VERTICALLY INTEGRATED UNIT LABOR COSTS BY SECTOR MEXICO AND USA 1970-2000*

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*This work is a result of a research project funded by UNAM, PAPIIT no. IN313202-2. The author acknowledges and thanks the assistance of David Díaz and Jesús Santamaría, undergraduate students at UNAM, the technical advice of Martín Puchet, Armando Sánchez and Valentín Solís, colleagues at UNAM, and the commentaries of Juan Carlos Moreno, regional advisor at ECLAC, UN. All the errors in this work are the sole responsibility of the author.

Introduction

The purpose of this paper is to develop and apply a methodology for measuring unit labor costs by sector in two countries, which are neighbors and trading partners, Mexico and the United States, for the period 1970-2000. In the first section of the paper we present some theoretical considerations regarding labor costs, real exchange rates, competitiveness and international trade. In the second section we develop the methodology, which consists of a model, based on input-output analysis, designed for the calculation of vertically integrated unit labor costs by sector of production. In the third section we apply the model for the Mexico-US case, so that annual relative unit labor costs between these two countries are estimated for the period 1970-2000. In the fourth section the obtained results are analyzed as determining factors of Mexico's revealed comparative advantages by sector.

I. PURCHASING POWER PARITY, UNIT LABOR COSTS AND THE TRADE BALANCE

1. **The neoclassical theory of trade**

It has been commonly believed that the real exchange rate, as determined by price ratios, *i.e*. the Purchasing Power Parity, is the best indicator of relative competitiveness of any country. So much so that the traditionally recommended policy for countries facing trade deficits has been to depreciate the currency in order to make exports relatively cheap for the rest of the world and imports relatively expensive for nationals. If the home country is relatively open and the exchange rate is flexible, the theory implies no deliberate action on the part of the authorities, the mere tendency for a trade deficit would move the exchange rate so as to prevent the deficit to appear and trade equilibrium may be maintained through the market mechanism (Friedman, 1953).

This theory fits perfectly well with the Heckscher-Ohlin (H-O) theorem for trade patterns, and in fact, assuming no capital movements between trading countries, there would be an exchange rate that keeps the trade balance in equilibrium, that is the *equilibrium exchange rate* (Ohlin, 1933). Together, the H-O theorem and the PPP doctrine can be interpreted as the two components of the neoclassical theory of trade in its real side (Krueger, 1983).

It follows that if we can estimate the real exchange rate of any given country by the PPP theory, using price indexes of some sort for the home country and its trading partners, we can also do it for each and everyone of the various sectors of the home country's economy, as long as they are compared to the same sectors of its trading partners economies.[1]

[1] Hiroshi and Li (2001) estimated PPP by sector for China relative to Japan, using Input-Output techniques.

What would be expected for an open economy with a flexible exchange rate regime? In principle if the home country is relatively abundant, say, in factor Z, we would expect prices of goods that use factor Z intensively to be relatively lower than the corresponding foreign prices, which will show up in its PPP index. Most other goods we expect to be, either as expensive or more than the same foreign goods. Now, since we will be using price indexes and not absolute prices, we need a common base year and this would necessarily be a year in which the foreign trade of the home country is more or less balanced. This means that the overall PPP index of any year will be referred to a given year in the past, showing trade competitiveness changes relative to that base year. And this also apply to each and every sector to be compared, even though it cannot be assumed that when the overall trade balance is in equilibrium each and every one of tradable goods sectors is balanced too. And precisely because of this, the picture shows which of all tradable goods and services sectors have advantages in terms of prices with respect to foreign countries and which have not, and how these advantages or disadvantages have evolved through time. However, both theories have been seriously challenged over the years. Curiously enough, both the H-O theorem and the PPP doctrine have been criticized not as theoretical statements, but rather as empirical propositions.[2]

Despite these criticisms PPP doctrine has stayed so even the so called “New” Trade Theory, a theory that takes into account imperfect competition (Helpman and Krugman, 1985) has also shown to be related to exchange rate and competitiveness, that is, to Purchasing Power Parity (see MacDonald and Ricci, 2002).

[2] See Ruiz-Nápoles (2004) for a detailed and actualized comment on the PPP literature.

2. **Unit Labor Cost and Real Exchange Rate**

Within the context of the neoclassical tradition, the calculation and use of unit factor costs was conceptualized as a cost-parity theory alternative to the commonly accepted price-parity theory as determinant of the Purchasing Power Parity of any given country, relative to its trading partners. It considered a ratio of costs -unit factor costs- rather than a ratio of prices between countries, to be the correct measure of a country's relative competitiveness and more representatives of long-run prices (see Officer, 1976, p.10). This early cost-parity concept could not, however, be employed in a quantitative fashion because unit factor costs were impossible to calculate due to the unavailability of data. Houthakker (1963) presented an alternative cost-parity theory: relative unit labor costs. But to consider *labor cost*-parity instead of *price*-parity, within the neoclassical general equilibrium theoretical framework, called for some debate.

Thus, motivated by Houthakker's ideas, Samuelson (1964) formally considered relative unit labor costs as determinant of the real exchange rate, in the equation:

$$e = \frac{w \cdot a_l}{w^* \cdot a_l^*} \tag{1}$$

where: e = exchange rate, w = the average wage rate, a_l = average quantity of labor per unit of output, for the home country; variables with (*) are foreign country's.

Samuelson criticized two crucial aspects of this theory; he concludes that equality between the exchange rate and relative unit labor costs is *superficial*. On the one hand, in addition to labor costs, tastes and demands need to be taken into account in order to determine relative prices. On the other, nominal exchange rates can also fluctuate with capital movements and gold flows (Samuelson, 1964, p.146). These points were also directed to criticize Houthakker's belief that this measure of the real exchange rate is the *equilibrium* rate; that is, the one that produces foreign trade equilibrium (Houthakker, 1963; Samuelson, 1964). Bela Balassa (1964) rejected also Houthakker's unit labor cost approach to estimate the real exchange rate, but on statistical grounds.

Despite these controversial considerations about the unit labor cost approach, some authors and even the International Monetary Fund have been using relative labor costs as equivalent to real exchange rates without much theoretical discussion (Krugman, 1992, Ch.I, p.23; Zanello and Desruelle, 1997). In the case of Mexico and Central America, there have been some studies, carried out mainly by central banks' economists, using or calculating unit labor costs in relation to competitiveness and exchange rates (Gil-Díaz and Carstens, 1996; Graf, 1996; CMC, 2003). In fact, the IMF calls these rates the "Real Effective Exchange Rates."

Outside the neoclassical tradition, there are some authors somehow related to the Ricardo and Marx labor-theory of value tradition, who consider important relative unit labor costs in manufacturing to be either, a measure of relative international competitiveness (Capdeville and Alvarez, 1981; Dosi, *et al.*, 1990), the main determinant of real exchange rates (Shaikh, 1991), or *the* real exchange rate itself (Agglietta and Oudiz, 1984).

Empirical tests for different countries' cases using new econometrics techniques strongly support that unit labor costs in manufacturing are the main determinant of real exchange rates (see Shaikh and Antonopoulos, 1998; Ruiz-Nápoles, 2001). In these empirical tests, causality is proved to run from unit labor costs to exchange rates (see Ruiz-Nápoles, 2001).

On the other hand, the H-O theorem is based on the idea that relative costs determine general equilibrium relative prices (Ohlin, 1933, p.12). This idea depends on various assumptions about similarities between countries with respect to tastes, demand, income distribution and availability of technology, all of which are highly questionable. But, it is precisely with respect to real exchange rates that many authors have stressed the importance of costs, in particular labor costs, as the determining forces, based mostly on empirical evidence.

In that respect, there is not much difference between Ricardo's concept of direct labor costs and the unit labor costs calculated by the IMF's methodology (see Zanello and Desruelle, 1997), except for the national income accounts terminology that was not yet available in Ricardo's time. The real difference is theoretical: while for Ricardo, labor costs *regulate* prices, for the neoclassical general equilibrium tradition, prices are also determined by other forces, especially by demand forces.

II. Unit Labor Cost based on Vertically Integrated Labor

1. **The real effective exchange rate**

For Ricardo, value regulates price; that is, the exchange value of a commodity regulates its relative price. In turn, what regulates the exchange value of commodities is the quantity of labour embodied in them; that is, the relative quantities of direct and indirect labour bestowed in their production (Ricardo, 1973, pp.6-7).

Using input-output techniques Pasinetti (1977) interprets Ricardo's labor value theory by the equation:

$$\mathbf{v} = \mathbf{a}\,(\mathbf{I} - \mathbf{A})^{-1} \tag{2}$$

where: **v** is the vector of *vertically integrated* labor coefficients, or direct and indirect labor requirements, **a** = row vector of direct labor coefficients, **A** = technical coefficients matrix.

