Lerner Index: Estimation and the Impact of its Market Structure Determinants

Alejandro Castañeda Sabido*
Fecha de recepción: 9 de julio de 2004; fecha de aceptación: 28 de marzo de 2006.

Abstract: Using the reasoning that assumes that a pro-cyclical Solow residual is an indication of the presence of market power, the paper estimates the Lerner index. At the same time in which we estimate the Lerner index, we measure the impact of industry structure variables (concentration and imports) on this index. Because we have panel data, we also allow for a change in the impact of these variables across time. For the whole manufacturing sector, we find that concentration and imports have a differing impact on the Lerner index across the business cycle. We find evidence that shows that the Lerner index behaves anticyclically. And we also make the analysis by type of good (durables and non-durables) and find differing impacts of concentration and imports by type of good.
Keywords: Lerner index estimation, concentration, import-penetration, pro-cyclical Solow residual.

Resumen: Asumiendo que un residual de Solow procíclico es evidencia de poder de mercado, el trabajo calcula el índice de Lerner. Al mismo tiempo en que se estima el índice de Lerner, se mide el impacto de variables industriales (concentración e importaciones) sobre el índice. Debido a que tenemos datos en panel, también se estima cómo cambia, a través del tiempo, el impacto de estas variables. Se encuentra que la concentración y las importaciones tienen un impacto diferente sobre el índice de Lerner a lo largo del ciclo económico. Asimismo, se encuentra evidencia de que el índice de Lerner se comporta anticíclicamente. También se hace el análisis por tipo de bien (durables y no durables) y se encuentran impactos diferentes de la concentración y las importaciones por tipo de bien.
Palabras clave: Estimación del índice de Lerner, concentración, penetración de importaciones, residual de Solow procíclico.

JEL *Classification*: L00, L11, L60.

---

* El Colegio de México, Camino al Ajusco 20, México, D.F., 10740, Phone: (55) 5727-9839, Fax: (55) 5645-0464, acasta@colmex.mx. I am grateful to Claudia Sámano and Eduardo Muñoz for their helpful assistance.

Introduction

There is a long tradition in industrial organization that has studied the determinants of price-cost margins[1] A typical model would establish the price cost margin as the dependent variable with concentration indexes, the capital-output ratio and other variables as explanatory variables. In this framework, the price-cost margin is calculated with industry data, assuming that variable cost is an appropriate surrogate for marginal cost. Also, this kind of studies has mainly used cross-section observations.

More new approaches use the Solow equation (1959) to detect the presence of market power. In this tradition, Hall (1988) states that the finding of a pro-cyclical Solow residual is an implication of market power. Under the assumption that the true Solow residual is not intrinsically pro-cyclical, Hall has suggested an econometric method that gives us an estimate of the markup.

This paper uses data obtained from the Encuesta Industrial Anual, published by INEGI, to pool cross-section and time series observations to estimate the Lerner Index, with the help of Hall's methodology. In contrast with traditional industrial organization approaches, the measurement of the Lerner index does not assume a particular form for marginal costs (similar to variable costs). Rather, the econometric approach based on Hall's methodology has sound basic principles. The data used is at the four-digit level that allows us to study the price setting behavior of industries that produce similar products. Previous studies (Castañeda, 1996a, 1996b), have used two-digit data. These data set may have included, in the same industry, rather dissimilar products.

Similarly to the traditional industrial organization literature, the paper introduces variables that affect this latter index, such as concentration indexes and an import penetration index. The rationale for using some of these variables emerges from one stage game theoretic models. From these settings, we can obtain the following results: first, a higher level of concentration has a positive impact on the (average) Lerner index of the industry. Second, a reduction in protection through quotas or tariffs diminishes the Lerner index. Finally, a change in the elasticity of market demand changes the ability of firms to raise prices

[1] Bain (1951) initiated this effort, but there are more recent attempts.

above marginal cost.[2] Thus, this approach gives us the way some industry variables affect the Lerner Index.[3]

The paper also allows for interaction between business cycle and market structure variables. Green and Porter (1984), Rotemberg and Saloner (1986), Haltiwanger and Harrington (1991), and Athey, Bagwell and Sanchirico (2002) argue that oligopolistic industries have varying incentives to collude across the business cycle. A reason consistent with these theories would predict that the impact of industry concentration would not be stable across time. Also, the disciplining impact of imports may vary across the business cycle because peso depreciations have accompanied several downturns in the recent Mexican experience. We investigate for these possibilities. The behavior of the Lerner index across the cycle is also important for macroeconomics. Bils (1987) shows that the Lerner index behaves anti-cyclically in the United States. Several papers of imperfect competition in macroeconomics try to model this situation.

Among the main findings are the following: For the 1986-1998 period, concentration has a positive impact on the Lerner index. Most of the results show that the impact of concentration appears to behave anti-cyclically for this period. This evidence is consistent with the theories advanced by Rotemberg and Saloner (1986) and Haltiwanger and Harrington (1991). When controlling for pro-cyclical impacts, the import-penetration ratio has a negative impact on the Lerner index. The disciplining impact of imports behaves anti-cyclically. There are also differing impacts of industry variables depending upon the type of good (durables and non-durables).

Methodology

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

---

[2] See, for example, Ordover, Sykes and Willig (1982) and Waterson (1984). We are assuming that international competition affects the price setting behavior of domestic firms by modeling this fringe as competitive. A reduction in tariffs or the elimination of quotas affects the elasticity of supply of this fringe and thereby diminishes market power. The so-called new industrial organization (which is not new anymore) uses first order conditions of these types of games to measure market power.

[3] Rotemberg and Saloner (1986) predict that collusion may decrease whenever a quota is established; the reason comes from the fact that the punishment from defection becomes smaller whenever an industry experiences an import quota.

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

$A(t)$ 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 sub-indexes express partial derivatives. Using Euler's theorem for homogenous functions and assuming homogeneity of degree 1 in technical progress, the last expression can be written in the following form:

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

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:

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

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:

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

Divide both sides of equation (4) by β:

$$\left(\frac{\dot{Y}}{Y}-\frac{\dot{K}}{K}\right)\frac{1}{\beta}=\frac{wL}{pY}\left(\frac{\dot{L}}{L}-\frac{\dot{K}}{K}\right)+\frac{\dot{A}}{A}\frac{1}{\beta} \tag{5}$$

Define the Lerner index as $\gamma=\frac{p-c}{p}$ with p representing price and c marginal cost. Then $\beta=\frac{1}{1-\gamma}$. Using the last expression, equation (5) can be rewritten in the following fashion:

$$\left(\frac{\dot{Y}}{Y}-\frac{\dot{K}}{K}\right)(1-\gamma)=\frac{wL}{pY}\left(\frac{\dot{L}}{L}-\frac{\dot{K}}{K}\right)+\frac{\dot{A}}{A}(1-\gamma)$$

Rearranging the last expression we obtain:

$$\left(\frac{\dot{Y}}{Y}-\frac{\dot{K}}{K}\right)-\frac{wL}{pY}\left(\frac{\dot{Y}}{Y}-\frac{\dot{L}}{L}\right)=\gamma\left(\frac{\dot{Y}}{Y}-\frac{\dot{K}}{K}\right)+\frac{\dot{A}}{A}(1-\gamma) \tag{6}$$

Solow assumed that $\gamma = 0$ in the last expression and calculated the so-called Solow residual. In contrast, Hall assumed that A followed a random walk with drift and used a similar equation to (4) to estimate β (which implies a value for γ). He advocated the use of instrumental variables to solve for the potential endogeneity present in equation (6). Domowitz, Hubbard and Petersen (1988) estimated the last equation for the U.S. manufacturing.

