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Long-term Relationship**

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A Note on Mexico and U.S. Manufacturing Industries' Long-term Relationship*

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Abstract

The results in Chiquiar and Ramos-Francia (2005) suggested that the long-run relationship between the US's and Mexico's manufacturing sectors was weakened after China joined the World Trade Organization (WTO). When that paper was made, however, this shock was too recent and, therefore, the analysis was based only on end-of-sample structural break tests. In this note we use updated information to revisit this issue. The results suggest that, by shifting resources towards those sectors where it remained competitive, Mexico's response allowed the effect of China's entry to the WTO on its long-term relationship with the U.S. manufacturing sector to be only temporary.

Keywords: Business Cycle Synchronization, Trade Integration, NAFTA.

JEL Classification: E32, F15, F32

Resumen

Los resultados en Chiquiar y Ramos-Francia (2005) sugerían que la relación de largo plazo entre los sectores manufactureros de México y Estados Unidos se debilitó después de que China entró a la Organización Mundial de Comercio (OMC). Cuando se llevó a cabo ese documento, sin embargo, este choque había sido muy reciente y, por ende, el análisis se basó exclusivamente en pruebas de cambio estructural al final de la muestra. En esta nota, se utiliza información actualizada para analizar nuevamente este tema. Los resultados sugieren que, al haber reasignado recursos hacia sectores en los que permaneció siendo competitiva, la respuesta de la economía mexicana permitió que el efecto de la entrada de China a la OMC sobre su relación de largo plazo con el sector manufacturero estadounidense fuera únicamente temporal.

Palabras Clave: Sincronización de Ciclos Económicos, Integración Comercial, TLCAN.

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1. Introduction

In Chiquiar and Ramos-Francia (2005), we provided evidence that China's entry to the World Trade Organization (WTO) seems to have led to a decrease in Mexico's export share in the U.S. market and to an apparent weakening of the degree of business cycle synchronization between the manufacturing sectors of Mexico and the U.S. This seems to have been a result of Mexico's loss of comparative advantage in some manufacturing product categories in which it had previously specialized in, as a consequence of China's increased market access.¹

As was pointed out in the conclusions of that article, however, most of the evidence supporting the results was based on newly-developed end-of-sample structural break tests, which did not allow us to distinguish if the structural break took the form of a downward level shift in Mexico's relative output levels or of a decrease in their elasticity with respect to U.S. output. More importantly, the evidence was not sufficient to discard the possibility that the apparent weakening of the links between Mexico and U.S. manufacturing was a temporary phenomenon, driven by an extraordinarily long lag in Mexico's response to the upturn in U.S. manufacturing after the 2001 recession. We therefore acknowledged that future data was needed to distinguish more clearly between these possibilities.

In this context, it is relevant to note that a large part of the evidence in Chiquiar and Ramos-Francia (2005) relied on a disaggregated analysis, in which the degree of cyclical synchronization between Mexico and the U.S. was assessed at a sector-by-sector level. We showed that there were specific sectors where Mexico and U.S. production links were especially affected after China's entry into the WTO, and this is what seems to have led to an apparent breakdown of cointegration between the aggregate series of manufacturing production in these two countries after 2001.

However, it would be natural to expect that Mexico would tend to reallocate its resources towards sectors where it remained competitive. Thus, the fact that cointegration would break down in some specific manufacturing activities where Mexico lost competitiveness does not necessarily imply that cointegration at an aggregate level should break down too after China joined the WTO. This hypothesis could not be tested in Chiquiar and Ramos-Francia (2005), however, due to two features of the data used: i) we had only two and a half years of data corresponding to the period

¹ For evidence on this point, see Chiquiar, Frago and Ramos-Francia (2008).

after China's entry to the WTO; and, ii) the Mexican aggregate manufacturing production index used had weights based on Mexico's 1993 production structure and, therefore, did not take into account the changes that this structure may have suffered after NAFTA and after China's entry to the WTO.

We are now in a position to readdress these issues with better data. In particular, we now have six years of data after China entered the WTO, and Mexico's National Statistics Institute (INEGI) has recently published a new manufacturing production series based on the 2003 production structure of this country. As we will see below, the results that we obtain using this new series suggest that the weakening of the business-cycle synchronization between the U.S. and Mexico's manufacturing sectors after China joined the WTO seems to have been temporary. This seems to reflect the fact that Mexico's production structure changed after this shock, becoming increasingly specialized in product categories in which this country remained competitive.