Now, by introducing wages in the equation (2), we are calculating *vertically integrated unit labor costs* (VIULC). According to Ricardo, the average VIULC will *determine* average prices in *each* economy. So we have for country's VIULC:

$$vu = \mathbf{a}(\mathbf{I} - \mathbf{A})^{-1}\,\mathbf{w} \tag{3}$$

where: vu = weighted average of vertically integrated unit labor costs (a scalar), **w** = column vector of wages (wages per unit of labor).

It follows that the ratio of two countries' VIULC determines their real exchange rate between these two countries' currencies.

Consequently, in principle, the real exchange rate determination equation is:

$$R = \frac{vu}{vu^{*}} \tag{4}$$

where: R = real effective exchange rate; vu = vertically integrated unit labor costs in the home country, vu^* = vertically integrated unit labor costs in the foreign country.[3]

According to Ricardo, labor costs *regulate* prices. But they are costs not prices; that is to say, labor costs act as "centers of gravity" for prices (see Semmler, 1984). In other words, price variations in the short and medium terms are also explained by other factors. Therefore, this *real effective* exchange rate must be distinguished from the *market* real exchange rate, that is, the price-parity rate. To make the formula operational, the foreign country's VIULC - the denominator in equation (4) - must be a weighted average of the home country trading partners' VIULC.

As mentioned above relative unit labor costs have been calculated by various different academic authors, economic analysts and institutions, as *real effective exchange rates* or competitiveness indicators for a given sector like manufacturing or for a whole economy. However, the formulas they used, while putting a lot of emphasis on a complex of weights needed to measure the rest of the world's competitiveness (the denominator), their measure of productivity (labor per unit of output) considers only direct labor, and not vertically integrated labor (see, for instance, Zanuello and Desruelle, 1997, p.7). In contrast, input-output analysis gives us the opportunity of capturing both direct and indirect labor requirements per unit of output.[4]

Anyway, relative unit labor costs, whichever the technique utilized for their calculation, have proven to be real effective exchange rates that show the overall competitiveness of the economy in most cases. But this says very little about the specific

[3] Note that equation (3) is different from Samuelson's equation (1) above this latter is referred to direct labor alone.
[4] Still, previous calculations for the Mexican economy show a strong correlation between direct labor costs per unit of output and vertically integrated unit labor costs over a long period (see Ruiz-Nápoles, 1996, p. 120-121).

advantages in trade a country may have with respect to other countries. Therefore, there seems to be a need to estimating relative labor costs by sector in order to find out a country's advantages or disadvantages in trade.

2. **Sectoral unit labor costs**

There have been some interesting theoretical approaches to productivity estimation with vertically integrated sectors (Dosi, *et al*., 1990; De Juan and Febrero, 2000). As we mentioned above average overall competitiveness says very little about trade advantages. In the line of input-output analysis, we can calculate relative VIULC by industry, which will give us a good indicator of relative sector's competitiveness.[5]

In matrix notation for each country, we have:

$$\mathbf{vu} = \mathbf{a}\,(\mathbf{I} - \mathbf{A})^{-1}\,\hat{\mathbf{W}} \qquad (5)$$

where: $\mathbf{vu}$ = row vector with real VILUC for each industry, and $\hat{\mathbf{W}}$ = diagonal matrix of the same order as $\mathbf{A}$, with wages in the main diagonal and zeros elsewhere. Thus:

$$\hat{\mathbf{W}} = \mathbf{w} \cdot \mathbf{I} \qquad (6)$$

where: $\mathbf{w}$ = column vector of wages and $\mathbf{I}$ = identity matrix. Each element in vector $\mathbf{vu}$ corresponds to vu_i, where the subscript i denotes a particular industry, $i = 1, 2, 3, \ldots, n$, being n the number of industries included in the matrix $\mathbf{A}$.

3. **Revealed Comparative Advantages**

The neoclassical theory of comparative advantages predicted that trade specialization could maximize welfare. Different trade theories discussed the different determinants of comparative advantages, but comparative advantages are in the neoclassical approach defined in terms of autarkic price relationships that in fact are not observable. The revealed comparative advantage (RCA) measure, pioneered by Balassa (1965, 1977, 1979, 1986), assumed that the true pattern of comparative advantage could be observed from post-trade data. Balassa's (1965, 1979) RCA index compares the export share of a given sector in a country with the export share of that sector in the world market.

Over the years, there have been some improvements and variations of Balassa's RCA index. Most differences between the various RCA indices are related to the industry classification system utilized in the countries' trade data and the availability of the data for various periods, so as to make valid aggregations and comparisons (Balassa, 1986; Vollrath, 1991; Yeats, 1992; Li and Bender, 2001, 2003; Lee, 2003).

For the purposes of our study, we consider initially two RCA measures. One is Balassa's (1979, 1986) equation[6]:

$$RCA_i = \frac{\left(\dfrac{X_{ij}}{\sum_j X_{ij}}\right)}{\left(\dfrac{\sum_i X_{ij}}{\sum_j \sum_i X_{ij}}\right)} \tag{7.1}$$

where: RCA_i = relative comparative advantage of the i sector; X_{ij} = exports of sector i at country j, $\sum_i X_{ij}$ = total exports of country j, $\sum_j X_{ij}$ = World exports of sector i, and $\sum_j \sum_i X_{ij}$ = total world exports.

The other is Vollrath's (1991) equation:[7]

[5] We are using, indistinctly, sector or industry as synonymous.
[6] This formula was used by Casar (1991) in estimating Mexico's manufacturing competitiveness.
[7] This equation is used by Li and Bender (2003) in their study of various countries.

$$RCA_i = \frac{\left\{ \dfrac{X_{ij}}{(\sum_i X_{ij}) - X_{ij}} \right\}}{\left\{ \dfrac{\left((\sum_j X_{ij}) - X_{ij} \right)}{\left((\sum_j \sum_i X_{ij}) - (\sum_j X_{ij}) \right) - \left((\sum_i X_{ij}) - X_{ij} \right)} \right\}} \tag{7.2}$$

where all variables have the same meaning as in equation (7.1).

Alternative to the conventional interpretation of H-O comparative advantages in trade, there is a line of analysis developed by Giovanni Dosi (Dosi, *et al*. 1990), which proposes that technology between the same sectors of different countries cannot be assumed to the be same, as it is assumed in any General Equilibrium model, and that differences in technology between countries play an important role in determining trade patterns between countries. This approach (sometimes called *neo-structuralist*) considers also as determinant forces of trade advantages between countries, the "industrial organization" - which is also viewed as sector specific - in each country, and labor costs. Accordingly, Dosi's technology gap model of international competitiveness for any country is formally defined by the equation:

$$X_{ij} = f\,(T_{ij}, C_{ij}, O_{ij}) \tag{8.1}$$

where: i = sector and j = country; T = indicator of technological levels; C = labor costs (either wage rates or unit labor costs); O = sectoral forms of industrial organizations.

The general *structural* competitiveness of each economy can be represented by:

$$X_j = F\,(T_j, C_j, O_j) \tag{8.2}$$

Revealed comparative advantage is the ratio of two absolute competitiveness measures, sectoral and overall competitiveness:

$$RCA_{ij} = \frac{f_j\left(T_{ij}, C_{ij}, O_{ij}\right)}{F\left(T_j, C_j, O_j\right)} \tag{8.3}$$

where: RCA_{ij} = index of revealed comparative advantage of country j in sector i.

If the relative unit labor cost approach has any influence in determining the trade pattern of the home country relative to others, this influence must be shown in the home country's comparative advantages measure.

III. A MODEL OF VIULC MEXICO-USA AND MEXICO'S RCA

Since a very long time before NAFTA, Mexico and the US have had a very strong trade relationship, given the large border line they share, and the prevailing close connection between Mexican and US firms and banks. However, there was an important shift in Mexico-US trade and investment flows with the opening of the Mexican economy since the mid eighties and the change in Mexico's regulation regarding foreign direct investment in the early nineties, not to mention NAFTA, since 1994.[8]

In this new trade and investment relationship, it has been assumed that Mexico's advantage was in having abundant and, consequently, *cheap* labor, so the opening of Mexico's and US's markets to firms of both countries, would help to define their trade pattern according roughly to the H-O theorem, with Mexico exporting labor-intensive goods and importing capital-intensive goods.[9] However, it must be recognized that besides relative factor endowments (*i.e.*, H-O theorem) there are other forces that influence the determination of trade patterns between nations, even under free trade conditions.[10]

Thus, by applying this unit labor cost model to the Mexico and US economies, and calculating RCA measures of Mexico's trade flows, we are going to find out: a) in what sectors Mexico has labor-costs advantages; b) whether these advantages have changed over time; c) whether they show a direct influence on Mexico's trade pattern and/or trade balance.

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[8] For an updated analysis of NAFTA's impact on the Mexican economy see Moreno-Brid, Ruiz-Nápoles and Rivas-Valdivia (2005).

[9] This factor endowment assumption inspired Mexico's in-bond plants program since 1965.

[10] New Trade theories stress the importance of plant localization, product cycle, imperfect competition, and technical gap between nations as determining factors (see Markusen, *et al.*, 1995, Dosi, *et al.*, 1990).