Define $\frac{\dot{Y}}{Y}-\frac{\dot{K}}{K}=yk$, similarly $\frac{\dot{L}}{L}-\frac{\dot{K}}{K}=lk$, $\frac{\dot{Y}}{Y}-\frac{\dot{L}}{L}=yl$, $\frac{wL}{pY}=\alpha$ and $a=\frac{\dot{A}}{A}$. Then expression (6) can be written in the following way:

$$yk-\alpha lk=\gamma yk+a(1-\gamma) \tag{6'}$$

We could estimate the last equation to obtain a measure of the price-cost margin. The advantage of that approach would be that we would be estimating the Lerner index from first principles, without the need to assume that variable cost is an appropriate surrogate for marginal cost. The standard procedure would be either to use instrumental variables as in Hall (1988), or an OLS approach as suggested by Caballero and Lyons (1989). Instrumental variables are used when concerns about potential endogeneity of *yk* in (6') are present. However, we are interested in estimating the impact of industry variables on the Lerner index, thus we substitute the price cost margin (γ) by the variables that affect it. So, the next step in our procedure is to make the price cost margin (γ) a function of industry specific factors. Among them the following:

$$\gamma = c + \delta_1 C4 + \delta_2 M/TS \tag{7}$$

With C4 denoting the four firm concentration ratio obtained from INEGI and M/TS is the ratio of imports to total sales. Thus, substituting (7) in expression (6′) and proceeding with the estimation, we obtain the estimates of these factors on the price-cost margin. After substituting (7) in (6′) we get the following equation:

$$yk - \alpha lk = cyk + \delta_1 C4yk + \delta_2 M/TS\, yk + a(1-\gamma) \tag{6''}$$

Once we recover the values of δ_1 and δ_2 from (6″), we can have an estimate of the price cost margin from equation (7). To control for cyclical behavior, a modified version of equation (7) (equation (7′)) is also substituted in expression (6′):

$$\gamma = c + \delta_1 C4 + \delta_2 M/TS + \delta_3 DC4 + \delta_4 DM/TS \tag{7'}$$

D is a pro-cyclical dummy.[4] The resulting equation is:

$$yk - \alpha lk = cyk + \delta_1 C4yk + \delta_2 M/TSyk + \delta_3 DC4yk + \delta_4 DM/TSyk + a(1-\gamma) \tag{6'''}$$

We also estimate an equation that interacts the constant with the dummy.

$$\gamma = c + \delta_1 C4 + \delta_2 M/TS + \delta_3 DC4 + \delta_4 DM/TS + \delta_5 Dc \tag{7''}$$

[4] We will be more explicit about this variable later.

Thus in an additional estimate, equation (7″) is inserted in equation (6′). The resulting equation is:

$$yk - \alpha lk = cyk + \delta_1 C4yk + \delta_2 M/TSyk + \delta_3 DC4yk + \delta_4 DM/TSyk + \delta_5 Dcyk + a(1-\gamma) \qquad (6'''')$$

We also adjusted the $C4$ index by the following expression:

$$C4' = C4(1 - M/TS) \qquad (8)$$

and make γ a function of this $C4'$.

This approach gives us a better understanding of the determinants of the price cost margins, while using a calculation of this that is supported on stronger microeconomic foundations. In other words, we do not need to calculate the price cost margins (as in other approaches) by approximating the marginal cost with variable costs. In the procedure listed above, we used Hall's technique (that allows us to estimate the price cost margin by using equation (6′)) and coupled this technique with the traditional organization approach to obtain an estimate of the determinants of the price-cost margin (the substitution of equation (7), (7′) or (7″) into equation (6′)). Hall's approach assumes a stochastic behavior for technical progress (that it follows a random walk with drift). We assume that behavior in equation (6′) and use it to estimate the parameters.[5]

Results

Expression (7) is inserted in equation (6′), and we obtain an estimating equation (6″) of the determinants on price cost margins. We use data from the Encuesta Industrial Anual published by INEGI. The data runs from 1975 to 1998. We pool four-digit data for the whole manufacturing sector to get panel estimates. We also got panel estimates for durable and non-durable sectors.[6]

In Table 1 we show the results for all the manufacturing industries pooled with fixed effects assumed for each industry. The table shows the GLS estimates and the TSGLS estimates using, for these last set of

[5] Thus, we do not need to measure technical progress but only assume its stochastic behavior.
[6] See Appendix A.2 for the definitions.

estimates, the rate of growth of gross domestic product (current and lagged), the price of oil and the terms of trade as instruments. We used the generalized least squares technique to account for potential heteroscedastic effects, appearing because of the presence of cross-section observations. All tables have weighted least squares and two stage weighted least squares. These techniques estimate previously a covariance matrix to use this as weight for the generalized least square technique. TSGLS estimates are obtained to solve for the potential endogeneity problems present in equation (6′) with regard to the variable yk. However, Nelson and Starz (1988a, 1988b) have shown that there may be significant biases for small samples and poorly chosen instruments. The results of Nelson and Starz show me a tradeoff in the choice of the estimation technique: if I choose instrumental variables, the results may be biased in small samples but are asymptotically correct. On the other hand, non-instrumental estimates are asymptotically biased but behave better for small samples. Shea (1997) has also shown that instrumental variables are not very appropriate if we have multiple parameters to estimate. Given these arguments, I report in Table 1 the results for GLS and TSGLS estimates. We include in Table 1 the variables $C4$ and M/TS in an isolated fashion in order to avoid potential biases. However, the reader must remember that the insertion of equation (7) (or 7′) into equation (6′) (equation (6″)), does not entail the inclusion of these variables.

The literature has also expressed concern about the potential endogeneity present in equation (7) (and 7′), modern industrial organization approaches have criticized equations similar to (7) by questioning the exogeneity of $C4$ and M/TS. To address this concern we present in Appendix A.1 Hausman tests for Tables 1-4, shown in this paper. Appendix A.1 explains carefully how the tests are performed. As the reader can verify, most of the tests do not reject the hypothesis of no endogeneity for the after-liberalization period.[7] The coefficients shown in Table 1 are obtained from equation (6″).

The results show the expected signs for the after trade liberalization period. For both TSGLS and GLS, market concentration increases the price cost margin. For this period, we have that imports, although non-significant, have a negative impact on the Lerner index. These are the salient features of this table. The pre-liberalization (GLS) results show

[7] Doubts may arise in relation to the explanatory power of the instruments used to construct the Hausman tests; however, Table A.5 shows that the R^2 and adjusted R^2 for the instruments as explanatory variables of the $C4$ and M/TS are very large.

