand side variable of equation (4) in the space spanned by the instruments. Here we use pure cross-section techniques and no instruments, for the purposes of illustration.

[8] We say equivalent price-cost margins because there is a one to one relation between these measures and the markup.

Figure 1. The markup calculated with Hall's methodology



III. Results

III.1. Whole Manufacturing

Equation (4) is estimated for the mexican manufacturing sector to detect the change in the level of market power generated by trade liberalization. Thus, equation (4) is run over two sample periods that pretend to detect the changes in market power due to changes in the trade regime. The sample periods are: the period before GATT (1975-1986) and the period after GATT (1987-1998), the period before NAFTA (1975-1993) and the period after NAFTA (1994-1998).[9] We pool four-digit data into sectors and for the whole manufacturing sector, to check for the change in the degree of market power. For the whole manufacturing sector, we also include a table that divides the sample

[9] As argued in the introduction, the reason for choosing this partition of the periods comes from the reduced number of data that we have after the NAFTA agreement. The inter GATT-NAFTA period is longer but not as long as the one before the GATT period. Thus to gain efficiency we chose this partition. Also, we needed periods with large size to account for the potential cyclical behavior in the markup. In Table 2 we divide the sample in three periods to analyze the two main changes in the trade regime, the GATT process and the NAFTA agreement. We divide in three periods only for the whole manufacturing sector.

period in three periods: The period before GATT, the period after GATT-before NAFTA and the period after NAFTA.

To control for the potential cyclical behavior in the markup we include a dummy variable that attains the value of one whenever GDP is growing in that year and zero if the growth is negative. This variable is included in equation (4) by multiplying the weighted change in the labor-capital ratio by the dummy and including it as an additional regressor.

The results are shown in the following order: first, we show the change in the degree of market power for the whole manufacturing sector pooled under the assumption of a common degree of market power and fixed effects for each industry. For these type of estimates we present two tables, in the first table (Table 1), we partition the estimation period in two; in the second, we partition the estimation period in three (Table 3). We include the procyclical dummy to control for the cyclical behavior of the markup in tables 2 and 4. Then, we pool industries into sectors and discuss the impact of trade liberalization at the sector level (Table 6). For all sector estimates, we assume fixed effects for each four-digit industry.

Hall (1988) argues that a procyclical productivity measurement obtained from (4) (under the assumption of perfect competition, $\beta = 1$) is an indication of the presence of market power (i.e. that the assumption $\beta = 1$ is violated). He advocates the use of instrumental variables correlated with business cycle fluctuations to obtain an estimate of β. By using an instrument correlated with business cycles he obtains the level of β that makes the estimated productivity orthogonal to business cycle fluctuations.

In other words, when market power is present, the weighted change in the labor-capital ratio variable may be correlated with technical progress, thus yielding a classical simultaneous equation bias. However, the use of instrumental variables may be inadequate if we have a small sample and the instruments are poorly chosen. Nelson and Starz (1988) have shown significant biases in instrumental variable estimates when the sample is small and the performance of the instrument is poor. Thus, the use of instrumental variables yields asymptotically consistent estimates but may give biased estimates for small samples and inadequate instruments. On the other hand, non-instrumental estimates are asymptotically biased but behave better for small samples. Given these arguments, we estimated

equation (4) with instrumental and non-instrumental techniques. We report in Table 1 the results for least squares and two-stage least squares estimates. The instruments used are the current rate of gross domestic product, its lagged value, the rate of change of the terms of trade and the rate of change of the price of oil.

The estimated equation shown in Table 1 is obtained from the following expression:

$$\left(\frac{\dot{Y}}{Y}-\frac{\dot{K}}{K}\right)_{it} = Fixed\ Effect_i + \beta\left(\frac{wL}{pY}\left(\frac{\dot{L}}{L}-\frac{\dot{K}}{K}\right)\right)_{it} + \omega_{it}. \qquad (5)$$

Thus, we pool all manufacturing industries in the sample indexed by the variable *i* to obtain a common estimate for the markup for the whole manufacturing sector. Assuming that technical progress for each industry has a random walk with drift in levels, we have that the rate of growth of technical progress for each industry ($\dot{A}/A$ in the notation of equation (4)) is given by a constant (the fixed effect) and the random effect (ω). To check for the impact of trade liberalization, we choose two sample periods. First, we run a regression for the period before trade liberalization took place (before GATT or before NAFTA), and then we run a second regression for the period after trade liberalization took place (after GATT or after NAFTA).[10] In Table 3, discussed after, we divide the sample in three periods, the before GATT period, the after GATT-before NAFTA period and the after NAFTA period.