We test the hypothesis that, if Mexico foreign trade follows a H-O determined pattern and given that Mexico has an abundance in labor with respect to capital, relative to its closest trade partner and competitor so that wages are persistently lower in Mexico than in the US- the Mexican net exporting sectors must be labor-intensive and show low VIULC relative to the corresponding sectors in the United States. The market that would show these differences is not, however, just the NAFTA market but the world market for tradable goods.

1. **The VIULC Mex-US equations**

We start out by recalling equations (3) and (4) above, in this case applied to each country's data:

$$vu_{ht} = \mathbf{a}_{ht}\,(\mathbf{I} - \mathbf{A}_{ht})^{-1}\,\mathbf{w}_{ht} \tag{9}$$

$$vu_{jt} = \mathbf{a}_{jt}\,(\mathbf{I} - \mathbf{A}_{jt})^{-1}\,\mathbf{w}_{jt} \tag{10}$$

$$\mathbf{a} = (a_1, a_2, \ldots, a_n)$$

$$a_i = l_i / y_i \tag{11}$$

$$R_{(h/j)t} = \frac{vu_{ht}}{\sum_j vu_{jt}} \qquad j \neq h \tag{12}$$

where: vu_{ht} = weighted total of vertically integrated unit labor costs of country h, in time t; $\mathbf{a}_h$ = vector of labor coefficients in country h; $\mathbf{w}_h$ = vector of wages per unit of labor in country h; $\mathbf{A}_h$ = technical coefficient matrix of country h; l_i = labor units used in industry i per unit of time; y_i = output of industry i per unit of time; vu_j = total vertically integrated unit labor costs of country j; $\mathbf{a}_j$ = vector of labor coefficients in country j; $\mathbf{A}_j$ = technical coefficient matrix of country j; $\mathbf{w}_j$ = vector of wages per unit of labor in country j; $R_{(k/j)t}$ =

real effective exchange rate in terms of VIULC between h and j countries in time t; subscripts, h stands for home country and j for its trading partner country ($j = 1,2,3,\ldots,m$; $j \neq h$).

For the application of the system of equations (9) - (12) to any particular comparison between countries, the denominator in (12) must be a weighted average of h trading partners, that is of all j; and all variables must be denominated in US dollars (labor costs and weights).

Similarly, we recall equations (5) and (6) above to define:

$$\hat{\mathbf{W}}_j = \mathbf{w}_j \cdot \mathbf{I} \tag{13}$$

$$\mathbf{vu}_j = \mathbf{a}_j\, (\mathbf{I} - \mathbf{A}_j)^{-1}\, \hat{\mathbf{W}}_j \tag{14}$$

where: $\mathbf{w}_j$ = column vector of real wages in each country, $\mathbf{I}$ = identity matrix, $\mathbf{vu}j$ = row vector of VIULCs for each industry in each country, and $\hat{\mathbf{W}}_j$ = diagonal matrix of wages of each country, $\mathbf{A}_j$ = technical coefficients matrix of each country, the subscript j denotes any country (including home country, $h = j$).

Each element in vector $\mathbf{vu}_j$ corresponds to $vu_i^{\,j}$, where the subscript i denotes a particular industry, $i = 1, 2, 3,\ldots, n$, being n the number of industries included in matrix $\mathbf{A}_j$ and the superscript j denotes de country (including home country, $h = j$).

So we finally define relative vertically integrated unit labor costs (RULC) Mexico-US as:

$$\mathbf{rulc}_t = \frac{vu_{it}^{mx}}{vu_{it}^{us}} \tag{15}$$

where: $\mathbf{rulc}_t$ = vector of relative vertically integrated unit labor costs in time t, vu_{it}^{mx} = vertically integrated unit labor costs of industry i in time t in Mexico, measured in constant

Mexican Pesos; and vu_{it}^{us} = vertically integrated unit labor costs of industry i, in time t, in the US, measured in constant US Dollars; t = (1970,…, 2000).

Equation (14) is similar to equation (11) adapted to the Mexico-USA case under the assumption that Mexico -home country in the numerator- is a small economy whose foreign trade (exports and imports) is highly concentrated in the US market -foreign country in the denominator.[11]

We estimated the system defined in equations (9) to (15), with data taken from the Mexican and US official sources, for the period 1970-2000. The period of analysis was determined mainly by the availability of the data, especially with regard to input-output matrices of Mexico.[12] In order to make compatible labor, wages, input-output, gross domestic product and trade data of both countries, in terms of industry classification, we had to do some aggregation of industries ending up with information for 36 industries in the whole, fully comparable between the two countries, 24 out of which were identified as traded goods industries.

2. **The RCA equations**

We estimated equations 7.1 and 7.2 for Mexico's RCA. We found two problems that restricted our analysis. One was that the system of classification and aggregation of trade data we used was compatible with world data only from 1989 on, so we missed 19 years of estimates. The other is that both formulas of RCA only include exports and at the level of aggregation we use, the RCA indicator is positive for all 24 traded goods industries. The

[11] Otherwise, we should have to include a weighted average of h country's trading partners in the denominator, see equation (11).

reason is simple while it would be impossible that each and every industry of the Mexican economy could be a net exporter, it is none the less true that today's trade is mostly intra-industry rather than inter-industry, so there are exports and imports in each industry. It seemed therefore that a better indicator for RCA would be the trade balance for each industry. This latter had the advantage of being available for the whole period of analysis, that is, 1970-2000. So we estimated also Mexico's trade balance by sector according to the equation:

$$TB_{it} = X_{it} - M_{it} \tag{16}$$

where: TB_{it} = trade balance of sector i in time t, X_{it} = exports of sector i in time t, M_{it} = imports of sector i in time t, $i = (1,\ldots,24)$ traded goods sectors, t = 1970 to 2000.

[12] The last officially calculated input-output matrix for Mexico is that of 1980. The others we used 1990, 1993 and 1996 were all estimated by a private consulting agency. We know that the 2003 is already estimated by the government agency INEGI but it has not been released as of yet.

IV Results of model estimation

1. **Relative VIULC and PPP exchange rate Mexico-US**

The results from estimating equations (9) to (12)[13] are related to the exchange rate in terms of *VIULC* between Mexico and the USA for the period 1970-2000. They are shown in Table 1, and Figure 1, including a measure of the real exchange rate estimated by the ratio of consumer prices (one version of relative *PPP*) in US Dollars. Both are expressed in index numbers with the base year of 1990,[14] as *RULCI* (relative unit labor costs index) and *RERI* (real exchange rate index).

[13] Equation (11) was modified to include in the denominator only US values, under the assumption that most of Mexico's trade in carried out with the US.
[14] This year was chosen because within the period of study (1970-2000) this was the year when Mexico's foreign trade was more balanced, *i.e.*, closest to zero.

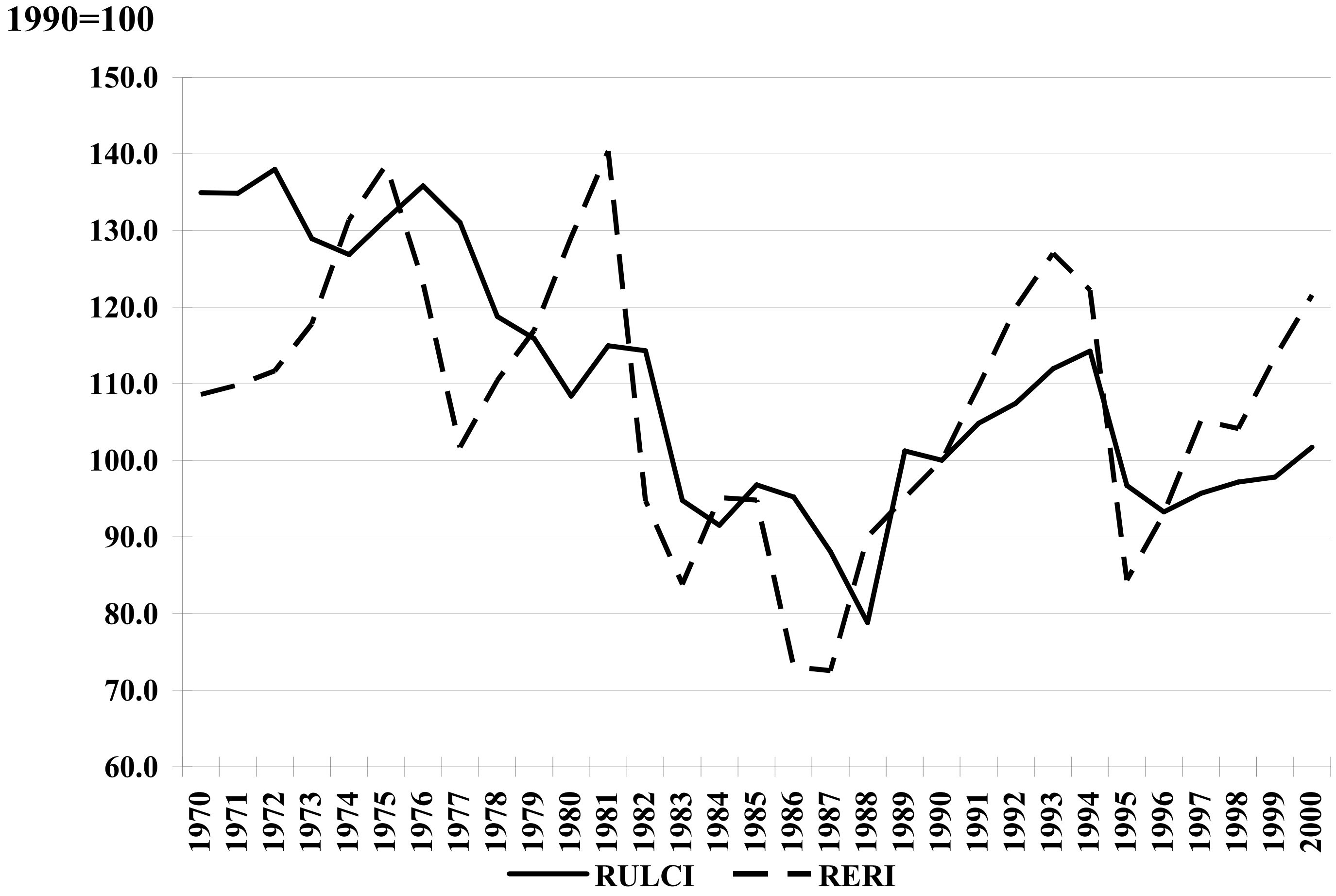
Table 1
Relative ULC and PPP Exchange Rate
Mexico-USA
Index 1990=100