The rest of the note is organized as follows. In Section 2 we update the analysis in Chiquiar and Ramos-Francia (2005) corresponding to the aggregate-level cointegration of Mexico and U.S. manufacturing sectors, using the same series as in that paper, but updating them to 2007. We show that the results would suggest, in fact, that the weakening between both countries' manufacturing cycles was permanent. In Section 3 we provide evidence that the Mexican manufacturing sector indeed reacted to the increase in competition on the U.S. import market by shifting resources towards sectors where it remained competitive. In Section 4 we replicate the exercises in Section 2, but using the new series based on the 2003 production structure. This is done to show that, once we use data that take into account Mexico's new production structure, the results in Section 2 tend to be overturned. Finally, Section 5 concludes.

2. Analysis using data with the old 1993 base

In this section, we update the analysis in Chiquiar and Ramos-Francia (2005) concerning the existence of cointegration between Mexico's and the U.S.'s manufacturing industries and the stability of this relationship, using the same series as in that paper but including more recent data. In particular, whereas in the cited paper this analysis was carried out for the period going from the first quarter of 1996 to the second of 2004, here we update the series up to the fourth quarter of 2007. However, in this section we continue using Mexico's manufacturing series that have 1993 weights.

It is first relevant to illustrate how, using Mexico's manufacturing series based on the 1993 production structure, the updated series would seem to suggest that a downward permanent shift in the long-run relationship between Mexico and U.S. production levels had occurred. This is illustrated in Figure 1. As may be noted, according to these series a downward shift in Mexico's relative output levels seems to have occurred after 2001. More importantly, this relative shift would seem to have persisted up to the end of 2007. As will be seen immediately below, a cointegration stability analysis using these particular series would tend to confirm this view.

As stated in Chiquiar and Ramos-Francia (2005), after NAFTA went into effect, Mexico's manufacturing sector seems to have become cointegrated to the U.S. manufacturing sector. This conclusion is supported by a cointegration test between Mexico and U.S. manufacturing production indexes, using updated series up to the last quarter of 2007. The results, shown in the left hand side of Table 1, suggest that there is a long-run relationship between these two series in which these two series tend to move in tandem. Indeed, Johansen's (1991) trace statistic suggests that we can reject the null hypothesis of no cointegration between the manufacturing series in both countries. Furthermore, the cointegrating coefficient between Mexican and U.S. manufacturing production levels is close to 1.

It is relevant to emphasize that we obtain the same pattern of results when we use series that intend to reflect more accurately the nature of the relationship between these economies. In particular, in the right hand side of Table 1 we report the results of a similar analysis as above, but after having excluded high-technology products from the U.S. manufacturing production series and the automobile sector in both Mexico and U.S. data. This is made to account for the facts that only a very small percentage of Mexican manufacturing is dedicated to high-technology products and that automobile manufacturing in both countries may respond to specific idiosyncratic factors.

As in Chiquiar and Ramos-Francia (2005), we now assess the stability of the dynamic relationship between Mexico and U.S. manufacturing production indexes estimated before. Given the limitations posed by the fact that the apparent structural change in this relationship was relatively recent when we conducted the analysis, in that paper we had to rely on end-of-sample structural break tests. Given the currently available information, however, this is no longer the case. We therefore test the stability of the dynamic relationship between Mexico and U.S. manufacturing production

indexes using Seo's (1998) stability test for Vector Error-Correction models (VEC) with an unknown breakpoint.

The particular tests we illustrate here have as a null hypothesis the non-existence of structural breaks in the set of cointegrating and adjustment parameters (α, β) of the VEC model characterizing the dynamic behavior of the two series. If the maximum value of the test statistic (SupLM) obtained across the sample (after trimming the 15% initial and final segments of the sample) is above the 10% critical value for this test, we conclude that there exists evidence of instability in the dynamic relationship between Mexico and U.S. manufacturing production indexes.

Figure 2 summarizes the results. As may be noted, the stability tests on the bivariate dynamic relationship between Mexico and U.S. manufacturing production indexes, when using the Mexican index based on the 1993 production structure, suggest that there has been a structural change. Indeed, the null hypothesis is rejected both for the whole manufacturing sector data and for the adjusted series that do not include the high-tech industries in the U.S. and the automobile sector in both countries. These results are consistent with the findings described in our previous paper.