According to the results presented in Table 1, for both the OLS estimates and the TSLS results, trade liberalization (through GATT and NAFTA) reduces the degree of market power (the markup). In several cases, the change in the level of market power appears to be rather significant. Standard F-tests that determine the significance of the change in the degree of market power between the two periods considered, do show a breakup in the degree of market power for the OLS estimates before and after NAFTA and also for the TSLS estimates, before and after GATT and before and after NAFTA**.**

The average tariff rate for the manufacturing sector went from 38.6 in 1985 to 14.9 in 1990. Thus, substantial trade liberalization

[10] Se Domowitz, Hubbard, and Petersen (1988).

Table 1. Whole manufacturing sector: markup estimation. Two periods

	Coefficient (β)	*Std. Error*	*T statistic β>1*	R^2
OLS				
Before NAFTA	2.30's	0.19	6.84	0.160
After NAFTA	1.83's*	0.20	4.15	0.374
Before GATT	2.24's	0.25	4.96	0.158
After GATT	1.99's	0.15	6.60	0.289
Whole Period	2.07's	0.14	7.64	0.174
TSLS				
Before NAFTA	2.89's	0.32	5.91	+
After NAFTA	1.80s*	0.21	3.81	+
Before GATT	2.89's	0.36	5.25	+
After GATT	2.03's*	0.21	4.90	+
Whole Period	2.58's	0.26	6.08	+

Notes:
We imposed as restriction that all industrial sectors had the same degree of market power. We also assume fixed effects for individual industries.
s Means that the estimated parameter is statistically significant at the 5 percent.
' Denotes the rejection of the hypothesis of perfect competition at the 5 percent.
* Indicates that this coefficient is significantly smaller than the coefficient of the previous period at the 5 percent.
+ There is not a unique R^2 for the whole system. Rather, we have one for each industry included in the pool.

was occurring in the mexican economy at the same time.[11] However, as mentioned in the introduction, the average import duty for the whole economy in 1994 was 18.59, thus the trade liberalization process initiated by NAFTA implied a second round liberalization process. Kowalcsyk and Davis (1996) estimated that the NAFTA agreement implied that Mexico took, on average, 5.64 years to phase out protection from its NAFTA partners. The results shown in this table show that after the trade liberalization program was announced in 1985 (joining the GATT), the impact was a reduction in market power. Similarly, the NAFTA announcement also had implications for a reduction in market power.

In summary, the results of Table 1 suggest that trade liberalization has an impact on market power. Grether (1996) uses calculated measures of markups and concludes that exposure to foreign competition significantly reduced the profit rate of mexican manufacturers. The results of Table 1 are consistent with his conclusions.

[11] See Hanson and Harrison (1995).

Table 2. Whole manufacturing sector: cyclical behavior of the markup. Two periods

	β *recession*	*D*	β *growth*	R^2
OLS				
Before NAFTA	3.64'^{s} (0.38)	−1.53^s (0.33)	2.11'^{s} (0.20)	0.174
After NAFTA	2.65'^{s}* (0.43)	−1.08^s (0.51)	1.57'^{s}* (0.24)	0.387
Before GATT	3.66'^{s} (0.47)	−1.86^s (0.53)	1.80'^{s} (0.28)	0.176
After GATT	2.75'^{s}* (0.36)	−0.90^s (0.39)	1.85'^{s} (0.16)	0.296
Whole Period	3.28'^{s} (0.30)	−1.51^s (0.33)	1.77'^{s} (0.15)	0.188
TSLS				
Before N AFTA	4.17'^{s} (0.59)	−1.85^s (0.88)	2.32'^{s} (0.55)	+
After NAFTA	2.65'^{s}* (0.44)	−1.07^s (0.51)	1.57'^{s} (0.15)	+
Before GATT	3.97'^{s} (0.61)	−1.66^s (0.76)	2.31'^{s} (0.44)	+
After GATT	2.91'^{s}* (0.41)	−1.20^s (0.49)	1.71'^{s} (0.24)	+
Whole Period	3.70'^{s} (0.42)	−1.94^s (0.58)	1.76'^{s} (0.35)	+

' Means that the thesis of perfect competition is rejected, at least at the 10 percent level.
s Means that the coefficient is significantly different from zero at the 5 percent.
* Indicates that this coefficient is significantly smaller than the coefficient of the previous period at the 5 percent.
Standard errors in parenthesis.
+ There is not a unique R^2 for the whole system. Rather we have one for each industry included in the pool.