Year	RULCI	RERI
1970	134.94	108.58
1971	134.85	109.81
1972	137.98	111.66
1973	128.94	117.81
1974	126.85	131.30
1975	131.43	138.52
1976	135.84	123.12
1977	131.02	101.72
1978	118.78	110.39
1979	115.89	116.94
1980	108.36	129.10
1981	114.97	140.33
1982	114.29	94.68
1983	94.75	83.82
1984	91.50	95.12
1985	96.80	94.80
1986	95.23	73.08
1987	88.07	72.56
1988	78.79	89.97
1989	101.23	95.08
1990	100.00	100.00
1991	104.83	109.67
1992	107.43	119.92
1993	111.96	126.99
1994	114.27	122.18
1995	96.72	84.36
1996	93.27	93.03
1997	95.69	105.24
1998	97.16	104.13
1999	97.81	113.51
2000	101.72	121.57

Sources: Estimated with data from: INEGI, and
Banco de México, México; BEA, and BLS, U.S

Figure 1

Relative ULC and PPP Real Exchange Rate Indexes



As we explained above we do not expect the ratio of VIULC between Mexico and the US to be in exact correlation with the PPP real exchange rate.[15] It is clear from the graph, however, that they follow the same long run tendency, with the price-parity exchange rate moving around the RULCI main trend. It is important to observe two important turning points in the RULCI tendency, in the open economy period, that is, from 1983 on: one is in 1988 when relative VIULC got a bottom and started to grow and the other is in 1994 when they got a peak and then began to go down, until is has been more or less stabilized (see Figure 1).

The US trade balance with Mexico during the period 1985-2000, shown in Table 2 and Figure 2, presents a tendency that goes close to RULCI up to 1994 thereafter the trade deficit gets wider while RULCI declines.

[15] We already mentioned that there is proof of high correlation and cointegration between these two series in the Mexico-US case, in an equation including other variables (see Ruiz-Nápoles, 2001).

Table 2
US-Mexico Trade and RULCI
Billions of US dollars

Year	Exports	Imports	Balance	RULCI
1985	13,635	19,132	-5,497	96.80
1986	12,392	17,302	-4,910	95.23
1987	14,582	20,271	-5,689	88.07
1988	20,629	23,260	-2,631	78.79
1989	24,982	27,162	-2,180	101.23
1990	28,279	30,157	-1,878	100.00
1991	33,277	31,130	2,148	104.83
1992	40,592	35,211	5,381	107.43
1993	41,581	39,918	1,663	111.96
1994	50,844	49,494	1,350	114.27
1995	46,292	62,100	-15,808	96.72
1996	56,792	74,297	-17,506	93.27
1997	71,389	85,938	-14,549	95.69
1998	78,773	94,629	-15,856	97.16
1999	86,909	109,721	-22,812	97.81
2000	111,349	135,926	-24,577	101.72

Source: Bureau of Economic Analysis, U.S. Department of Commerce

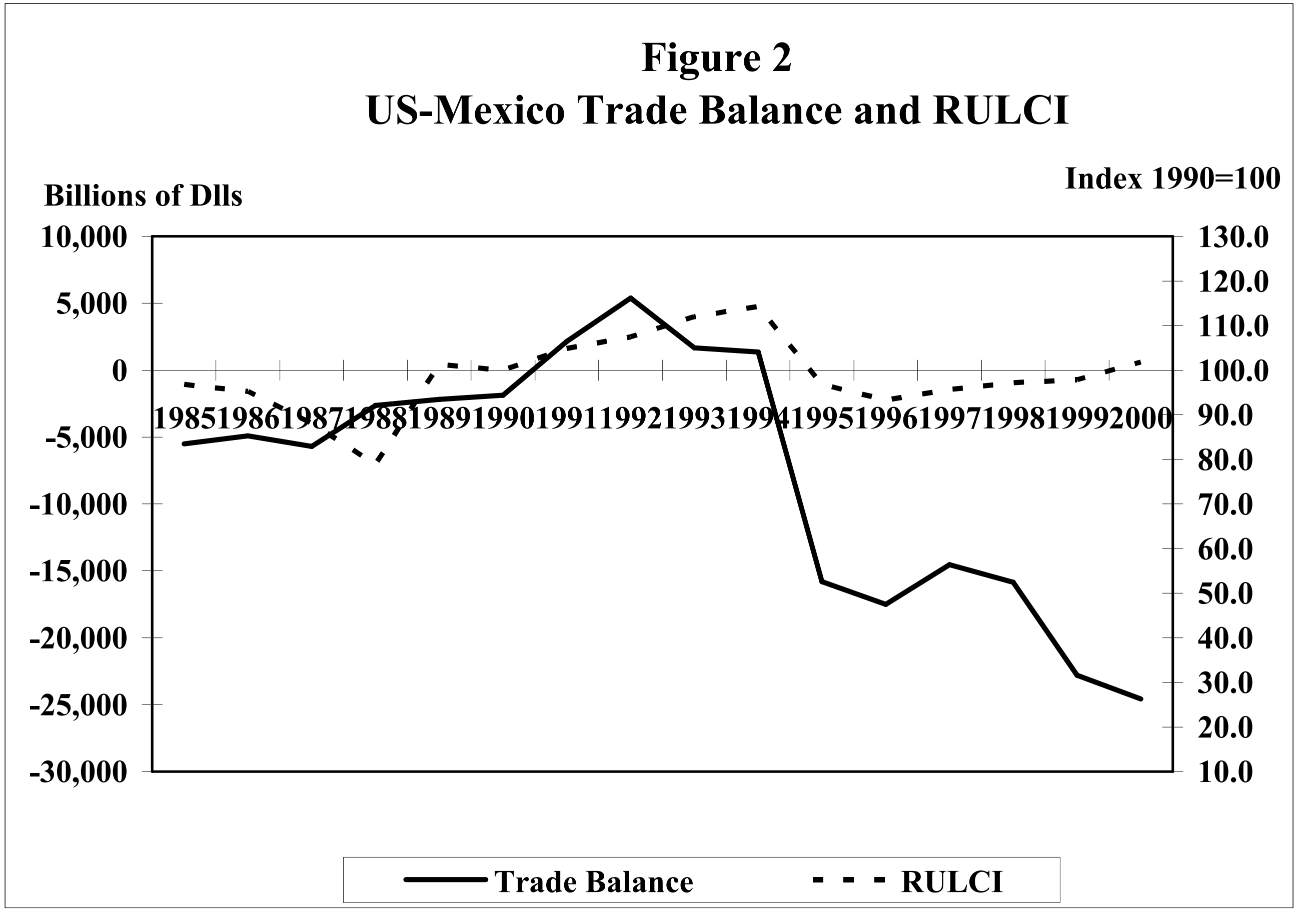


Figure 2
US-Mexico Trade Balance and RULCI
Billions of Dlls
Index 1990=100
10,000
5,000
0
-5,000
-10,000
-15,000
-20,000
-25,000
-30,000
130.0
120.0
110.0
100.0
90.0
80.0
70.0
60.0
50.0
40.0
30.0
20.0
10.0
1985 1986 1987 1988 1989 1990 1991 1992 1993 1994 1995 1996 1997 1998 1999 2000
Trade Balance
RULCI

These two tendencies suggest that in general relative labor costs determine the sign and the size of the trade balance between the US and Mexico, as a real effective exchange rate under relatively restricted trade and relatively fixed exchange rate. But since 1995, that is when trade and capital flows are fully liberalized by NAFTA and a flexible exchange rate regime is established, it is no longer the ratio of labor costs *alone* that determines the trade deficit. Then, it may be that factors other than relative labor costs are playing an important role influencing trade, that is, exports and imports, between US and Mexico, under free trade conditions, and with a flexible exchange rate. One may venture the hypothesis that these other factors may be - as Dosi *et al*. (1990) theorized - technology gaps and industrial organization, not in general but by sector. If this is true, there might have been a "structural" change in Mexico's foreign trade produced by the liberalization of trade and capital flows, in turn, brought about by NAFTA. Structural change in trade is therefore interpreted as the change in the composition of exports from the predominance of primary and traditional manufactures to highly mechanized manufacturing production.