Table 1. Pooled Regressions. Whole Manufacturing Sector

		C4	*C4 * yk* δ_1	*M/TS * yk* δ_2	*M/TS*	*yk* *c*	*Adjusted* R^2
1975-1998	GLS	–0.0046	–0.024	–0.014	–0.008	0.91*	0.908147
		(0.0095)	(0.02)	(0.033)	(0.01)	(0.012)	
	TSGLS	–0.0031	0.0289	–0.081	–0.0071	0.841*	
		(0.0097)	(0.040)	(0.058)	(0.011)	(0.024)	
1975-1985	GLS	0.058*	–0.085*	0.0043	–0.062*	0.94*	0.966438
		(0.02)	(0.028)	(0.085)	(0.028)	(0.016)	
	TSGLS	0.056*	–0.062	–0.042	–0.058*	0.92*	
		(0.02)	(0.042)	(0.112)	(0.027)	(0.024)	
1986-1998	GLS	–0.032*	0.07*	–0.014	–0.0007	0.87*	0.972887
		(0.009)	(0.022)	(0.031)	(0.013)	(0.013)	
	TSGLS	–0.033*	0.080*	–0.041	–0.0023	0.863*	
		(0.009)	(0.030)	(0.04)	(0.013)	(0.018)	

Note: Due to the use of instrumental variables, the adjusted R^2 (Adjusted R^2) for TSGLS is reported on a per industry basis, thus we do not have an aggregate measure of goodness of fit. Number of Observations: 1975-1998 = 1656; 1975-1985 = 759; 1986-1998 = 897. * Significant at 5%. ** Significant at 10%.

a negative relation between concentration and market power, and the impact of import-penetration is non-significantly positive.

Next we insert equation (7′) and equation (7″) into equation (6′). With the help of these estimates, we check for the behavior of these variables across the business cycle. After completing this analysis, we make an analysis by type of good.

In Table 2, we show the results of the pooled regressions for the whole manufacturing sector. The regressions control for business cycles impact by incorporating a dummy variable, which has the value of 1 whenever GDP is growing, and 0 if there is a recession (*D* indicates the dummy variable in the table).[8] As in Table 1, in regressing the modified version of (6) (with 7′ or 7″ inserted) we include *C*4 and *M*/*TS* in an isolated fashion, to avoid potential biases. The coefficients of equation (6‴) and (6⁗) are shown in Table 2.

[8] We tried with other business cycle variables like unemployment; however, we did not get a good fitting.

Table 2. Pooled Regressions. Controlling for Cyclical Effects. Whole Manufacturing Sector

		C4	*C4*yk* δ_1	*M/TS*yk* δ_2	*M/TS*	*Yk* *C*	*D*C4*yk* δ_3	*D*M/TS* yk* δ_4	*D*yk* Δ_5	*Adjusted* R^2
1975-1998										
GLS	(*m*1)	–0.0038	0.0032	–0.08	–0.01	0.91*	–0.038**	0.093		0.958959
		(0.009)	(0.026)	(0.066)	(0.01)	(0.012)	(0.022)	(0.077)		
	(*m*2)	–0.0026	0.044	–0.065	–0.01	0.88*	–0.093*	0.069	0.036	0.959102
		(0.009)	(0.039)	(0.067)	(0.01)	(0.023)	(0.046)	(0.079)	(0.027)	
TSGLS	(*m*1)	–0.0021	0.098*	–0.14**	–0.011	0.84*	–0.093*	0.14		
		(0.009)	(0.042)	(0.079)	(0.011)	(0.023)	(0.03)	(0.099)		
	(*m*2)	–0.0023	0.096**	–0.14**	–0.011	0.85*	–0.084	0.147	–0.0063	
		(0.009)	(0.058)	(0.081)	(0.011)	(0.036)	(0.075)	(0.105)	(0.047)	
1975-1985										
GLS	(*m*1)	0.058*	–0.13*	0.035	–0.068*	0.94*	0.071*	0.003		0.967138
		(0.02)	(0.036)	(0.154)	(0.029)	(0.015)	(0.032)	(0.189)		
	(*m*2)	0.063*	0.016	0.047	–0.061*	0.85*	–0.12**	–0.067	0.11*	0.968089
		(0.02)	(0.057)	(0.16)	(0.029)	(0.031)	(0.065)	(0.19)	(0.036)	
TSGLS	(*m*1)	0.054*	–0.112*	–0.056	–0.065*	0.95*	0.0096	0.11		
		(0.021)	(0.045)	(0.158)	(0.03)	(0.021)	(0.037)	(0.21)		
	(*m*2)	0.058*	–0.001	–0.017	–0.059**	0.877*	–0.14**	0.023	0.096*	
		(0.021)	(0.066)	(0.16)	(0.031)	(0.037)	(0.076)	(0.21)	(0.043)	

* Significant at 5%. ** Significant at 10%.

Table 2 (continued). Pooled Regressions. Controlling for Cyclical Effects. Whole Manufacturing Sector

		C4	*C4*yk* δ_1	*M/TS*yk* δ_2	*M/TS*	*Yk* *C*	*D*C4*yk* δ_3	*D*M/TS* yk* δ_4	*D*yk* Δ_5	*Adjusted* R^2
1986-1998										
GLS	(*m*1)	–0.032*	0.15*	–0.14*	–0.003	0.87*	–0.12*	0.19*		0.974666
		(0.009)	(0.027)	(0.06)	(0.013)	(0.013)	(0.022)	(0.069)		
	(*m*2)	–0.033*	0.069	–0.17*	–0.003	0.93*	–0.0017	0.23*	–0.072*	0.974830
		(0.009)	(0.044)	(0.062)	(0.013)	(0.026)	(0.052)	(0.072)	(0.031)	
TSGLS	(*m*1)	–0.032*	0.19*	–0.17*	–0.0034	0.85*	–0.134*	0.23*		
		(0.009)	(0.033)	(0.064)	(0.013)	(0.016)	(0.028)	(0.078)		
	(*m*2)	–0.033*	0.12*	–0.18*	–0.002	0.89*	0.0047	0.24*	–0.08*	
		(0.009)	(0.05)	(0.067)	(0.011)	(0.031)	(0.066)	(0.079)	(0.039)	

Note: Due to the use of instrumental variables, the adjusted R^2 (Adjusted R^2) for TSGLS is reported on a per industry basis, thus we do not have an aggregate measure of goodness of fit. Number of observations: 1975-1998 = 1656; 1975-1985 = 759; 1986-1998 = 897. * Significant at 5%. ** Significant at 10%.

Table 2 shows two sets of regressions, depending upon which equation is inserted (7′ or 7″) in equation 6′. In the first set, we insert equation (7′) ($m1$), we include the dummy only in an interactive way, thus showing its interaction with $C4 * yk$ ($D * C4 * yk$) and with $M/TS * yk$ ($D * M/TS * yk$). This procedure allows for potential changes across time in the impact of imports, or the concentration index on the Lerner index. For this set of regressions, we see that the interaction effects appear to be significant after trade liberalization. As before, the signs of the coefficients for concentration have the expected sign in the 1986-1998 period. In contrast with Table 1, the impact of the import to sales ratio is now significantly negative for the after liberalization period. More foreign competition decreases the market power of domestic firms.

The pro-cyclical variable interaction with the concentration index shows that the impact of this variable on the index is anti-cyclical.[9] For most cases (the whole period and the after liberalization period), this variable is significant. As the economy moves into an expansion, the impact of concentration on the Lerner index diminishes; the opposite occurs in a recession. The evidence is consistent with the story about price wars in booms (Rotemberg and Saloner, 1986; Haltiwanger and Harrington, 1991; Athey, Bagwell and Sanchirico, 2002), concentrated industries may collude less in a boom to avoid the possibility of defections; in a recession, the firms experience more collusion because the incentive to deviate is less important. Also, for the after liberalization period, the disciplining impact of imports is significantly anti-cyclical; industries with high imports to sale ratio increase their market power whenever there is a boom in the economy, and diminishes this in a recession. This inference is valid for TSGLS and for GLS.