To check for the robustness of the inferences drawn from Table 1 we consider explicitly the impact of business cycle fluctuations on our measurements of the markup. In Table 2 we account for cyclical behavior of the markup by including a multiplicative dummy (*D*) that has the value of 1 whenever the GDP of the year is growing and the zero value whenever there is a negative rate of growth. We multiply this dummy by the weighted average rate of the labor-capital ratio in equation (4) and run the regression with this extra regressor. Thus the equation estimated in Table 2 is:

$$\left(\frac{\dot{Y}}{Y}-\frac{\dot{K}}{K}\right)_{it} = Fixed\ Effect_i + \beta\left(\frac{wL}{pY}\left(\frac{\dot{L}}{L}-\frac{\dot{K}}{K}\right)\right)_{it} + D\beta\left(\frac{wL}{pY}\left(\frac{\dot{L}}{L}-\frac{\dot{K}}{K}\right)\right)+\omega_{it}, \quad (6)$$

where *D* represent the multiplicative dummy. The results shown are for the whole (pooled) manufacturing sector. The first column in Table 2 shows the markup under the condition of negative growth. The third

column in that table shows the markup in periods of growth. The second column gives the value of the multiplicative dummy. The interesting point to highlight from Table 2 is that the inclusion of the dummy does not affect our inference with regard to the effect of trade liberalization.

The OLS results show a significant reduction in the markup (in periods of recession) for the two rounds of liberalization (NAFTA and GATT). Similarly, the TSLS results show a significant reduction in the NAFTA and GATT liberalization rounds. Standard F-tests confirm these assertions. In periods of growth, the OLS results show that trade liberalization affects significantly the degree of market power only for the after NAFTA period. Thus, most of the results of Table 2 confirm the conclusions advanced before: trade liberalization appears to affect the price setting behavior of the mexican manufacturing firms.

Another interesting result obtained from Table 2 is the anticyclical behavior of the markup. For almost all the results shown in the table, the dummy appears significant at the 5 percent showing that the markup changes across business cycle fluctuations. This evidence is consistent with the theoretical arguments advanced by Rotemberg and Saloner (1986) which argue that in periods of growth firms tend to reduce the level of colussion to avoid the possibility of defectors.

To grasp better the differential impact of the two rounds of liberalization, we divide the time span in three periods, the before GATT period, the after GATT-before NAFTA period and the after NAFTA period. Table 3 shows the results for the pooled manufacturing sectors with the time span divided in these three periods. We estimate equation (5). There is a tradeoff in the results shown in Table 1 and 3. On one hand, those shown in Table 1 allow us to have a more efficient estimation because we have a larger number of observations after liberalization took place (for the after GATT estimates). On the other hand, the partition in three periods shown in Table 3 gives us a better description of the two rounds of liberalization. This happens at the expense of the shortcomings accompanying a shorter period of estimation.

The results of Table 3 are indicative of the impact of trade liberalization, especially the effect of the NAFTA agreement on market power. For the OLS technique of estimation, there is a significant reduction in the degree of market power after the NAFTA agreement went into effect. Standard F-tests for structural change confirm this

Table 3. Whole manufacturing sector: markup estimation. Three periods

	Coefficient β	*Std. Error*	R^2
OLS			
Before GATT	2.24'^{s}	0.25	0.158
After GATT-before NAFTA	2.76'^{s}	0.28	0.338
After NAFTA	1.83'^{s}*	0.20	0.374
TSLS			
Before GATT	2.89'^{s}	0.36	+
After GATT-before NAFTA	2.73'^{s}	0.35	+
After NAFTA	1.80'^{s}*	0.21	+

' Means that the hypothesis of perfect competition is rejected, at least at the 10 percent level.
s Means that the coefficient is significantly different from zero at the 5 percent.
* Indicates that this coefficient is significantly smaller than the coefficient of the previous period at the 5 percent.
+ There is not a unique R^2 for the whole system. Rather, we have one for each industry included in the pool.

intuition. The TSLS results show a reduction in the degree of market power in the period after GATT-before NAFTA, although non-significant. There is also a significant reduction in the markup for the transition between after GATT-before NAFTA period to the after NAFTA period. The OLS results point to an increase in the degree of market power after the GATT trade liberalization went into effect.