2. **Factor intensities, wages and absolute advantages**

With the all the industrial information we collected for the two countries we tried an exercise resembling that of Leontief's test of the H-O theorem (Leontief, 1953). In this case we consider only two countries, the home country being Mexico, the foreign country being the US. The idea was to estimate the amount of labor required in each industry to produce one million dollars worth of GDP's respective industry per year during the study period, in each country. The formulas used were, for the US and Mexico, respectively:

$$L_i^{US} = \frac{\lambda_i^{US}}{y_i^{US}} \tag{17}$$

$$L_i^{Mex} = \frac{\lambda_i^{Mex}}{y_i^{Mex}} \cdot e \qquad (18)$$

where: $\lambda_i^{\ j}$ = number of workers per year in industry i in country j , $y_i^{\ j}$ = gross domestic product of industry i in country j, in millions of domestic currency at constant prices of 1996, i = (1, 2, 3…36), j = (US, Mex), e = average nominal spot exchange rate in pesos per US dollar, in 1996.

Then we find the ratio L^{Mex} / L^{US} for each and every industry and in the average. The results for selected years are shown in Table 3. They indicate that in the average labor in Mexico is five times less productive than labor in the US. This average has remained almost constant through the period of study (1970-2000), also with variable degree the same result holds true for almost each and every industry, with few exceptions. If this were interpreted as Ricardos' famous example of Portugal and England, the US would take the place of Portugal, having absolute advantages in all tradable goods, according to the labor requirements in each industry (Ricardo, 1973, p.82). But the true reason of these advantages lies in the use of different technologies between countries, in each and every industry, which in turn may be the result of wage differentials, even if the same set of technologies were available for both countries at the same time.

Table 3
Labor-Output Ratio Mexico-US*
Traded goods industries

Industry	1970	1980	1990	1996	2000
Agriculture, livestock, forestry and fishing	14.1	12.8	21.4	21.0	26.1
Metal mining	1.4	1.4	3.2	1.7	2.8
Coal mining	0.5	0.7	2.1	4.6	5.7
Oil and gas extraction	5.4	2.3	5.7	3.3	2.9
Nonmetallic minerals, except fuels	1.8	2.2	3.0	4.9	5.5
Food and kindred products	2.3	2.4	2.6	2.2	1.9
Tobacco products	7.1	11.7	2.3	2.5	1.0
Textile mill products	2.6	2.1	3.0	2.9	3.1
Apparel and other textile products	2.6	2.4	3.0	3.5	4.7
Lumber and wood products	8.8	8.3	8.4	5.7	5.3
Furniture and fixtures	4.3	3.6	2.9	3.1	3.2
Paper and allied products	4.5	3.1	3.1	2.5	2.3
Printing and publishing	5.5	4.7	4.1	3.6	2.9
Chemicals and allied products	3.5	2.5	3.2	2.7	2.5
Petroleum and coal products	1.3	2.4	6.7	7.2	7.7
Rubber and misc. plastics products	2.7	1.7	2.4	2.8	3.1
Leather and leather products	2.7	2.3	3.2	3.2	3.7
Stone, clay, and glass products	3.0	1.7	2.2	1.8	1.8
Primary metal industries	2.3	2.5	1.7	1.0	1.0
Fabricated metal products	4.7	3.6	3.7	3.4	3.1
Industrial machinery and equipment	2.0	1.7	3.6	3.6	5.6
Electronic and other electric equipment	6.1	4.3	6.2	10.9	19.0
Motor vehicles and equipment	7.6	5.1	4.2	2.8	2.8
Miscellaneous manufacturing industries	1.8	2.0	4.0	3.9	4.1
Total Average	**5.7**	**4.8**	**5.2**	**5.3**	**5.3**

* Number of times Mexico requires more workers per year to produce the same GDP in each industr
urce: Elaborated with data from INEGI, Mexico; for the US, from BEA, US DOC and BLS, US, DC

In order to check the size of wage differences, we calculated also, the wage rate, in each country, by industry, measured in constant US Dollars. The results are presented in Table 4 as the ratio of wage rates between the US and Mexico. They indicate that in average the wage rate is more than 8 times higher in the US than in Mexico during the whole period, getting a peak of 9 times in the late nineties. Thus, in comparison to the US, Mexico is clearly labor abundant in the H-O sense and this is clearly reflected in wages (factor prices) and in the technology utilized which is in general labor intensive in most industries. The Samuelson's extension of the H-O theorem about the tendency to equalize factor prices, in this case labor wages (Samuelson, 1948) did not happen in the Mexico-US case but, on the contrary, the wage gap widened in the NAFTA period in most traded goods industries and in the average (see Table 4).

Table 4 Wage Rates Ratio USA/Mex Constant 1996 US Dollars					
Industry	**1970**	**1980**	**1990**	**1996**	**2000**
Agriculture, livestock, forestry and fishing	9.6	10.6	33.9	42.5	52.1
Metal mining	2.6	2.7	8.0	7.5	6.1
Coal mining	0.6	0.9	5.4	8.3	8.5
Oil and gas extraction	2.0	2.8	6.3	3.0	2.7
Nonmetallic minerals, except fuels	2.8	2.4	7.1	10.9	11.1
Food and kindred products	3.8	4.7	6.5	6.6	5.2
Tobacco products	5.6	14.0	5.4	7.6	1.4
Textile mill products	3.8	4.4	5.5	6.1	4.7
Apparel and other textile products	6.3	6.0	5.7	6.8	6.4
Lumber and wood products	10.0	12.5	14.8	9.6	9.1
Furniture and fixtures	10.7	9.8	9.2	9.3	9.1
Paper and allied products	7.0	6.3	6.3	6.1	4.7
Printing and publishing	7.2	7.3	7.1	6.5	5.1
Chemicals and allied products	4.6	3.6	5.0	4.5	4.3
Petroleum and coal products	2.1	1.4	4.2	5.6	3.1
Rubber and misc. plastics products	4.4	3.2	5.4	6.1	5.4
Leather and leather products	4.1	2.9	5.0	8.2	8.3
Stone, clay, and glass products	5.3	4.1	5.6	6.2	6.0
Primary metal industries	3.9	4.1	4.0	4.5	4.0
Fabricated metal products	6.2	5.7	7.9	7.5	5.6
Industrial machinery and equipment	2.6	2.7	5.4	6.8	10.5
Electronic and other electric equipment	10.7	6.7	3.8	8.0	15.9
Motor vehicles and equipment	8.6	7.6	4.8	5.6	4.4
Miscellaneous manufacturing industries	3.4	5.1	9.4	9.2	7.4
Total Average	**8.2**	**7.2**	**8.3**	**9.1**	**9.0**

* Number of times the wage rate is higher in the USA than in Mexico

urce: Elaborated with data from INEGI, Mexico; for the US, from BEA, US DOC and BLS, US, DC

Ricardo considered that there was no free mobility of factors, *i.e.*, capital and labor, between countries and this prevented wages and profits to equalize between countries so that absolute advantages could not be the determinants of trade flows, but relative advantages (Ricardo, 1973, p.83). So, in our case while there is absolute free mobility of capital since 1992 between Mexico and the US, there is no legal mobility of labor, which naturally would tend to flow from the low wage country to the high wage country, that is, from Mexico to the US, and it does flow, in fact, in great numbers (see Cornelius, 2002).

3. **Relative Vertically Integrated Unit Labor Costs by sector Mexico-US**

The results of the equations (13) to (15) are the estimated relative vertically integrated unit labor costs Mexico-US for the period 1970-2000, which are presented in three tables, 5.1, 5.2 and 5.3 by groups of industries: primary traded goods and two groups of manufacturing traded goods industries (so divided for convenience of presentation).

It is observable that the great majority of industries show levels below 1 which means that, in general, labor costs are lower in Mexico than in the USA. It was more or less expected that result, given the asymmetries in industrial structures, and the wage differentials, between these two countries. However, and even in those industries in which labor costs were higher in Mexico than in the US, relative ULC in all industries show a clear declining tendency over time although there are some years in which some industries get out of this tendency and go up, but afterwards they get back to the general tendency.