3. Mexico's comparative advantages and export specialization in the U.S. market

According to the previous results, the conclusions in Chiquiar and Ramos-Francia (2005) are roughly unchanged, even once we include two and a half more years of observations to the data set. As mentioned before, however, the manufacturing production index used in the previous section does not take into account the changes in the production structure of Mexico after NAFTA nor after China entered into the WTO.

In this context, the evidence from Mexico's export structure suggests that this country did in fact modify its specialization patterns after the shock it suffered from China's entry to the WTO. This is illustrated in Figure 3, which is based on data from the U.N.'s "Commodity Trade Statistics Database" (COMTRADE) database. We plot the change in the share within overall Mexico's manufacturing exports to the U.S. of each of 61 comprehensive manufacturing categories (2-digit level SITC classification) for the period 2001-2006, against the corresponding initial (2001) revealed comparative advantage index (RCA) within the U.S. market. The RCA index for each product category $i = 1 \dots n$ is calculated as follows (see Balassa, 1965 and 1979):

$$RCA_i^{Mexico} = \left(\frac{X_i^{Mexico} / \sum_{i=1}^n X_i^{Mexico}}{X_i^{World} / \sum_{i=1}^n X_i^{World}} \right) \quad (1)$$

where:

RCA_i^{Mexico} = Mexico's revealed comparative advantage within the U.S. in good i .

X_i^{Mexico} = value of Mexico's exports to the U.S. of good i .

X_i^{World} = value of world exports to the U.S. of good i .

The figure includes the corresponding linear and Spearman's correlation coefficients. One or two asterisks are added when such correlation coefficients are statistically significant at a 10 or 5% level, respectively. As can be seen, there is a significantly positive correlation between the initial comparative advantage of Mexico in the U.S. market and the growth of exports towards that market in the following 6 years. This correlation seems to be especially strong either if we use the usual linear correlation coefficient and we drop two outliers (apparel and office machinery), which are two sectors that were particularly affected by Chinese competition, or if we use the Spearman's rank correlation coefficient.

What these results suggest is that in the years following China's entry to the WTO, Mexico adjusted its export structure in favor of product categories in which it exhibited a larger comparative advantage index at the time of the shock. Thus, using an index based on Mexico's 1993 manufacturing production structure to assess its degree of synchronization with the manufacturing sector in the U.S., as was done in the previous section, could be masking the degree to which Mexico's output could be in fact adjusting to the U.S. output levels through changes in its sectoral composition.

4. Analysis using recently-published data with a 2003 base

Fortunately, INEGI has recently published a new manufacturing production series based on Mexico's 2003 production structure.² This index may be therefore

² INEGI published this series for the period going from 2003 to the first quarter of 2008. For the econometric analysis, we therefore needed to join it with the previous series (with a corresponding base year change) to complete a full series starting in 1996. Note, however, that the differences between the

giving a larger weight to those sectors in which Mexico has increasingly specialized in recent years than the index used in Section 2. This, in turn, could imply a different dynamic relationship between Mexico and U.S.'s manufacturing production indexes, as compared to the relationship identified using the old index. Indeed, Figure 4 compares the same data that was illustrated in Figure 1 above, which uses the old index, with an equivalent graph using the new index. As may be noted, whereas the old index would suggest that the downward relative shift in Mexico's production after 2002 was permanent, the index based on the 2003 output structure instead suggests that Mexico started to catch up to its previous relationship with the U.S. output levels in 2005. Thus, in contrast with the old series, the new series suggests that the downward relative shift in Mexico's production after 2002 was transitory. Taking into account that the analysis in Chiquiar and Ramos-Francia (2005) used data up to the first half of 2004, which is before the period when the new series seems to have started to converge again towards its previous relationship with the U.S. output levels, it is clear that even if we had the new data series available at the time when we conducted the analysis in that paper, our conclusions would have been roughly the same. It is thus the combination of using the new series based on the 2003 output structure *and* the fact that we now have a much longer sample period what seems to lead to new conclusions.

To formalize the discussion above, we now repeat the analysis made in Section 2, but using the new manufacturing series with base 2003. The sample period remains as before. Once more, we present cointegration tests for both the whole manufacturing sector and for series that exclude high-tech from the U.S. and the automobile industry from both countries.