In the second set of regressions, we insert equation (7″) ($m2$) and we allow for an independent impact of the dummy variable on the Lerner index ($D * yk$). The results are shown in the second line for each period ($m2$). This inclusion changes the results. The inclusion appears significant in the after liberalization period, showing that the Lerner index is anti-cyclical. Second, some of the periods that showed significance of the concentration variable before the inclusion of this dummy ($D * yk$) loose the significance of this variable. However, for the after liberalization period and for the whole period, the TSGLS results indicate a significant effect of the concentration variable.

[9] This assertion is not true for the 1975-1985 period.

The results for the impact of the import-penetration ratio are similar in model 1 ($m1$) and model 2 ($m2$). For the after liberalization period, we have that for all models (($m1$) and ($m2$)) and for all techniques (GLS and TSGLS), the import-penetration variable has a negative impact on the Lerner index. The dummy that accounts for the cyclical impact of concentration loose significance in model 2 ($m2$) for the after liberalization period. However, the dummies for the impact of the import-penetration ratio keep their significance. The sign of this dummy shows that the disciplining impact of imports is anti-cyclical. In booms, there is a lower role for imports to affect the Lerner index; in recessions, imports have a bigger role in disciplining the domestic firms.

In summary for model 2 ($m2$), the import-penetration ratio disciplines the price-setting behavior of domestic firms for the after liberalization period (1986-1998). Also, for the after liberalization period, the Lerner index shows anti-cyclical behavior. These last assertions are valid for both techniques of estimation (GLS and TSGLS).[10]

As in Table 1, model 1 ($m1$) shows a negative impact of the concentration index in the pre-liberalization period. However, model 2 ($m2$) does not show a significant impact of the concentration index with regard to the GLS technique. The import-penetration rate has a non-significant effect for all models and all techniques of estimation for this period (1975-1985).[11]

Notice that the technique used in this paper is useful in several ways. First, we estimate the Lerner index at the industrial level with stronger microeconomic foundations. Second, by exploiting the nature of the data (cross-section with time series) we estimate the behavior across time of this index. Traditional industrial organization approaches lack these two advantages. A typical industrial organization regression will use similar variables that explain some measure of profitability. However, they typically use cross-section data; thus, the inferences yielded by this kind of approach will vary depending upon the year of choice for running the regressions; inferences obtained in years of expansion will be different from those obtained in times of recession. Also, the price-cost margin typically used in this kind of re-

[10] Thus it appears that the dummy ($D * yk$) is now picking the anti-cyclical behavior of the Lerner index shown in model ($m1$) in the anti-cyclical impact of concentration.

[11] Nonetheless, we must remember that we are referring to the pre-liberalization stage in which imports are not significant and most of the imports were subject to quotas and tariffs. If we model foreign competition as perfectly competitive firms competing internationally, then the degree of competition that foreign import impinges on domestic price setting depends upon the supply elasticity of foreign firms; if Mexico established quotas in this period, then the elasticity of supply of imports is diminished considerably. Thus, we should not expect a disciplining impact of foreign imports for this period.

gressions is calculated directly from industry data; the technique assumes that variable cost is an appropriate surrogate for marginal cost. This shortcoming is absent in the approach followed in this paper.

The literature on the topic has incorporated the degree of foreign competition directly into the concentration index, thus showing the combined index in a single variable. We incorporate a modified concentration index in which the concentration index incorporates directly the import-penetration sales ratio and run a new model with only this index considered. The new index is defined above in equation (8). A similar expression can be obtained from standard one-stage non-cooperative oligopolists with foreign competition,[12] the difference lies in the concentration index used for this expression, while theoretical results would yield an expression with the Herfindahl concentration index, equation (8) uses the four firm concentration ratio.[13] Notice that in this new approach, the whole impact of foreign competition is being channeled through the concentration index. Thus, a high degree of foreign competition reduces the degree of concentration and, according to this approach, will generate a lower Lerner index. In the former approach, the impact of foreign competition on the Lerner index is independent of the impact from concentration.

In Table 3, we insert equation (9) into equation (6′).

$$\gamma = c + \lambda C4' \tag{9}$$

A comparison between Table 1 and Table 3 will indicate that the results are very similar, the concentration index adjusted for foreign competition has the same sign for the three periods considered as the unadjusted concentration index. For the after liberalization period, the results for the two techniques of estimation are very similar. In Table 4, we show the impact of cyclical variables on the adjusted $C4$ index ($C4'$). We insert equation (10) into equation (6′).

$$\gamma = c + \lambda_1 C4' + \lambda_2 DC4' \tag{10}$$

The impact of the adjusted concentration index on the markup is similar to that found before (Table 2). For the 1986-1998 period, the interaction term ($D * C4' * yk$) shows that the adjusted index has an

[12] See Waterson (1984).

[13] In fact, here we have the four plant concentration ratio.

Table 3. Pooled Regressions. Whole Manufacturing Sector

		C4'	*C4' * yk* λ	*yk* *c*	*Adjusted* R^2
1975-1998	GLS	–0.0012	–0.032	0.91*	0.959318
		(0.0085)	(0.021)	(0.011)	
	TSGLS	–0.0004	0.053	0.82*	
		(0.0086)	(0.043)	(0.023)	
1975-1985	GLS	0.065*	–0.092*	0.94*	0.966421
		(0.018)	(0.029)	(0.015)	
	TSGLS	0.061*	–0.043	0.89*	
		(0.017)	(0.049)	(0.027)	
1986-1998	GLS	–0.028*	0.068*	0.88*	0.972961
		(0.009)	(0.023)	(0.012)	
	TSGLS	–0.028*	0.079*	0.86*	
		(0.0095)	(0.033)	(0.017)	

Note: Due to the use of instrumental variables, the adjusted R^2 (Adjusted R^2) for TSGLS is reported on a per industry basis, thus we do not have an aggregate measure of goodness of fit. Number of observations: 1975-1998 = 1656; 1975-1985 = 759; 1986-1998 = 897. * Significant at 5%. ** Significant at 10%.

Table 4. Pooled Regressions. Whole Manufacturing Sector

		C4'	*C4' * yk* λ_1	*C4' * yk * D* λ_2	*yk*	*Adjusted* R^2
1975-1998	GLS	–0.0004	–0.009	–0.032	0.91*	0.959304
		(0.008)	(0.026)	(0.021)	(0.011)	
	TSGLS	0.0014	0.12*	–0.079*	0.83*	
		(0.009)	(0.04)	(0.032)	(0.021)	
1975-1985	GLS	0.067*	–0.14*	0.065*	0.94*	0.966794
		(0.018)	(0.035)	(0.027)	(0.015)	
	TSGLS	0.063*	–0.1*	0.02	0.93*	
		(0.019)	(0.05)	(0.034)	(0.024)	
1986-1998	GLS	–0.028*	0.13*	–0.098*	0.88*	0.974565
		(0.009)	(0.027)	(0.022)	(0.012)	
	TSGLS	–0.028*	0.16*	–0.13*	0.87*	
		(0.0095)	(0.035)	(0.029)	(0.015)	

Note: Due to the use of instrumental variables, the adjusted R^2 (Adjusted R^2) for TSGLS is reported on a per industry basis, thus we do not have an aggregate measure of goodness of fit. Number of observations: 1975-1998 = 1656; 1975-1985 = 759; 1986-1998 = 897. * Significant at 5%. ** Significant at 10%.