Table 5.1 Relative Unit Labor Cost Mex/US Traded Primary Goods					
Year	**Agriculture live stock, forestry and fishing**	**Metal mining**	**Coal mining**	**Oil and gas extraction**	**Nonmetallic minerals, except fuels**
1970	0.7998	0.6718	1.2770	1.8872	0.5087
1971	0.8216	0.6531	1.3963	1.6588	0.5141
1972	0.9452	0.7263	1.3852	1.7853	0.5676
1973	0.9551	0.7334	1.1811	1.1914	0.5954
1974	0.8259	0.6310	1.6965	0.6434	0.6103
1975	0.8328	0.6256	1.5494	0.7503	0.5485
1976	0.7738	0.7164	1.4074	1.0253	0.6033
1977	0.7389	0.5738	1.2674	0.6303	0.6194
1978	0.7515	0.6070	1.3831	0.5275	0.5659
1979	0.8000	0.5200	1.3306	0.5443	0.5643
1980	0.6680	0.5373	1.2556	0.5897	0.6147
1981	0.7602	0.8427	1.4727	0.9959	0.5984
1982	0.6260	0.5800	1.7673	0.6088	0.5142
1983	0.5302	0.4892	0.9240	0.1620	0.4538
1984	0.5359	0.6357	0.6850	0.2062	0.4030
1985	0.4548	1.0159	0.6667	0.2893	0.3777
1986	0.4556	0.7015	0.9360	0.2452	0.3775
1987	0.4455	0.6065	0.8777	0.1627	0.4095
1988	0.4177	0.5248	0.5262	0.3637	0.3618
1989	0.3913	0.4122	0.4695	0.4753	0.2896
1990	0.3313	0.3359	0.3761	0.3769	0.2785
1991	0.3082	0.4229	0.5078	0.4810	0.2975
1992	0.3457	0.5138	0.5959	0.4889	0.2991
1993	0.3462	0.6012	0.5346	0.6662	0.2562
1994	0.3574	0.5880	0.6073	0.6296	0.2672
1995	0.3054	0.1876	0.3725	0.3943	0.2728
1996	0.2732	0.1698	0.3028	0.5088	0.2779
1997	0.2514	0.1834	0.3134	0.4731	0.2918
1998	0.2416	0.1838	0.3189	0.3827	0.2741
1999	0.2476	0.2152	0.3411	0.3361	0.2856
2000	0.2538	0.2503	0.3309	0.5425	0.2985
Source: Estimated by the model with data from INEGI for Mexico and BEA for USA					

Table 5.2
Relative Unit Labor Cost Mex/US
Traded Manufactured Goods I

Year	Food and kindred products	Tobacco products	Textile mill products	Apparel and other textile products	Lumber and wood products	Furniture and fixtures	Paper and allied products	Printing and publishing	Chemicals and allied products	Petroleum and coal products
1970	1.1963	0.9489	0.7560	0.3621	0.7288	0.3732	0.5806	0.3765	0.6520	0.9748
1971	0.9881	0.8361	0.8635	0.3303	0.7153	0.3723	0.6103	0.3608	0.6530	0.8020
1972	1.0523	0.8597	0.7753	0.3534	0.8074	0.4003	0.6359	0.3818	0.6890	0.9231
1973	1.0674	0.5925	0.6439	0.3471	0.8036	0.4084	0.6005	0.3651	0.6914	0.9906
1974	1.0199	0.5807	0.6783	0.3639	0.7990	0.4040	0.5397	0.3570	0.7346	0.7936
1975	1.0075	0.6335	0.6898	0.4260	0.6877	0.4234	0.5524	0.3772	0.6919	0.6393
1976	1.0877	0.4232	0.7149	0.4347	0.7679	0.4654	0.5421	0.4249	0.7393	0.8547
1977	0.9852	0.3995	0.6512	0.4389	0.7876	0.4596	0.5538	0.4212	0.6823	0.7042
1978	0.8181	0.2610	0.5660	0.3980	0.7748	0.4319	0.4943	0.3765	0.6013	0.4209
1979	0.9014	0.2591	0.5369	0.3958	0.6439	0.3785	0.4703	0.3485	0.5861	1.1382
1980	0.8044	0.2546	0.4648	0.3269	0.4969	0.3594	0.4037	0.3023	0.6019	1.5420
1981	0.8951	0.2322	0.4968	0.3374	0.5500	0.3489	0.4033	0.2766	0.6450	1.1299
1982	0.8699	0.2663	0.5307	0.3726	0.6122	0.3198	0.4182	0.2593	0.5888	0.9262
1983	0.6847	0.1804	0.3849	0.2932	0.5376	0.2693	0.2962	0.2270	0.4621	0.6253
1984	0.6649	0.1827	0.3751	0.2796	0.4506	0.2674	0.3034	0.1900	0.4776	0.5242
1985	0.6675	0.3350	0.4219	0.2937	0.4467	0.2506	0.3337	0.1924	0.5286	0.5162
1986	0.6279	0.3268	0.4148	0.2983	0.4849	0.2524	0.3211	0.1812	0.4882	0.6807
1987	0.5978	0.3227	0.3594	0.2666	0.5057	0.2331	0.2573	0.1690	0.4285	0.5259
1988	0.5168	0.2938	0.3686	0.2315	0.3795	0.1822	0.2647	0.1578	0.4124	0.6079
1989	0.6631	0.3401	0.4373	0.3965	0.4704	0.3209	0.4178	0.2967	0.5173	0.8500
1990	0.6905	0.4796	0.5056	0.3872	0.5179	0.3302	0.4182	0.3099	0.4806	0.8350
1991	0.7563	0.5173	0.5585	0.3987	0.6232	0.3444	0.4254	0.3291	0.5139	0.8463
1992	0.7925	0.6871	0.5563	0.3918	0.7625	0.3473	0.4510	0.3367	0.4877	0.8138
1993	0.8407	0.5452	0.5911	0.4188	0.8489	0.3511	0.4464	0.3555	0.5410	0.9083
1994	0.8791	0.5184	0.5741	0.4221	0.9238	0.3775	0.4596	0.3611	0.5762	0.8103
1995	0.7235	0.4553	0.4887	0.4063	0.7329	0.3759	0.4235	0.3170	0.4546	0.4540
1996	0.6694	0.4110	0.4864	0.3807	0.6413	0.3720	0.4068	0.3462	0.4380	0.5365
1997	0.7006	0.6098	0.4802	0.3858	0.6376	0.3618	0.4104	0.3334	0.4538	0.6659
1998	0.7447	0.9698	0.5443	0.4101	0.6466	0.3560	0.4360	0.3468	0.4767	0.8184
1999	0.8360	1.5433	0.5991	0.4432	0.6556	0.3868	0.4627	0.3706	0.4703	0.6262
2000	0.8213	1.8194	0.6662	0.4985	0.6529	0.3948	0.5058	0.3796	0.4443	0.9575

Source: Elaborated by the model with data from INEGI for Mexico and BEA, US DOC for the US

Table 5.3
Relative Unit Labor Cost Mex/US
Traded Manufactured Goods II

Year	Rubber and misc. plastics products	Leather and leather products	Stone, clay, and glass products	Primary metal industries	Fabricated metal products	Industrial machinery and equipment	Electronic and other electric equipment	Motor vehicles and equipment	Miscellaneous manufacturing industries
1970	0.5816	0.5936	0.5008	0.6134	0.5554	0.7452	0.4645	0.4179	0.7141
1971	0.6413	0.5716	0.5473	0.6631	0.6051	0.7817	0.5383	0.5224	0.7062
1972	0.6916	0.5340	0.5394	0.6609	0.6007	0.7721	0.5361	0.4463	0.6987
1973	0.7410	0.5999	0.5508	0.6143	0.6195	0.7516	0.4939	0.4034	0.4597
1974	0.7109	0.6406	0.5601	0.5794	0.5890	0.7072	0.4865	0.4509	0.4673
1975	0.7714	0.6461	0.5622	0.5650	0.5604	0.7540	0.5783	0.5375	0.4596
1976	0.8271	0.7520	0.6011	0.3395	0.5697	0.8214	0.5752	0.6709	0.4779
1977	0.8283	0.7220	0.5724	0.5778	0.5641	0.7772	0.6256	0.5159	0.4459
1978	0.6574	0.6484	0.5514	0.5514	0.4997	0.6674	0.5589	0.3932	0.4268
1979	0.6013	0.7266	0.5278	0.4919	0.4734	0.5827	0.5203	0.3815	0.3820
1980	0.5023	0.7237	0.4104	0.4669	0.4101	0.5430	0.4770	0.3439	0.3349
1981	0.5444	0.7616	0.3898	0.5095	0.4143	0.5485	0.5150	0.3945	0.3456
1982	0.5378	0.6706	0.3713	0.5233	0.3968	0.5354	0.5271	0.4176	0.3062
1983	0.4145	0.5292	0.3095	0.4081	0.2940	0.4227	0.4168	0.3511	0.2455
1984	0.3674	0.5184	0.3115	0.3505	0.2634	0.3860	0.4073	0.2655	0.2349
1985	0.3646	0.5703	0.3266	0.3790	0.2864	0.3610	0.4238	0.2478	0.2308
1986	0.3652	0.5252	0.3304	0.3539	0.2937	0.3535	0.4025	0.3266	0.2293
1987	0.3204	0.4585	0.2791	0.3126	0.2492	0.3218	0.3557	0.2891	0.2532
1988	0.2964	0.4210	0.2752	0.3264	0.2194	0.2813	0.4089	0.2821	0.1946
1989	0.3703	0.4683	0.3585	0.4637	0.3103	0.4286	1.0906	0.4478	0.2544
1990	0.3752	0.4967	0.3454	0.4316	0.3049	0.4184	1.0146	0.4768	0.2720
1991	0.4412	0.5089	0.3465	0.4409	0.3320	0.4166	1.0642	0.4283	0.2907
1992	0.4803	0.5336	0.3683	0.4759	0.3595	0.4273	0.9813	0.4572	0.3007
1993	0.4987	0.4847	0.3596	0.4681	0.4060	0.4600	0.9917	0.5009	0.3234
1994	0.4920	0.4775	0.3826	0.4720	0.4218	0.4498	0.9685	0.5039	0.3161
1995	0.3999	0.4046	0.3959	0.3241	0.3424	0.4046	0.9328	0.4428	0.3044
1996	0.3942	0.3238	0.3193	0.2738	0.3162	0.3477	0.8013	0.3780	0.3205
1997	0.3928	0.3203	0.3316	0.2894	0.3155	0.3036	0.7532	0.4056	0.3638
1998	0.4231	0.3192	0.3294	0.3099	0.3374	0.2799	0.6476	0.4295	0.3614
1999	0.4725	0.3103	0.3498	0.3153	0.3770	0.2704	0.5973	0.4652	0.3873
2000	0.4713	0.3561	0.3291	0.3091	0.4042	0.2771	0.4955	0.4827	0.4230