The results of the after GATT-before NAFTA period for the OLS technique appear counterintuitive.[12] The effect may be due to the fact that the markup might change across the cycle. We have a period of recession or slow growth before the GATT went into effect (1982-1985) and then we have an expansion period after the GATT went into effect (especially from 1988).[13] This might have affected the behavior of the markup. Domowitz, Hubbard, and Petersen (1988) show evidence that the markup is procyclical in the U.S.

To check for this possibility, we estimate equation (6) in three periods with the same dummy used for Table 2. Although there is still an increase in the markup from the before GATT to the after GATT before-NAFTA period, the increase does not appear significant. Table 4 illustrates the results. The first column shows the markup in periods of negative growth, the second column shows the dummy and the third column shows the markup in periods of growth.

[12] We changed the year that defines the change between the before GATT period to the after GATT-before NAFTA period, without finding significantly different results.

[13] The reduction in market power after NAFTA may also be related to the impact of the 1995 recession.

Table 4. Whole manufacturing sector. Cyclical behavior and markup estimation. Three periods

	β *recessions*		*D*		β *growth*		R^2
OLS							
Before GATT	3.66'^{s}	(0.47)	−1.860^s	(0.53)	1.80'^{s}	(0.28)	0.176
After GATT-before NAFTA	3.94'^{s}	(0.81)	−1.210^s	(0.84)	2.73'^{s}	(0.41)	0.231
After NAFTA	2.65'^{s}	(0.43)	−1.080^s	(0.51)	1.57'^{s}*	(0.24)	0.387
TSLS							
Before GATT	3.97'^{s}	(0.61)	−1.660^s	(0.76)	2.31'^{s}	(0.44)	+
After GATT-before NAFTA	3.76'^{s}	(0.86)	−1.020	(0.95)	2.74'^{s}	(0.44)	+
After NAFTA	2.61'^{s}	(0.47)	0.038	(0.87)	2.64'^{s}	(0.69)	+

' Means that the hypothesis of perfect competition is rejected, at least at the 10 percent level.
s Means that the coefficient is significantly different from zero at the 5 percent.
* Indicates that this coefficient is significantly smaller than the coefficient of the previous period at the 5 percent.
+ There is not a unique R^2 for the whole system. Rather, we have one for each industry included in the pool.

III.2. Sector Results

To find out about the sector impact of NAFTA, we pooled four-digit industries into sectors (in the appendix we give the definition of sectors). For this section we estimate equation (5). The only difference with the last section is that we only pool industries included in the sector. In the last section we pool all manufacturing industries included in this study. The section is organized as follows: first we implement endogeneity tests for each sector, then we report the results of the estimates at the sector level.

Given the arguments mentioned above about the potential endogeneity of the weighted labor-capital ratio variable $[(wL / pY)(\dot{L} / L - \dot{K} / K)$ in the notation of equation (5)], we implemented Hausman specification tests. The instruments used for the tests are those mentioned above: the rate of growth of GDP and its lagged value, the rate of change of the terms of trade and the rate of change of the price of oil. The results are reported in Table 5.

We can see that for the period before GATT, six sectors (food and beverages, glass and cement, wood, basic metals, machinery and equipment and transport equipment) reject the hypothesis of no endogeneity at the 10 percent and two at the 5 percent (machinery and equipment and glass and cement). After GATT, the hypothesis of no endogeneity is rejected for three sectors (chemicals, basic metals and machinery and equipment). Before NAFTA, the hypothesis of no