Table 5. Pooled Regressions

		C4	*C4*yk* δ_1	*M/TS*yk* δ_2	*M/TS*	*yk* *c*	*Adjusted* R^2
Durables							
1975-1998	GLS	0.011	0.13*	0.13*	–0.007	0.76*	0.939030
		(0.018)	(0.035)	(0.041)	(0.013)	(0.024)	
	TSGLS	0.009	0.15*	0.016	–0.007	0.72*	
		(0.018)	(0.062)	(0.072)	(0.013)	(0.041)	
1975-1985	GLS	0.048	0.14*	0.16	–0.073*	0.75*	0.944945
		(0.037)	(0.058)	(0.11)	(0.037)	(0.037)	
	TSGLS	0.042	0.21*	0.086	–0.074*	0.69*	
		(0.035)	(0.071)	(0.14)	(0.036)	(0.047)	
1986-1998	GLS	–0.0096	0.1*	0.037	0.011	0.81*	0.950069
		(0.02)	(0.042)	(0.04)	(0.022)	(0.027)	
	TSGLS	–0.0084	0.157*	0.025	0.015	0.76*	
		(0.021)	(0.057)	(0.058)	(0.023)	(0.038)	
Non-Durables							
1975-1998	GLS	–0.022**	–0.014	–0.16*	–0.0048	0.97*	0.986155
		(0.012)	(0.016)	(0.054)	(0.015)	(0.007)	
	TSGLS	–0.013	–0.068	–0.13	–0.0043	0.95*	
		(0.012)	(0.043)	(0.1)	(0.018)	(0.022)	
1975-1985	GLS	0.036	–0.0023	–0.43*	0.017	0.99*	0.991659
		(0.028)	(0.014)	(0.13)	(0.048)	(0.009)	
	TSGLS	0.037	–0.035	–0.4*	0.007	1.0*	
		(0.028)	(0.024)	(0.19)	(0.05)	(0.015)	
1986-1998	GLS	–0.038*	0.056*	–0.081**	0.0034	0.92*	0.984153
		(0.011)	(0.022)	(0.045)	(0.017)	(0.013)	
	TSGLS	–0.038*	0.039	–0.07	0.003	0.92*	
		(0.011)	(0.033)	(0.065)	(0.018)	(0.017)	

Note: Due to the use of instrumental variables, the adjusted R^2 (Adjusted R^2) for TSGLS is reported on a per industry basis, thus we do not have an aggregate measure of goodness of fit. Number of observations for durables: 1975-1998 = 888; 1975-1985 = 407; 1986-1998 = 481. Number of observations of non-durables: 1975-1998 = 768; 1975-1985 = 352; 1986-1998 = 416. * Significant at 5%. ** Significant at 10%.

anti-cyclical impact on the markup. Again, this evidence is consistent with that found above. As the economy moves into a boom, concentrated industries collude less to prevent a defection, in a recession there is less incentive to deviate; thus, firms can collude more. For the after liberalization period, the results for both techniques of estimation do not differ significantly. We included a dummy interacted with yk, but we did not find this variable significant.

Next we make the analysis by type of good —durable and non-durable—. Table 5 reports the results for these categories. The coefficients estimated are those from equation (6).

An interesting point to notice is that the constant of the markup equation (yk) is larger for non-durable goods. The difference in the size of the coefficients is much larger than two times the largest of the standard deviations. A second point to notice is that, except for the GLS estimate of the after liberalization period, concentration does not affect (significantly) the Lerner index of non-durable goods; however, it does impact (significantly) in a positive way the Lerner index of the durable goods industries. This result is true for all periods considered and for both techniques of estimation (GLS and TSGLS). A similar result was found by Domowitz, Hubbard and Petersen (1988) for the U.S.[14] For almost all models, the degree of foreign competition, as indexed in the import to sales ratio, does affect the Lerner index of non-durable goods in a negative way. More foreign competition reduces the domestic Lerner index of non-durable goods.[15] For durable goods, we have, for most results, a positive non-significant impact of imports. Almost all the signs of the impacts of the variables are similar for both techniques of estimation (GLS and TSGLS).

To check for the impact of the business cycle on the model, we incorporate in the analysis by type of good the dummy used in Table 2. As explained before, the dummy takes the value of one, whenever GDP is growing and the value of zero, whenever GDP is not growing. The results with this interactive variable (D) are shown in Table 6. The coefficients shown are those from equation ($6'''$) and ($6''''$).

Table 6 illustrates two models (($m1$) and ($m2$)), as in Table 3 ($m1$) corresponds to the insertion of equation ($7'$) into equation ($6'$) and in ($m2$) we insert equation ($7''$) into equation ($6'$). The first model, ($m1$),

---

[14] Domowitz, Hubbard and Petersen (1988) did not use the same concentration index that we are using in Table 5; they used the adjusted concentration index as defined in equation (8).

[15] For some periods this impact is negative but statistically non-significant.

Table 6. Pooled Regressions

		C4	*C4 * yk* δ_1	*M/TS * yk* δ_2	*M/TS*	*yk* *c*	*D * C4 * yk* δ_3	*D * M/TS * yk* δ_4	*D * yk* δ_5	*Adjusted* R^2
Durables										
1975-1998										
GLS	(*m*1)	0.012	0.14*	0.1	–0.008	0.76*	–0.017	0.036		0.938039
		(0.018)	(0.044)	(0.074)	(0.013)	(0.024)	(0.033)	(0.088)		
	(*m*2)	0.016	0.32*	0.16*	–0.0098	0.63*	–0.26*	–0.042	0.17*	0.939562
		(0.018)	(0.067)	(0.075)	(0.013)	(0.045)	(0.08)	(0.091)	(0.054)	
TSGLS	(*m*1)	0.014	0.23*	–0.014	–0.012	0.72*	–0.13*	0.13		
		(0.018)	(0.064)	(0.086)	(0.014)	(0.039)	(0.047)	(0.12)		
	(*m*2)	0.015	0.25*	–0.006	–0.0119	0.71*	–0.16	0.12	0.025	
		(0.018)	(0.085)	(0.089)	(0.013)	(0.057)	(0.12)	(0.13)	(0.082)	
1975-1985										
GLS	(*m*1)	0.43	0.12**	0.018	–0.085*	0.75*	0.022	0.36		0.945284
		(0.038)	(0.067)	(0.18)	(0.038)	(0.037)	(0.044)	(0.24)		
	(*m*2)	0.035	0.38*	0.02	–0.088*	0.58*	–0.33*	0.35	0.24*	0.946611
		(0.036)	(0.1)	(0.17)	(0.039)	(0.069)	(0.12)	(0.23)	(0.08)	
TSGLS	(*m*1)	0.034	0.18*	–0.038	–0.081*	0.74*	–0.066	0.47**		
		(0.036)	(0.075)	(0.18)	(0.039)	(0.044)	(0.046)	(0.25)		
	(*m*2)	0.046	0.33*	0.026	–0.089*	0.63*	–0.29**	0.46**	0.17**	
		(0.04)	(0.13)	(0.19)	(0.043)	(0.084)	(0.15)	(0.27)	(0.099)	

* Significant at 5%. ** Significant at 10%.