Source: Elaborated by the model with data from INEGI for Mexico and BEA, US DOC for the US

4. **Mexico's RCA and VIULC by Sector**

We started out by utilizing the estimation of RCA by industry from Vollrath's equation and compared it with the corresponding VIULC value, in terms of rates of change from 1989 to 2000. The results in Table 6 show a correlation coefficient between 0.3 and 0.6 for half of the traded goods industries with the right (negative) sign. The value of the *Beta* parameter was, in most of these cases, high.

Table 6
Correlation between RCA and VIULC growth rates

Industry	Correlation Coefficient	Beta value
Agriculture, livestock, forestry and fish	0.3255	3.2659
Metal mining	-0.1337	-1.0774
Coal mining	-0.4160	-0.9027
Oil and gas extraction	0.0531	0.1576
Nonmetallic minerals, except fuels	-0.3093	-12.6140
Food and kindred products	-0.2425	-0.7686
Tobacco products	-0.4243	-2.6784
Textile mill products	-0.4786	-2.6784
Apparel and other textile products	-0.5126	-0.6118
Lumber and wood products	0.3145	0.0801
Furniture and fixtures	-0.3627	-1.0548
Paper and allied products	0.4501	0.6741
Printing and publishing	-0.0972	-0.5307
Chemicals and allied products	0.2472	0.5820
Petroleum and coal products	-0.0257	-0.0307
Rubber and misc. plastics products	-0.4613	-0.2013
Leather and leather products	0.3490	0.2885
Stone, clay, and glass products	0.1484	0.7593
Primary metal industries	-0.4358	0.7593
Fabricated metal products	-0.4401	-1.6794
Industrial machinery and equipment	-0.3009	-0.3087
Electronic and other electric equipment	-0.3077	-0.1180
Motor vehicles and equipment	-0.5955	-1.9051
Miscellaneous manufacturing industries	-0.1495	-0.0967

Source: Estimated by the model with data from INEGI and World Bank

These results indicate that for half of the trading industries in Mexico labor costs changes directly affected their competitive position in the world market in the period 1989-2000, but it is also clear that labor costs were not the only factor influencing them. In other cases, labor costs changes were not relevant.

Table 7.1
Mexico's Trade Balance by Industry 1970-1985
Thousands of 1980 Pesos

Industry	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985
Agriculture, livestock, forestry and fishing	9,224	10,477	9,677	4,563	-5,575	-7,210	957	-3,714	-1,876	-5,290	-29,732	-35,823	-9,323	-27,601	-22,841	-18,165
Metal mining	4,742	1,610	4,201	2,587	6,637	4,950	4,636	4,239	3,111	3,073	4,400	9,142	8,852	9,813	10,536	10,077
Coal mining	-1,294	-1,188	-1,366	-1,504	-1,635	-1,388	-377	-316	-936	-1,313	-1,582	-1,140	-1,139	-247	-416	-1,106
Oil and gas extraction	1,936	1,025	481	224	1,311	25,496	29,217	49,944	88,851	128,027	216,993	282,308	384,512	395,144	391,021	367,586
Nonmetallic minerals, except fuels	1,747	2,480	2,181	1,572	2,536	1,483	1,976	2,020	2,144	2,548	2,995	1,798	896	2,853	2,350	2,029
Food and kindred products	24,244	25,639	26,110	25,831	19,388	17,720	15,339	15,715	19,453	18,902	-3,271	-5,323	5,595	9,766	16,988	20,155
Tobacco products	495	504	685	834	1,176	783	789	819	1,168	977	1,117	963	862	517	611	426
Textile mill products	9,759	8,526	10,964	11,327	9,801	9,096	9,125	7,939	10,145	10,315	7,048	7,768	6,484	6,591	10,098	6,401
Apparel and other textile products	-2,552	-3,039	-3,368	-3,212	165	-820	-1,491	-849	-1,362	-2,782	-3,408	-5,141	-2,539	653	1,029	526
Lumber and wood products	-1,375	-1,106	-1,211	-1,051	-1,448	-1,920	-1,461	-1,323	-1,234	-1,568	-1,805	-1,991	-1,102	-220	-707	-795
Furniture and fixtures	-2	625	791	1,128	1,457	696	940	1,173	1,248	867	465	654	792	3,102	4,060	2,885
Paper and allied products	-6,585	-5,269	-4,276	-7,953	-9,274	-7,921	-7,408	-8,304	-6,006	-7,832	-12,872	-11,623	-7,410	-4,960	-5,278	-5,881
Printing and publishing	-275	-717	-1,602	-915	-446	-135	-213	215	-66	-311	-675	-2,384	-1,749	539	-500	-567
Chemicals and allied products	-23,358	-22,811	-25,022	-27,876	-42,651	-29,058	-23,116	-27,543	-25,279	-29,481	-40,382	-40,770	-25,022	-9,819	-9,326	-22,755
Petroleum and coal products	-9,163	-16,757	-22,053	-35,993	-29,183	-11,986	-13,795	-5,669	-7,239	-6,284	2,549	5,273	-4,749	10,116	23,563	18,013
Rubber and misc. plastics products	-975	-965	-1,076	-1,277	-1,709	-2,111	-2,195	-1,160	-1,792	-3,103	-5,075	-5,921	-3,156	-1,570	-1,842	-3,176
Leather and leather products	-1,775	-962	-479	-208	109	121	58	615	922	734	473	36	198	646	861	733
Stone, clay, and glass products	-320	-165	336	402	872	-516	1,597	3,306	3,042	-85	-1,431	-2,700	-168	5,049	6,702	6,505
Primary metal industries	-2,412	2,296	2,384	-6,443	-9,505	-12,823	-7,383	-5,428	-24,769	-30,191	-47,680	-57,527	-24,126	-243	-7,445	-15,932
Fabricated metal products	-5,999	-6,904	-7,210	-7,522	-8,892	-9,093	-6,606	-4,810	-6,508	-10,727	-13,456	-18,487	-9,880	-1,489	-4,759	-6,448
Industrial machinery and equipment	-34,224	-32,542	-35,636	-37,743	-42,314	-51,186	-50,053	-33,092	-42,937	-74,944	-101,627	-125,269	-69,771	-23,334	-32,986	-43,291
Electronic and other electric equipment	-11,466	-9,842	-10,400	-9,440	-7,919	-6,248	-6,805	-6,903	-6,438	-13,658	-15,696	-20,375	-13,169	-4,071	-7,989	-12,049
Motor vehicles and equipment	-18,557	-18,694	-16,898	-18,623	-35,785	-40,139	-33,037	-28,342	-19,373	-35,784	-42,837	-57,654	-22,943	2,747	4,413	4,634
Miscellaneous manufacturing industries	-5,372	-4,849	-5,425	-6,287	-6,776	-5,905	-3,850	-3,691	-4,892	-12,171	-15,441	-21,409	-13,692	-3,735	-4,890	-8,779
Total Traded Goods Industries	**-73,558**	**-72,630**	**-78,212**	**-117,577**	**-159,657**	**-128,113**	**-93,156**	**-45,157**	**-20,623**	**-70,083**	**-100,930**	**-105,595**	**198,253**	**370,247**	**373,253**	**301,026**