As shown in Table 2, the results with the new base year are roughly similar to those obtained before and, in particular, suggest the existence of a long-run relationship between aggregate manufacturing production in Mexico and the U.S. While the adjustment coefficient for Mexico's production during the period 2002-2007 is only significant at a 15% level, this seems to be a consequence of the smaller sample used for this particular period since, as will be seen below, there is no evidence that there has been a structural break in this dynamic relationship. The results using the series that exclude high-tech from the U.S. and the automobile industry in both countries do not seem to be affected by this. In this case, we again find strong evidence of a log-run

1993 and 2003 base series that we highlight in this note correspond specifically to the period going from 2003-2007, for which the data under the new production structure is indeed available from INEGI.

relationship in which Mexico's output tends to move in tandem with the U.S.'s manufacturing production levels.

In contrast with the results shown in Section 2, the VEC stability tests using the index with the new base do not allow us to reject the null hypothesis of stability, either for the total manufacturing sector indexes or for the modified series (see Figure 5). Thus, using the new production index, the evidence suggests that the shock that Mexico's manufacturing production suffered after China's entry to the WTO was temporary. Comparing these results with those obtained in the previous sections suggests that this seems to have been a consequence of Mexico's reallocation of resources towards sectors in which it remained competitive. This can be the case even if, as suggested by Chiquiar and Ramos-Francia (2005), a weakening of the link between Mexico and the U.S. in some particular sectors may have occurred.

5. Conclusions

In a previous paper, we found that the entrance of China to the WTO caused an apparent weakening of the degree of business cycle synchronization between the manufacturing sectors of Mexico and the U.S. However, due to: i) the short time that had elapsed between the period in which China joined the WTO and the moment when we conducted the analysis in Chiquiar and Ramos-Francia (2005); and, ii) the base year of the Mexican series we used in that paper, we were not able to establish if this weakening was permanent or transitory.

Using longer time series and a new production index that reflects to a greater extent Mexico's current production structure, in this note we obtain results that suggest that the apparent weakening of the business-cycle synchronization between the U.S. and Mexico's manufacturing sectors after China joined the WTO seems to have been mainly temporary. This, in turn, appears to be a consequence of the fact that Mexico's export structure changed after this shock, becoming increasingly specialized in product categories in which this country remained competitive.

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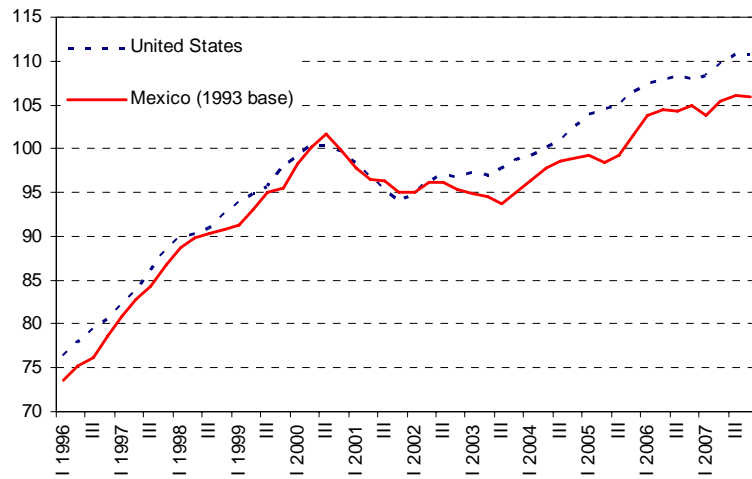
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Figure 1. Manufacturing Production in Mexico and the United States
2000=100, Seasonally Adjusted



Source: Federal Reserve and INEGI.

Figure 2. Joint (α, β) Stability Tests of VEC Model (1993 base)