Table 6 (continued). Pooled Regressions

		C4	*C4 * yk* δ_1	*M/TS * yk* δ_2	*M/TS*	*yk* *c*	*D * C4 * yk* δ_3	*D * M/TS * yk* δ_4	*D * yk* δ_5	*Adjusted* R^2
1986-1998										
GLS	(*m*1)	–0.0085	0.18*	–0.076	0.0075	0.81*	–0.11*	0.16**		0.950834
		(0.02)	(0.054)	(0.076)	(0.022)	(0.028)	(0.042)	(0.092)		
	(*m*2)	–0.0067	0.22*	–0.06	0.0072	0.78*	–0.16	0.14	0.035	0.950812
		(0.02)	(0.086)	(0.079)	(0.022)	(0.054)	(0.1)	(0.097)	(0.065)	
TSGLS	(*m*1)	–0.007	0.27*	–0.07	0.008	0.76*	–0.13*	0.19**		
		(0.02)	(0.065)	(0.08)	(0.022)	(0.035)	(0.052)	(0.1)		
	(*m*2)	–0.0059	0.29*	–0.057	0.0076	0.74*	–0.17	0.18	0.031	
		(0.021)	(0.096)	(0.086)	(0.022)	(0.059)	(0.12)	(0.11)	(0.077)	
Non-durables 1975-1998										
GLS	(*m*1)	–0.02**	0.004	–0.39*	–0.007	0.98*	–0.031	0.26		0.986154
		(0.011)	(0.02)	(0.16)	(0.016)	(0.007)	(0.022)	(0.17)		
	(*m*2)	–0.02**	0.0057	–0.38*	–0.0072	0.97*	–0.027	0.27	–0.0023	0.985206
		(0.012)	(0.028)	(0.16)	(0.015)	(0.016)	(0.035)	(0.17)	(0.018)	
TSGLS	(*m*1)	–0.015	–0.0008	–0.36	–0.008	0.95*	–0.048	0.29		
		(0.012)	(0.049)	(0.29)	(0.018)	(0.019)	(0.046)	(0.3)		

* Significant at 5%. ** Significant at 10%.

Table 6 (continued). Pooled Regressions

		C4	*C4 * yk* δ_1	*M/TS * yk* δ_2	*M/TS*	*yk* *c*	*D * C4 * yk* δ_3	*D * M/TS * yk* δ_4	*D * yk* δ_5	*Adjusted* R^2
	(*m*2)	–0.015	–0.004	–0.35	–0.006	0.95*	–0.018	0.31	–0.02	
		(0.012)	(0.062)	(0.29)	(0.017)	(0.03)	(0.078)	(0.31)	(0.043)	
1975-1985										
GLS	(*m*1)	0.035	–0.013	–0.34	0.009	0.99*	0.017	–0.085		0.990564
		(0.029)	(0.022)	(0.28)	(0.05)	(0.009)	(0.025)	(0.31)		
	(*m*2)	0.038	0.029	–0.035	0.02	0.93*	–0.035	–0.42		0.991075
		(0.028)	(0.03)	(0.33)	(0.05)	(0.027)	(0.036)	(0.36)	(0.029)	
TSGLS	(*m*1)	0.037	–0.071*	–0.038	0.01	1.0*	0.04	–0.52		
		(0.028)	(0.03)	(0.33)	(0.052)	(0.015)	(0.032)	(0.39)		
	(*m*2)	0.041	–0.022	0.23	0.02	0.95*	–0.023	–0.84**	0.065**	
		(0.028)	(0.39)	(0.38)	(0.052)	(0.033)	(0.046)	(0.44)	(0.037)	
1986-1998										
GLS	(*m*1)	–0.037*	0.124*	–0.14	0.002	0.914*	–0.12*	0.15		0.984164
		(0.011)	(0.032)	(0.14)	(0.017)	(0.013)	(0.03)	(0.15)		
	(*m*2)	–0.039*	0.023	–0.19	0.003	0.97*	0.058	0.21	–0.1*	0.984794
		(0.011)	(0.044)	(0.15)	(0.017)	(0.025)	(0.053)	(0.15)	(0.03)	

* Significant at 5%. ** Significant at 10%.

Table 6 (continued). Pooled Regressions

		C4	*C4 * yk* δ_1	*M / TS * yk* δ_2	*M / TS*	*yk* c	*D * C4 * yk* δ_3	*D * M / TS * yk* δ_4	*D * yk* δ_5	*Adjusted* R^2
TSGLS	(m1)	–0.035*	0.136*	–0.21	0.0002	0.92*	–0.15*	0.214		
		(0.011)	(0.42)	(0.17)	(0.018)	(0.016)	(0.041)	(0.18)		
	(m2)	–0.039*	0.042	–0.166	0.0033	0.96*	0.091	0.2	–0.127*	
		(0.01)	(0.061)	(0.15)	(0.015)	(0.034)	(0.076)	(0.17)	(0.042)	

Note: Due to the use of instrumental variables, the adjusted R^2 (Adjusted R^2) for TSGLS is reported on a per industry basis, thus we do not have an aggregate measure of goodness of fit. Number of observations for durables: 1975-1998 = 888; 1975-1985 = 407; 1986-1998 = 481. Number of observations of non-durables: 1975-1998 = 768; 1975-1985 = 352; 1986-1998 = 416. * Significant at 5%. ** Significant at 10%.

incorporates the dummy interacted only with the concentration index ($D * C4 * yk$) and with the import penetration ratio ($D * M/TS * yk$). In the second one, ($m2$), we added an additional dummy that enters alone in the determination of the Lerner index ($D * yk$).

As before (Table 5), when we compare the coefficient of yk (c in equation (7)) between the two types of goods, we will find that this coefficient is smaller for durables. For each period (1975-1998, 1975-1985 and 1986-1998) and for each model (($m1$) and ($m2$)) the difference appears quite significant.[16]

Second, the impact of concentration on the Lerner index appears quite significant for durable goods. For all models, and for all periods considered, concentration has a positive significant impact on the Lerner index. Also, for durables, the inclusion of the additional dummy ($D * yk$) in model ($m2$) does not change our basic inferences with respect to the other coefficients of the regression. The sign of the coefficient of the regressor, $D * yk$, for durables, when it is significant, shows that the Lerner index for this type of goods is pro-cyclical. This inference is valid for the whole period (1975-1998) and for the pre-liberalization period (1975-1985). Additionally, we find that for durables and for these periods (1975-1985 and 1975-1998), the dummy for the cyclical impact of concentration becomes significant, every time the variable $D * yk$ is significant. When we control for the cyclical behavior of the index, concentration affects the index in an anti-cyclical fashion.

For durables and for the after liberalization period, there is no significant impact of $D * yk$. Thus we consider ($m1$) as more informative. For this model and for this period (1986-1998), concentration has an anti-cyclical impact on the Lerner index. As the economy moves into an expansion, the impact of concentration on the Lerner index of durables diminishes; the opposite occurs in a recession. Again, the story is consistent with the idea of price wars in booms.

For the after liberalization period, and for model ($m1$), the impact of concentration on the Lerner index appears to be smaller for non-durable goods in comparison with durable goods.

For non-durables, we have indication that the import penetration rate has a negative impact on the Lerner index only for the GLS estimates of the whole period. Concentration has a positive significant impact only for model 1 ($m1$) and for the after liberalization period. Also, for this period and for this model, concentration has an anti-

[16] By significant we mean that the difference in size of the coefficient for the same period is several times the largest of the standard deviations of the coefficients.

cyclical impact on the Lerner index. When we include the dummy interacted with *yk* ($D * yk$), we loose significance of all the determinants for the after liberalization period.

Concluding Remarks

For the 1986-1998 period, we find that concentration has a positive impact on the Lerner index. Foreign competition has a negative, although non-significant impact. When we control for pro-cyclical variables, we find, for the after liberalization period, that imports have a significant negative effect on the Lerner index. Also the impact of concentration appears to be anti-cyclical; increases in concentration generate a more anti-cyclical Lerner index. With respect to imports, we find, for the 1986-1998 period, that the disciplining impact of imports diminishes in a boom. Industries with large imports to sale ratios have a larger Lerner index in booms.