Table 5. Endogeneity tests for sectors

	CHI SQUARE	*PROB.*		*CHI SQUARE*	*PROB.*
Before GATT			**After GATT**		
Food and bev	3.27	0.07	Food and bev	0.170	0.68
Textiles	0.69	0.41	Textiles	0.110	0.74
Paper	0.87	0.35	Paper	0.240	0.63
Wood	2.71	0.10	Wood	0.003	0.97
Chemicals	0.04	0.84	Chemicals	6.220	0.01
Glass and ce	3.73	0.05	Glass and ce	1.210	0.27
Basic metals	5.40	0.02	Basic metals	2.780	0.10
Metal prod	0.16	0.68	Metal prod	0.640	0.42
Mach and eq	8.44	0.00	Mach and eq	6.130	0.01
Trans equip	11.05	0.00	Trans equip	0.310	0.58
Before NAFTA			**After NAFTA**		
Food and bev	4.19	0.04	Food and bev	0.020	0.88
Textiles	0.05	0.83	Textiles	2.900	0.08
Wood	0.03	0.87	Wood	1.100	0.29
Paper	0.04	0.85	Paper	0.370	0.54
Chemicals	0.30	0.59	Chemicals	3.080	0.08
Glass and ce	0.03	0.85	Glass and ce	0.270	0.60
Basic metals	1.17	0.28	Basic metals	0.480	0.49
Metal prod	4.10	0.04	Metal prod	2.060	0.15
Mach and eq	1.10	0.29	Mach and eq	11.370	0.00
Trans equip	5.19	0.02	Trans equip	3.260	0.07

endogeneity is rejected in three sectors at the 5 percent level (food and beverages, metal products and transport equipment). After NAFTA, the hypothesis of no endogeneity is rejected in four sectors at the 10 percent level (textiles, chemicals, machinery and equipment and transport equipment). One sector rejects the hypothesis at the 5 percent level (transport equipment).

Since most cases do not reject the hypothesis of no endogeneity, the results reported in Table 5 could be used to justify the use of non-instrumental variable techniques. However, the number of sectors in which instrumental variables is recommendable, can be significant for some periods such as the period before GATT. Also, the arguments mentioned above, about the advantages and disadvantages of the use of instrumental variables, advise us to report both sets of estimates.[14]

[14] Above, a paragraph discusses the advantages and disadvantages of using instrumental and non-instrumental techniques, following the assertions made by Nelson and Starz (1988) and Hall (1988).

Thus, Table 6 reports both, the non-instrumental and the instrumental variables results.

In Table 6 we show the impact of trade liberalization at the sector level. We pool four-digit industries into sectors and show the impact of trade liberalization.

We tested for the restriction that imposes a common markup across industries included in the sectors. Before GATT, we rejected the hypothesis of homogeneity in paper, chemicals and metal products. After GATT, the test reported a rejection on homogeneity for food and beverages, paper, glass and cement and basic metals. With regard to the period before NAFTA, the test rejected the hypothesis of homogeneity for glass and cement and metal products. After NAFTA, the results reject the homogeneity hypothesis for food and beverages, paper, and basic metals. In the worst case (the after GATT period), the hypothesis of homogeneity was rejected in only half of the sectors, for the other four periods (before GATT, before NAFTA and after NAFTA) the test is rejected in less than half the sectors.

The sector results appear less definitive than the whole manufacturing pooled estimates. Some estimates do increase after GATT and (or) NAFTA implementation. Most of them do not have a significant increase.[15]

The SUR estimates of food and beverages show this property. Even though there is an increase in the markup, the difference in the size of the markup is not enough when we look at the size of the standard deviation of the estimates. An F-test confirms the non-significance of the change. In some cases, the difference in the size of the markups turned out to be smaller than the standard deviations. The SUR results on wood and textiles show this behavior. As before, an F-test confirms our conclusion.

As expected, the GATT liberalization generated a reduction in the size of the markups for several SUR estimates: machinery and equipment, metal products, chemicals, paper and transport equipment. As before, several cases do not show a significant decrease in the markup. However, an F-test confirms that machinery and equipment, chemicals, metal products and transport equipment do show a

[15] However, the SUR estimates of Glass and Cement for the GATT change, do show a significant increase in the markup. We have a similar result for the 3SLS estimate for the GATT change in machinery and equipment. A potential explanation for the Glass and Cement sector is the highly collusive behavior that the cement industry has been showing in the last years. The *Comisión Federal de Competencia* is now conducting an investigation for monopoly power in this industry.