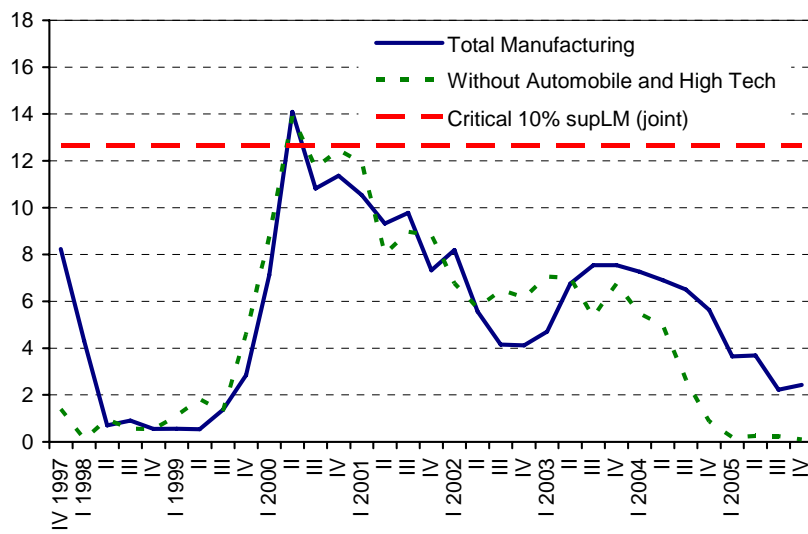
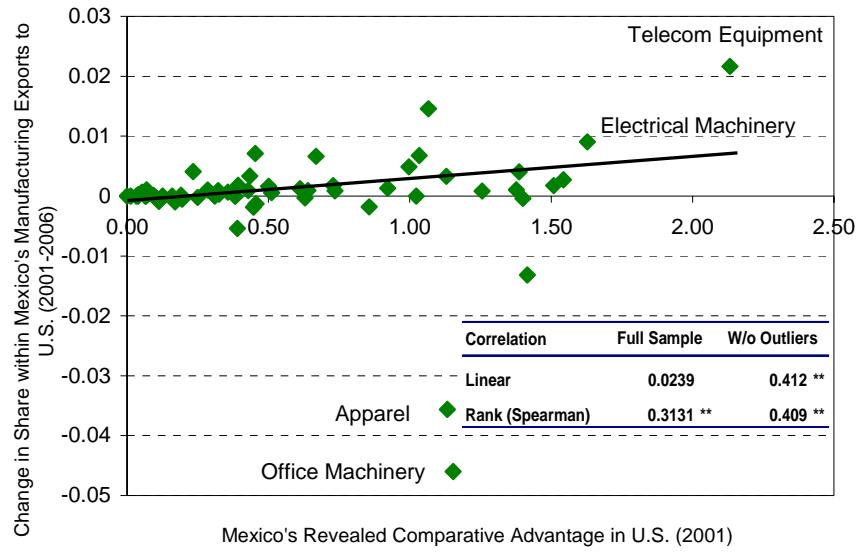
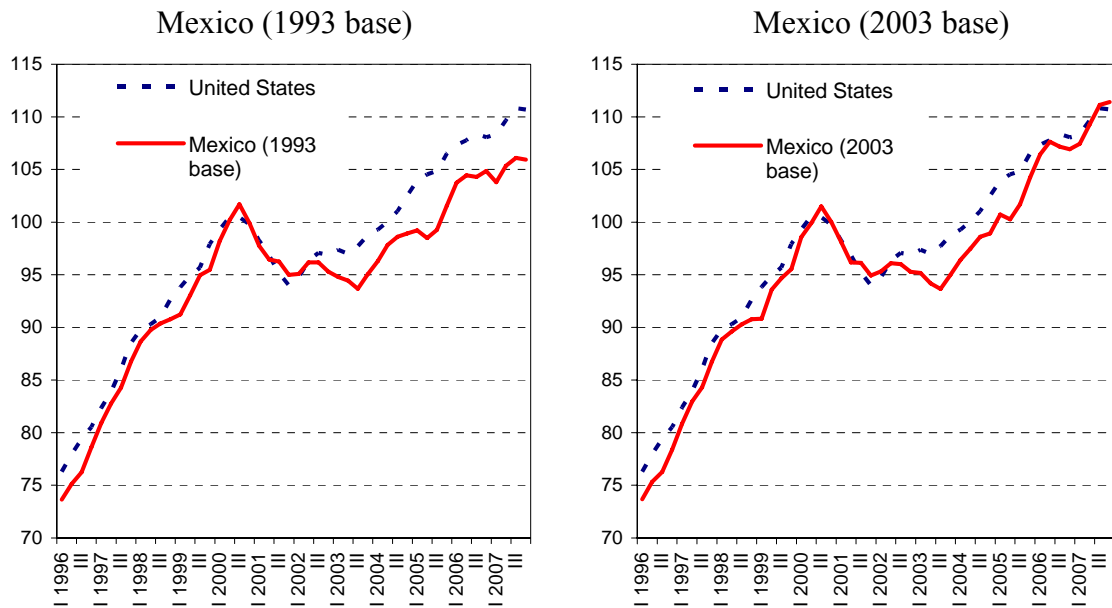


Figure 3. Mexico's Revealed Comparative Advantages and Export Specialization in the U.S. Market



Note: Based on 2-digit SITC (61 groups)
 Source: COMTRADE database, United Nations.