Source: Instituto Nacional de Geografía, Estadística e Informática, INEGI, México

Table 7.2
Mexico's Trade Balance by Industry 1986-2000
Thousands of 1980 Pesos

Industry	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
Agriculture, livestock, forestry and fishing	620	-3,194	-12,252	-13,565	-14,241	-15,734	-34,219	-25,008	-41,838	-12,268	-44,147	-41,900	-54,477	-61,740	-58,002
Metal mining	10,871	8,895	8,550	6,013	8,086	-1,485	-2,488	-1,339	68	-2,387	-3,701	-5,155	-4,052	-5,625	-3,106
Coal mining	-438	-363	-800	-1,283	-879	-937	-1,473	-1,775	-2,092	-2,359	-2,576	-3,649	-3,379	-2,693	-3,378
Oil and gas extraction	331,782	343,283	335,905	326,791	325,056	349,019	345,297	344,959	340,369	349,194	412,517	452,207	447,064	407,586	420,823
Nonmetallic minerals, except fuels	1,722	1,194	1,578	1,239	259	461	1,385	644	33	1,532	204	232	-468	337	337
Food and kindred products	27,333	35,642	21,935	12,828	-17,701	-10,991	-23,880	-21,053	-29,595	19,022	22,865	11,600	2,593	570	-11,663
Tobacco products	526	268	473	526	472	792	621	1,007	928	1,619	2,088	2,070	2,270	2,363	2,395
Textile mill products	8,078	10,397	8,073	5,513	1,434	776	-1,541	-3,255	-1,069	15,328	11,286	8,963	5,554	4,491	2,058
Apparel and other textile products	2,388	3,953	7,218	2,715	-825	-4,863	-14,476	-14,374	-9,980	17,597	28,714	32,191	37,058	44,456	49,753
Lumber and wood products	-568	-279	-529	-549	-1,226	-905	-1,703	-1,820	-1,736	1,752	2,226	2,285	599	-327	-3,004
Furniture and fixtures	5,090	6,515	12,921	13,969	11,172	9,358	10,045	9,955	8,210	11,978	20,745	25,313	23,758	23,259	19,241
Paper and allied products	-4,668	-6,430	-8,437	-10,453	-12,549	-15,011	-19,241	-21,637	-28,402	-18,886	-16,785	-19,829	-20,118	-21,864	-26,143
Printing and publishing	-1,344	-5	-61	-1,714	-3,043	-4,022	-6,163	-7,763	-10,902	-4,604	-3,714	-3,804	-4,827	-5,682	-6,373
Chemicals and allied products	-7,500	-2,593	-7,822	-11,979	-1,182	-4,317	-6,927	-17,971	-25,536	32,893	918	-23,677	-36,194	-46,485	-55,460
Petroleum and coal products	11,790	2,369	145	-12,283	-8,317	-17,117	-25,987	-19,674	-24,031	-10,782	-25,818	-49,581	-54,940	-60,389	-98,198
Rubber and misc. plastics products	-3,380	-1,087	-1,164	-1,906	-4,713	-10,400	-13,083	-14,661	-18,465	-9,864	-14,717	-17,902	-19,371	-17,891	-23,076
Leather and leather products	1,278	3,027	4,195	2,282	2,982	2,227	1,077	708	-370	7,117	9,550	10,754	7,876	8,061	7,842
Stone, clay, and glass products	8,345	9,858	11,195	6,600	3,676	437	-2,112	-3,071	-4,414	5,322	5,863	3,842	1,283	2,143	890
Primary metal industries	-2,698	2,921	-1,483	131	-1,053	-652	-10,289	5,802	-557	52,086	34,762	22,821	-3,449	-10,999	-26,419
Fabricated metal products	-3,755	-2,271	-5,033	-10,579	-13,805	-16,560	-23,095	-21,377	-28,115	-7,199	-12,426	-18,064	-31,060	-45,752	-52,164
Industrial machinery and equipment	-34,158	-27,838	-44,147	-50,575	-63,918	-72,206	-104,754	-97,102	-109,700	-34,926	-56,098	-61,776	-90,367	-104,792	-129,389
Electronic and other electric equipment	-11,683	-7,715	-20,560	-24,502	-27,586	-34,781	-43,254	-39,377	-45,846	-19,179	-33,692	-51,971	-65,344	-74,268	-102,827
Motor vehicles and equipment	2,307	-806	-11,041	-29,183	-36,599	-53,245	-68,968	-65,719	-73,324	11,684	51,398	29,756	31,946	41,033	35,079
Miscellaneous manufacturing industries	-4,779	-5,791	-7,657	-10,756	-11,547	-19,197	-27,998	-26,521	-32,011	-16,695	-23,949	-34,785	-37,920	-45,892	-51,814
Total Traded Goods Industries	**337,159**	**369,950**	**291,202**	**199,280**	**133,952**	**80,646**	**-73,230**	**-40,421**	**-138,375**	**387,972**	**365,511**	**269,940**	**134,031**	**29,903**	**-112,596**

Source: Instituto Nacional de Geografía, Estadística e Informática, INEGI, México

5. **Mexico's Trade Balance and VIULC by Sector**

As a second testing of the influence of unit labor costs, we considered a Panel Data Model for the determination of Mexico's trade balance by unit labor costs. The trade balance by sector clearly shows in what industries a country has advantages and in what other ones it has disadvantages in actual trade. Some of the changes in a sector's trade balance are to be attributed to demand variations, determined by foreign and domestic income changes. But the important influence - we hypothesized - were labor costs, relative to its corresponding sector in the trading partner and competitor, in this case the US, being Mexico the home country. We also wished to know whether there was any influence of trade opening in the trade balance, so we included a dummy variable with a value of 1 from 1985 on.

The equation was specified accordingly as:

$$TBM_{it} = \alpha + \beta_1\, GDPM_{it} + \beta_2\, GDPU_{it} + \beta_3\, RULC_{it} + \beta_4\, Dummy_{it} + \mu_{it} \qquad (19)$$

where: *TBM* = Trade Balance of Mexico, *GDPM* = Gross Domestic Product of Mexico, *GDPU* = Gross Domestic Product of the US, *RULC* = Relative vertically integrated unit labor costs, Dummy variable with values equal to 0 from 1970 to 1984 and equal to 1 from 1985 to 2000, t = 1970 to 2000, i = (1,…,24) industries.

The results of the estimation reported in Table 8, indicate that all the coefficients are significant, and with the correct sign. The R square coefficient is close to 0.7.

Table 8 **Panel Data Model for Trade Balance of Mexico** **Results**				
Dependent Variable: L(TBM)				
Method: GLS (Variance Components)				
Sample: 1970 2000				
Included observations: 31				
Number of cross-sections used: 21				
Total panel (unbalanced) observations: 344				
Cross sections without valid observations dropped				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	8.022048	0.766825	10.46138	0
L(RULC)	-0.972645	0.463408	-2.098895	0.0366
L(GDPM)	-1.22132	1.391266	-0.877848	0.3806
L(GDPU)	1.107717	1.209605	0.915768	0.3604
DUMMY	0.380146	0.164451	2.311603	0.0214
GLS Transformed Regression				
R-squared	0.680899	Mean dependent var		7.906615
Adjusted R-squared	0.677134	S.D. dependent var		2.268345
S.E. of regression	1.288902	Sum squared resid		563.1704
Durbin-Watson stat	0.32142			
Unweighted Statistics including Random Effects				
R-squared	0.693129	Mean dependent var		7.906615
Adjusted R-squared	0.689508	S.D. dependent var		2.268345
S.E. of regression	1.263963	Sum squared resid		541.587
Durbin-Watson stat	0.334229			
Source: E-Views 4.1				

The final estimated equation is:

$$\boldsymbol{LTBM = 8.02205 - 1.2213 * LGDPM + 1.1077 * LGDPM + 0.9726 * LULC + 0.3801 * D} \quad (20)$$

where all variables have the same meaning as in (18) except that they are all measured in logarithms.

CONCLUSIONS

After all the estimation and analysis of relative unit labor costs between Mexico and the US during a thirty year period in which Mexico's trade changed dramatically, we can draw some basic conclusions. First, that vertically integrated unit labor costs are a good measure of competitiveness as shown in the case of Mexico. Second, that intra-industry trade is getting more importance trough time than inter-industry trade. Third, despite the continuous flowing of Mexican workers towards the US labor market, and the also continuing flow of US capital to Mexico, wage and labor productivity differentials between the two countries remain the same in almost all branches of economic activity. Finally, Mexico's exports are moving from labor-intensive goods to capital-intensive goods, despite the relative lower wages that prevail in the country.

DATA SOURCES

Input-Output, domestic transactions matrices for Mexico, 72 entries, for years 1980 and 1985, from Instituto Nacional de Estadística, Geografía e Informática (INEGI), Matriz de Insumo Producto, México, 1986; for 1990, 1993 and 1996 from Consultoría Internacional Especializada, S.A. de C.V. (CIESA) **Stata Matrix**, Versions 1.0 (1994) and Versión 2.0, (1998).

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