Table 6. Sector results. Markup estimates. Two different periods

SUR	*Before* GATT	R^2	*After* GATT	R^2
Food and Beverages	$1.87^{s\ pc}$ (0.70)	0.62	$2.80^{s\ mp}$ (0.38)	0.36
Wood	1.54 (2.40)	0.05	$2.05^{s\ mp}$ (0.18)	0.91
Machinery and Equip.	$2.24^{s\ mp}$ (0.30)	0.20	$1.39^{s\ *\ pc}$ (0.30)	0.15
Basic Metals	$2.69^{s\ mp}$ (0.50)	0.21	$2.04^{s\ mp}$ (0.44)	0.28
Glass and Cement	$1.68^{s\ mp}$ (0.32)	0.22	$2.67^{s\ mp}$ (0.16)	0.67
Chemicals	$2.59^{s\ mp}$ (0.27)	0.35	$1.80^{s\ *\ mp}$ (0.15)	0.51
Paper	$3.03^{s\ mp}$ (0.51)	0.31	$2.55^{s\ mp}$ (0.77)	0.16
Textiles	0.46^{pc} (0.35)	0.10	1.29^{pc} (0.44)	0.17
Metal Products	$2.18^{s\ mp}$ (0.32)	0.25	$1.39^{s\ *\ pc}$ (0.30)	0.35
Transport Equipment	$2.85^{s\ mp}$ (0.29)	0.72	$2.06^{s\ *\ mp}$ (0.33)	0.40
SUR	***Before*** **NAFTA**	R^2	***After*** **NAFTA**	R^2
Food and Beverages	$2.06^{s\ mp}$ (0.53)	0.25	$2.71^{s\ mp}$ (0.59)	0.64
Wood	1.52 (1.93)	0.03	$2.06^{s\ mp}$ (0.22)	0.94
Machinery and Equip.	$2.03^{s\ mp}$ (0.25)	0.18	1.02^{pc} (0.92)	0.10
Basic Metals	$2.81^{s\ mp}$ (0.46)	0.21	$1.96^{s\ *\ mp}$ (0.02)	0.27
Glass and Cement	$2.17^{s\ mp}$ (0.31)	0.37	$2.87^{s\ mp}$ (0.50)	0.12
Chemicals	$2.61^{s\ mp}$ (0.37)	0.34	$1.53^{s\ *\ mp}$ (0.35)	0.10
Paper	$2.32^{s\ mp}$ (0.43)	0.30	1.91^{pc} (2.33)	0.31
Textiles	0.49^{pc} (0.41)	0.15	0.99^{pc} (0.03)	0.28
Metal Products	$2.32^{s\ mp}$ (0.40)	0.26	$1.26^{s\ *\ mp}$ (0.12)	0.59
Transport Equipment	2.74^{mp} (0.28)	0.64	$1.81^{s\ *\ mp}$ (0.19)	0.22
3SLS	***Before*** **GATT**	R^2	***After*** **GATT**	R^2
Food and Beverages	$3.34^{s\ mp}$ $(1.01)^{2s}$	+	$2.68^{s\ mp}$ $(0.54)^{2s}$	+
Wood	–7.39 (9.40)	+	$2.06^{s\ mp}$ (0.28)	+
Machinery and Equip.	$1.31^{s\ pc}$ (0.45)	+	$2.26^{s\ mp}$ (0.41)	+
Basic Metals	0.97^{pc} (0.93)	+	0.98^{pc} (0.63)	+
Glass and Cement	$2.39^{s\ mp}$ (0.68)	+	$3.08^{s\ mp}$ (0.41)	+
Chemicals	$2.52^{s\ mp}$ (0.52)	+	$2.17^{s\ mp}$ (0.20)	+
Paper	$3.72^{s\ mp}$ (0.86)	+	$3.12^{s\ pc}$ (1.28)	+
Textiles	0.63^{pc} (0.46)	+	0.93^{pc} (0.68)	+
Metal Products	$2.57^{s\ pc}$ (1.07)	+	$1.80^{s\ mp}$ (0.38)	+
Transport Equipment	$3.77^{s\ mp}$ (0.42)	+	$1.96^{s\ *\ mp}$ (0.38)	+
3SLS	***Before*** **NAFTA**	R^2	***After*** **NAFTA**	R^2
Food and Beverages	$4.00^{s\ mp}$ $(1.05)^{2s}$	+	$3.13^{s\ mp}$ $(1.01)^{2s}$	+
Wood	0.41^{pc} (7.21)	+	3.15^{pc} (2.00)	+
Machinery and Equip.	$2.04^{s\ pc}$ $(0.78)^{2s}$	+	$3.64^{s\ mp}$ $(1.52)^{2s}$	+
Basic Metals	1.69^{pc} (1.19)	+	$2.57^{s\ mp}$ (0.19)	+
Glass and Cement	$2.85^{s\ mp}$ $(0.67)^{2s}$	+	2.42^{pc} $(1.57)^{2s}$	+
Chemicals	$2.49^{s\ mp}$ $(0.68)^{2s}$	+	$2.93^{s\ mp}$ $(1.00)^{2s}$	+
Paper	$2.87^{s\ mp}$ (0.95)	+	0.01^{pc} (3.40)	+
Textiles	0.80^{pc} (0.98)	+	$2.81^{s\ mp}$ (0.14)	+
Metal Products	$3.34^{s\ pc}$ $(1.65)^{2s}$	+	$2.01^{s\ mp}$ $(0.52)^{2s}$	+
Transport Equipment	$3.33^{s\ mp}$ (0.50)	+	$1.81^{s\ *\ mp}$ (0.19)	+