Figure 4. Manufacturing Production in Mexico and the United States
Index 2000=100, Seasonally Adjusted



Source: Federal Reserve and INEGI.

Figure 5. Joint (α, β) Stability Tests of VEC Model (2003 base)

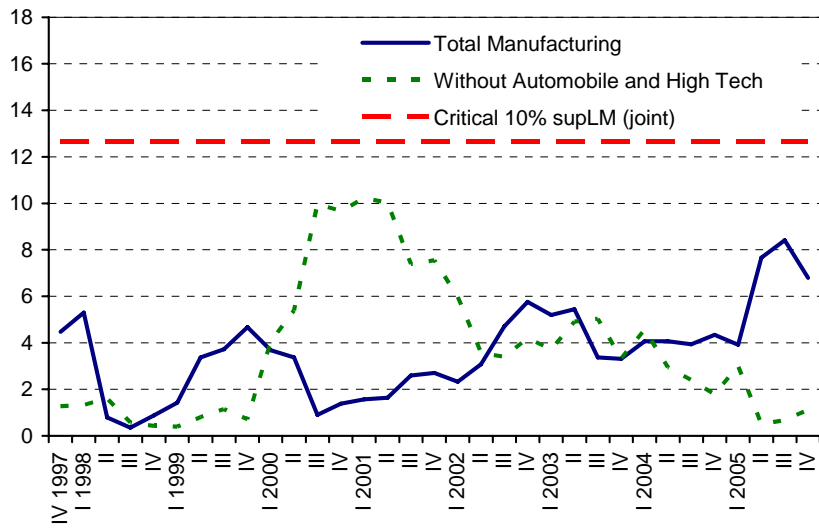


Table 1. Cointegration between the logs of Mexico (1993 base) and U.S. Manufacturing Production Indexes during 1996-2007

	Mexico (1993 base) and U.S.			Mexico (1993 base, without automobile industry) and U.S. (without automobile and hi-tech)		
	1996-2007	1996-2001	2002-2007	1996-2007	1996-2001	2002-2007
Trace Statistic (Ho: No Cointegration)	22.36***	—	—	25.335***	—	—
Mexican Production Adjustment Coefficient	-0.326***	-0.501**	-0.429***	-0.127***	-0.143***	-0.424***
Long Run Relation with U.S. Production	0.932***	1.069***	0.931***	1.060***	1.058***	0.797***

Notes. The trace statistic corresponds to Johansen's test for the null hypothesis of no-cointegration. The number of lags for this test was selected according to Akaike's criterion. The Mexican production adjustment coefficient and the long run relation with the U.S. production were estimated from a uni-equational dynamic model estimated with non linear least squares and specified according to a general to specific reduction methodology.

***, ** and * represent significance at 1%, 5% and 10%, respectively.

Table 2. Cointegration between the logs of Mexico (2003 base) and U.S. Manufacturing Production during 1996-2007

	Mexico (2003 base) and U.S.			Mexico (2003 base, without transport equipment) and U.S. (without automobile and hi-tech)		
	1996-2007	1996-2001	2002-2007	1996-2007	1996-2001	2002-2007
Trace Statistic (Ho: No Cointegration)	22.660***	—	—	27.910***	—	—
Mexican Production Adjustment Coefficient	-0.344***	-0.578**	-0.150^a	-0.116***	-0.143***	-0.644***
Long Run Relation with U.S. Production	1.003***	1.002***	1.641***	1.004***	0.999***	1.247***

Notes. The trace statistic corresponds to Johansen's test for the null hypothesis of no-cointegration. The number of lags for this test was selected according to Akaike's criterion. The Mexican production adjustment coefficient and the long run relation with the U.S. production were estimated from a uni-equational dynamic model estimated with non linear least squares and specified according to a general to specific reduction methodology. ***, **, * and *a* represent significance at 1%, 5%, 10% and 15%, respectively.