When we insert equation ($7''$) in equation (6) ($m2$), we find that the anti-cyclical impact of concentration is not significant anymore. The dummy $D * yk$ picks up the anti-cyclical impact now. However, in the after liberalization period, the other estimates remain relatively robust when moving from ($m1$) to ($m2$).

The distinction by type of good leads us to several interesting conclusions. The impact of concentration appears very robust for durable goods. For the after liberalization period, concentration has an anti-cyclical impact on the Lerner index of durables. The higher the level of concentration, the lower the Lerner index of durable goods in a boom.

The Lerner index exhibits more response to changes in concentration for durable goods than for non-durable goods. This happened for the after-liberalization period.

In the agenda for future research lies the investigation of the differing impacts of aggregate demand and industry demand into the behavior of the Lerner index. The dummy used here is a first attempt that pretends to detect how the business cycle affects the Lerner index. A further refinement of the sources of variability of demand is needed.

References

Athey, Susan, Kyle Bagwell and Chris Sanchirico (2002), *Collusion and Price Rigidity,* mimeo.

Bain, J.S. (1951), "Relation of Profit Rate to Industry Concentration: American Manufacturing, 1936-1940", *Quarterly Journal of Economics*, Vol. 65, pp. 293-324.

Bils, M. (1987), "The Cyclical Behavior of Marginal Cost and Price", *American Economic Review,* Vol. 77, pp. 838-55.

Caballero, R. and R. Lyons (1989), *The Role of Externalities in U.S. Manufacturing,* Working Paper No. 3003, National Bureau of Economic Research.

Castañeda, A. (1996a), "Poder de mercado en el sector manufacturero mexicano. Estimación con variables instrumentales", *Estudios Económicos,* Vol. 11, pp. 211-36.

——— (1996b), "Detección del poder de mercado en el sector manufacturero mexicano", *Economía Mexicana*, vol. 5, pp. 221-46.

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

——— (1986b), "Business Cycles and the Relationship between Concentration and Price-cost Margins", *Rand Journal of Economics*, Vol. 17, pp. 1-17.

——— (1988), "Market Structure and Cyclical Fluctuations in U.S. Manufacturing", *The Review of Economics and Statistics*, Vol. 70, pp. 55-66.

Geroski, P.A. and A. Jacquemin (1981), "Imports as a Competitive Discipline", *Recherches Economique de Couvan*, Vol. 47, pp. 197-208.

Green, E. and R. Porter (1984), "Non-cooperative Collusion under Imperfect Price Information", *Econometrica*, Vol. 52, pp. 87-100.

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. 921-47.

Haltiwanger J. and J.E. Harrington Jr. (1991), "The Impact of Cyclical Demand Movements on Collusive Behavior", *Rand Journal of Economics*, Vol. 22, pp. 89-106.

Jacquemin, A. (1982), "Imperfect Market Structure and International Trade-Some Recent Research", *Kyklos*, Vol. 35, pp. 75-93.

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 (1988a), *Some Further Results on the Exact Small Sample Properties of the Instrumental Variable Estimator*, NBER TWP 68.

——— (1988b), *The Distribution of the Instrumental Variable Estimator and its t Ratio when the Instrument is a Poor One*, NBER TWP 69.

Ordover, J.A., A.O. Sykes and R.D. Willig (1982), "Herfindahl Concentration, Rivalry and Mergers", *Harvard Law Review*, Vol. 95, pp. 1857-74.

Pugel, T.A. (1980), "Foreign Trade and U.S. Market Performance", *Journal of Industrial Economics*, Vol. 29, pp. 119-30.

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

Shea, J. (1997), "Instrument Relevance in Multivariate Linear Models: A Simple Measure", *Review of Economics and Statistics,* Vol. 79, pp. 348-52.

Solow, R. (1957), "Technical Change and the Aggregate Production Function", *Review of Economics and Statistics,* Vol. 39, pp. 312-30.

Waterson, M. (1984), *Economic Theory of the Industry*, Cambridge, Cambridge University Press.

Appendix A.1. Endogeneity Test

As discussed in the text, there are potential endogeneity problems present in the estimation process. These endogeneity problems have been advanced with the advent of the so-called new empirical industrial organization. Potential endogeneity problems pertain basically to the concentration index and the import to sales ratio in equation (7) (or (7′) and (7″)). We restate equation (7) here:

$$\gamma = c + \delta_1 C4 + \delta_2 M/TS + v \qquad (7a)$$

We included here the term v which represents the stochastic error. The potential endogeneity refers to a lack of independence between $C4$ and v and M/TS and v.

By substituting equation (7) into equation (6′) we get:

$$yk - \alpha lk = cyk + \delta_1 C4yk + \delta_2 M/TS\, yk + a(1-\gamma) + vyk \qquad (10a)$$

In this section we implement Hausman specification tests for the last equation and equations (6‴) and (6⁗). Since we are applying the endogeneity test in the last equation, we show in this part that if $E(ykv) = 0$ and if $E\,(yk^2)\,] \neq 0$ then condition *i)* $Cov\,(C4\,yk, vyk) = 0 \Rightarrow Cov\,(C4, v) = 0$. Thus if we show that asymptotically $Cov\,(C4yk, vyk) = 0$ then we expect that, asymptotically, $Cov(C4,v) = 0$, thus our Hausman tests apply to the endogeneity problem present in equation (7a). The assumption about $E(ykv) = 0$ is not restrictive, there is no *a priori* reason to expect a correlation between the stochastic error of equation (7a) and the growth of the output capital relation. Further, there is no reason to expect the second moment of *yk* to be equal to zero (i.e. there is no reason to expect that $yk = 0$ a.s.). The proof of condition *i)* is as follows:

By hypothesis:

$Cov(C4yk,vyk) = E(C4v\,yk^2) - E(C4v\,yk)\,E(v\,yk) = 0$. But $E(ykv) = 0$, thus $Cov(C4yk,vyk) = E(C4v\,yk^2) = 0$, but assuming independence of *C4v* and *yk* we have that $E(C4v\,yk^2) = E(C4v)E(yk^2) = 0$; thus given that $E(yk^2) \neq 0$ we have that $E(C4v) = 0$. Now given that $Cov(C4,v) = E(C4v) - E(C4)\,E(v)$ and that $E(v) = 0$, we gave that $Cov(C4,v) = E(C4v) = 0$. Thus, the Hausman test that shows that asymptotically $Cov(C4yk, vyk) = 0$ implies that asymptotically $Cov(C4, v) = 0$, which is the endogeneity test that we want to apply. A similar reasoning applies for M/TS with regard to endogeneity tests. The following tables apply the Hausman Test to equation (10a), (6‴) and (6⁗).

As explained in the main text, there is also a problem of potential endogeneity with regard to the original Solow equation as expressed in (6). In particular, there are concerns about the potential endogeneity of the output capital ratio (*yk*) being endogenous in equation (6′). In the text we dealt with that problem by using instruments and thus reporting in all tables the TSGLS and GLS estimates. We argued in the text that we reported both sets of estimates due to the concerns expressed by Nelson and Starz.