We imposed as restriction that all industries inside a sector has the same degree of market power. We also assume fixed effects for individual industries.

s Means that the estimated parameter is significant at the 10 percent level.

mp Denotes the rejection of the hypothesis of perfect competition.

pc Means that we cannot reject the hypothesis of perfect competition

2s Means that we were not able to obtain the 3SLS estimate and thus the 2SLS result is reported. Standard errors in parenthesis.

* Indicates that this coefficient is significantly smaller than the coefficient of the previous period at the 5 percent.

\+ There is not a unique R^2 for the whole system. Rather, we have one for each industry included in the pool.

statistically significant reduction in the size of the markups for the GATT liberalization process.

Hanson and Harrison (1995) show (see Table 2 of the aforementioned paper) that all these sectors experienced a strong liberalization process between 1985 and 1990. According to Table 2 of the Hanson and Harrison paper, chemicals went from a production weighted average tariff rate of 29.9 in 1985 to 14.4 in 1990. Metal products (which according to their classification include some industries from machinery and equipment, from transport equipment as well as the metal products industries from this paper classification) went from 46.3 in 1985 to 16.1 percent in 1990.

When we include a multiplicative dummy (in the SUR estimates) to control for the potential cyclical behavior of the markup we still have an impact of the GATT liberalization round on machinery and equipment and metal products. The markup (in times of positive growth) shows a significant reduction for these sectors.

Similarly, for the NAFTA round of liberalization, the SUR estimates indicate that chemicals, basic metals, metal products and transport equipment have a significant reduction in the level of the markup. Kowalcksy and Davis (1996) show that these sectors have a liberalization process in which protection is eliminated at a faster pace than the average for the whole economy. Basic metals have a phase out process of 3.38 years; chemicals and related products have a phase out process of 4.83 years; machinery and transport equipment has a phase out progression of 3.28 years, the average for all imports is 5.64 years.

The inclusion of a dummy that controls for the potential cyclical behavior of the markup does not affect our inference regarding the SUR results of the impact of NAFTA on basic metals, metal products and transport equipment. These sectors still show a significant reduction in the markup (for periods of positive growth) after the NAFTA implementation.

The 3SLS estimates show evidence of a significant reduction in the markup for transport equipment (for both GATT and NAFTA). Some other sectors show a non-significant reduction of the markup –food and beverages, chemicals paper and metal products after the GATT implementation. There are also non-significant increases in the size of the markup.[16] Consistent with Nelson and Starz (1988) results, the

[16] See footnote 15.

3SLS estimates are more imprecise, the ratio of the estimate to the standard deviation is smaller (on average) than the corresponding ratio for the SUR results.

IV. Concluding Remarks

In this paper we estimate the markup econometrically. This estimate is used to determine the impact of trade liberalization. In contrast with the previous literature that estimated the impact of trade liberalization by calculating the markup from industry data and assuming that variable costs are the right surrogate for marginal costs, this study uses Hall's suggestions to estimate the markup. This approach has stronger microeconomic foundations. Nonetheless, the results are similar to those obtained using calculated markups (Grether 1996). Most of our pool estimates for the whole manufacturing sector show that trade liberalization reduces market power for the whole manufacturing sector. This result has implications for economic welfare. As market power diminishes, deadweight losses diminish too. The reduction in markups implied by trade liberalization generates additional welfare gains to those traditionally stressed in the trade literature.