In the tables of this appendix we report Hausman tests for potential endogeneity in equation (10a), (6‴) and (6⁗), under the assumption that *yk* is endogenous and we also report here Hausman endogeneity tests under the assumption that *yk* is exogenous. Thus in the tables when we express instrumented *yk,* we refer to the case in which *yk* is assumed as endogenous, and when non-instrumented *yk* is reported, we are assuming that this variable is exogenous. As shown in most tables, for the after liberalization process and under both modeling paths for *yk* (*yk* exogenous and *yk* endogenous) we find that, for most cases, we do not reject the hypothesis that *C*4 and *M*/*TS* are non-endogenous.

The instruments for *C*4 are: *C*4 lagged one period, *C*4 lagged two periods, capital-output ratio lagged one period, capital-output ratio lagged two periods.

The instruments for *M*/*TS* are: *M*/*TS* lagged one period, *M*/*TS* lagged two periods, capital-output ratio lagged one period, capital-output ratio lagged two periods.

As shown in Tables A and B of this appendix, the instruments appear to fare well for both variables.

Table A.1. Endogeneity Test for Table 1.
Whole Manufacturing Sector

		Chi Square Marginal		*Significance Level*
		C4	*M/TS*	*C4 and M/TS together*
1977-1998	Non-instrumented *yk*	0.912336	0.007408	0.042523
	Instrumented *yk*	0.882738	0.006076	0.035224
1977-1985	Non-instrumented *yk*	0.721603	0.0656	0.188326
	Instrumented *yk*	0.530679	0.053692	0.126018
1986-1998	Non-instrumented *yk*	0.584786	0.481493	0.605509
	Instrumented *yk*	0.258872	0.457714	0.348814

Table A.2. Endogeneity Test for Table 2.
Whole Manufacturing Sector

			Chi Square Marginal		*Significance Level*
			C4	*M/TS*	*C4 and M/TS together*
1977 -1998	Non-instrumented *yk*	*m*1	0.937625	0.007927	0.045487
		*m*2	0.96115	0.005849	0.035423
	Instrumented *yk*	*m*1	0.951636	0.017707	0.087479
		*m*2	0.947323	0.013598	0.069806
1977 -1985	Non-instrumented *yk*	*m*1	0.830403	0.243589	0.529019
		*m*2	0.825506	0.151555	0.38349
	Instrumented *yk*	*m*1	0.729538	0.244258	0.498817
		*m*2	0.791432	0.140955	0.362819
1986 -1998	Non-instrumented *yk*	*m*1	0.592511	0.49918	0.629143
		*m*2	0.539616	0.589268	0.670915
	Instrumented *yk*	*m*1	0.447368	0.438216	0.479497
		*m*2	0.391616	0.566879	0.547184

Table A.3. Endogeneity Test for Table 3.
Whole Manufacturing Sector

		Chi Square Marginal Significance Level *C4**
1977-1998	Non-instrumented *yk*	0.002004
	Instrumented *yk*	0.033146
1977-1985	Non-instrumented *yk*	0.021288
	Instrumented *yk*	0.012473
1986-1998	Non-instrumented *yk*	0.073503
	Instrumented *yk*	0.149486

Table A.4. Endogeneity Test for Table 4.
Whole Manufacturing Sector

		*Chi Square Marginal Significance Level C4**
1977-1998	Non-instrumented *yk*	0.001436
	Instrumented *yk*	0.015603
1977-1985	Non-instrumented *yk*	0.076915
	Instrumented *yk*	0.040466
1986-1998	Non-instrumented *yk*	0.100282
	Instrumented *yk*	0.11721

Table A.5. R^2 and Adjusted R^2 for $C4$ as Dependent Variable of the Instruments

	R^2	*Adjusted* R^2
1977-1998	0.996492	0.996317
1977-1985	0.997942	0.997672
1986-1998	0.996341	0.996022

Table A.6. R^2 and Adjusted R^2 for M/TS as Dependent Variable of the Instruments

	R^2	*Adjusted* R^2
1977-1998	0.919528	0.915519
1977-1985	0.801168	0.775044
1986-1998	0.944696	0.939863

Table A.7. R^2 and Adjusted R^2 for $C4^*$ as Dependent Variable of the Instruments

	R^2	*Adjusted* R^2
1977-1998	0.970951	0.969504
1977-1985	0.974156	0.970761
1986-1998	0.971578	0.969095

Appendix A.2. Data

The data was obtained from the Encuesta Industrial Anual from 1980 to 1998. The data set includes 205 industrial classes. We took off several classes for the following reasons: We needed classes that had information on concentration indexes; we chose classes that did not produce miscellaneous goods. Also, we found the data unreliable for classes 313040 and 321204. We kept 69 classes to run the regressions.

The classes are the following:

Class EIA 1994	Industrial Activity
311101	Meat packing, preservation and preparation
311201	Pasteurization and milk canning
311203	Dry and condensed milk
311301	Canned fruits and vegetables
311404	Wheat milling
311501	Manufacturing of cookies and pasta
311405	Manufacturing of corn starch
312110	Manufacturing of instant coffee
311701	Manufacturing of oils and butters
312200	Manufacturing of animal foods
311304	Fish and shellfish packing
311903	Manufacturing of chewing gum
312123	Manufacturing of starch and leaven
313041	Manufacturing of beer
313050	Soda production
314002	Manufacturing of cigarettes

Textiles

321202	Yarn and textile tissues of soft fibers (cotton, wool and synthetic fibers)
321205	Manufacturing of woolen cloth
321207	Finished of threads

Wood

331102	Manufacturing of wood

Paper

341010	Manufacturing of paper
341022	Manufacturing of cardboard
341031	Paper and cardboard containers

Chemical

351300	Cellulose and synthetic fibers
352100	Pharmaceuticals
352210	Varnish and lacquer
352221	Perfumes and cosmetics
352222	Soap and detergents
351215	Turpentine and tar
351222	Insecticides
352231	Adhesives
352240	Manufacturing of other products of rubber
355001	Manufacturing of tires

Glass and cement

362011	Flat glass and engraved glass
362013	Glass fiber and mosaics
362021	Glass containers and glass vials
362022	Manufacturing of other glass products
369111	Manufacturing of hydraulic cement

Another mineral products

361203	Manufacturing of bricks and non-refractory bricks
369124	Manufacturing of asphalt

Basic metal

371001	Manufacturing of iron and steel
371006	Manufacturing of iron pipes and posts
372003	Melting of cupper
372005	Melting of aluminum

Metal products

381300	Manufacturing of metal furniture
381401	Manufacturing of tools
381404	Manufacturing of metal wires
381407	Manufacturing of iron containers
381408	Manufacturing of glazier and enameling
381412	Galvanization, nickel-plate and chroming of prices

Machinery and equipment

382101	Manufacturing and assembly of agricultural machines
382202	Towing and crane machinery
382205	Fire extinguishers
382206	Manufacturing of electrical equipment and parts
382301	Manufacturing and assembly of machines for offices
383107	Manufacturing of batteries
383109	Manufacturing of another electrical accessories
383110	Manufacturing of light bulbs
383201	Manufacturing of LPs and radios
383202	Manufacturing of diverse equipments and electronic appliance
383205	Manufacturing of records and tapes

Transport equipment

384110	Manufacturing and assembly of automobiles
384121	Manufacturing of chassis for auto vehicles

384122	Manufacturing of engines for automobiles
384123	Manufacturing of vehicle transmissions
384124	Manufacturing of parts for the suspension of automobile vehicles
384125	Manufacturing of parts for the braking systems of automobiles
383103	Manufacturing of parts for the electrical system of automobiles

Other manufacture industries

352233	Matches