At the sector level, we find a reduction of the impact of trade liberalization only in some industries (machinery and equipment, chemicals, metal products and transport equipment according to the SUR results). The evidence on tariffs suggests that these industries experienced strong reduction in their production-weighted average tariff rates after GATT. Also, the after NAFTA results indicate that all industries that experienced a significant reduction in the size of the markup had a phase out process in which protection is eliminated at a faster pace than the average for the manufacturing sectors. The coincidences in these evidences enhance the confidence of our results.

The paper controls for potential cyclical behavior of the markup and finds evidence in favor of anticyclical behavior of the markup. These results are consistent with the theoretical arguments pointed out by Rotemberg and Saloner (1986) and differ with the evidence found for other countries.[17]

[17] See Domowitz, Hubbard and Petersen (1988).

In a related study we are investigating the impact of NAFTA on markups calculated from industry data (similarly to Grether, 1996). Hopefully, this will shed more light on the impact of trade liberalization on these markets. In the agenda for future research remains the analysis of the cyclical properties of the markup in relation with the type of industries that exhibit this behavior, with the type of industry defined according to certain categories: concentration, type of good produced (durables, non-durables), etc.

Appendix

– The food and beverages sector includes six-digit industries 311101, 311203, 311301, 311404, 311501, 311405, 311701, 312200, 311304, 311903, 312123, 313040, 313040 and 313050.
– The machinery and equipment sector includes six-digit industries 381300, 381408, 381407, 381401, 382101, 383301, 383204, 383108, 383107.
– The basic metals sector includes six-digit industries 371001, 371006, 372003, 372005.
– The glass and cement sector includes six-digit industries 362011, 362013, 362021, 362022, 369111.
– The chemical sector includes six-digit industries 351300, 352100, 352222, 352210, 355001.
– The paper sector includes six-digit industries 341010, 341022, 341031.
– The textiles sector includes six-digit industries 321202, 321205, 321207.
– The metal products sector includes six-digit industries 381300, 381408, 381407.
– The transport equipment sector includes six-digit industries 384110, 384121, 384122.

References

Casar, J., C. Márquez, S. Marván, G. Rodríguez y J. Ros (1990), *La Organización Industrial en México,* México, Siglo XXI Editores.

Castañeda, A. (1998), "Measuring the Degree of Collusive Conduct in the Mexican Manufacturing Sector", *Estudios Económicos,* vol. 13, pp. 157-169.

Domovitz, I., R. G. Hubbard and B.C. Peterson (1986), "The Intertemporal Stability of the Concentration-Margins Relationship", *The Journal of Industrial Economics*, vol. 35, pp. 13-34.

——— (1988), "Market Structure and Cyclical Fluctuations in U.S. Manufacturing", *The Review of Economics and Statistics*, pp. 55-66.

Grether, J.M. (1996), "Mexico, 1985-90: Trade Liberalization, Market Structure, and Manufacturing Performance", in M. J. Roberts and J.R. Tybout (eds.), *Industrial Evolution in Developing Countries*, Oxford University Press.

Hall, R.E. (1988), "The Relation between Price and Marginal Cost in U.S. Industry", *Journal of Political Economy*, vol. 96, pp. 921-947.

Hanson, G.H. and A. Harrison (1995), "Trade, Technology and Wage Inequality," NBER WP, num. 5110.

Hoekman, B., H.L. Kee and M. Olarreaga (2001), "Markups, Entry Regulation and Trade: Does Country Size Matter?", Mimeo.

Kowalczyk, C. And D. Davis (1996), "Tariff Phase-outs: Theory and Evidence from GATT and NAFTA", NBER WP, num. 5421.

Nadiri, I.M. and R. Prucha (1996), "Estimation of the Depreciation Rate of Physical and R & D Capital in the U.S. Total Manufacturing Sector", *Economic Inquiry*, vol. 34, pp. 43-56.

Nelson, C.R. and R. Startz (1988), "Some Further Results on the Exact Small Sample Properties of the Instrumental Variable Estimator", NBER WP, num. 68.

Rotemberg, J. and G. Saloner (1986), "A Supergame-Theoretic Model of Business Cycles and Price Wars during Booms", *American Economic Review*, vol. 76, pp. 390-407.