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An Alternative Theory of Real Exchange Rate Determination: Theory and Empirical Evidence for the Mexican Economy, 1970-2011

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Summary

This paper presents an alternative theory with regard to the Mexico-US real exchange rate. Our approach takes a long term perspective and employs a classical political economy framework developed by Anwar Shaikh. Unlike mainstream theories which focus on relative consumer or producer prices, we argue that relative unit labor costs of the Mexican and US manufacturing sectors is a good indicator of the real exchange rate. Moreover, we explore the role of government expenditures and the net capital flows to Mexico in the determination of the real exchange rate. The empirical methods used in this paper include unit root tests and three ARDL-ECM models.

Key words: Non-neoclassical theory of competition, relative real unit labor costs, real exchange rate, ARDL-ECM models.
JEL Classification: F50, F31, F41, C32.

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Introduction

The recent history of the Mexican economy has shown that it's worst economic crises have been due to balance of payments problems, which eventually lead to foreign exchange rate crises (1976-1977, 1982, 1986-1988 and, 1994-1995). Although conventional exchange rate models hold that in the long-run real exchange rates will move in such a way as to make countries equally competitive, such an argument is far from being true because in reality countries are unequally competitive. In the case of Mexico (Mex), a clear and thorough assessment of real exchange rate determination and its relationship with the balance of payment, especially with the current account, which has been negative since the late forties despite currency devaluations, is necessary.

A serious problem with conventional economic analyses is its reliance on price mechanics [Purchasing Power Parity (PPP) and related theories] and comparative advantage theory, with the aim of expecting that in the long-run exports will equal imports. In other words, conventional analyses assume that, in the long-run, trade between countries will be roughly balanced.

On the one hand, international trade theory postulates that if one abstracts from various sources of financial flows and government intervention in the foreign exchange market, exchange rates will move toward their equilibria levels when they reach their market-clearing values. That is, at an equilibrium exchange rate that reflects the relative price levels of the trading-partners and the domestic economy. This then leads to the central proposition of foreign trade theory, namely, that under these circumstances, nominal exchange rates move automatically to make the balance of trade equal to zero. Along this line of thought, it follows that trade deficits and surpluses are the outcome of short-run deviations of exchange rates from their equilibrium levels (Antonopoulos, 1997; Ruiz-Nápoles, 1996).

On the other hand, neoclassical trade theory assumes that competitiveness between countries is determined by the comparative cost principle. Thus, according to this principle, any country would always find at least one industry in which it is competitive. Hence, if the exchange rate is adequately managed to achieve and maintain such competitiveness, foreign trade will tend to be balanced (Ruiz-Nápoles, 2010). In other words, this standpoint assumes that long-run real exchange rates will eventually do away with competitive differences, without requiring any change in wages, productivity, and technical change.

It is, nevertheless, important to point out that despite the fact that the two foregoing principles are too often embraced by academic analyses and economic policy makers; historical data have provided ample testimony to the persistence of trade imbalances [even under managed (dirty floats), fixed and flexible exchange rate regimes, across countries and across time]. Importantly, current models of the exchange rate perform quite poorly at the empirical level (Harvey, 1996; Kruger, 1983; Stein *et al.*, 1995). Hence, mainstream models may be unreliable guides to economy policy. This paper aims to put forth an alternative theory of real exchange rate determination of the Mexican peso with respect to the United States dollar (US dollar). Our model is based upon a classical approach to the theory of competition developed in Shaikh (1980, 1991, 1999b, and 2013).

According to this theory of competition, which has its origins in the works of Marx and Keynes (Milberg, 1994), the international competitiveness of a country, or industry, is primarily based on its absolute advantage in terms of product technology and labor productivity. This framework argues that it is a country's competitive position, measured by the real unit labor cost of its tradable sector, which determines the center of gravity of the real exchange rate. That is, differences among the real production costs of nations determine their international terms of trade and hence their long-run real exchange rates. Our alternative approach also argues that the international money flows occasioned by balance of trade imbalances do not change price levels as the quantity theory of money claims, but rather change interest rates as Marx, Keynes and Harrod claim. This means that absolute cost advantages are not eliminated by the money flows, so they continue to rule. It also means that free trade will give rise to trade imbalances which will be automatically covered by corresponding capital flows, so that a country with a balance of trade deficit could end up as an international debtor.

Three key proposals follow from our alternative approach. First, real exchange rates can be pinned down by the vertically integrated real unit labor cost ratios of the tradable sectors of the transacting countries. Second, trade surpluses and deficits are not anomalies of a competitively functioning international world market system, nor need they be temporary. Third, devaluations will not have a lasting effect on trade balances, unless accompanied by fundamental changes in national real wages or productivity.

In order to test the main hypotheses of Shaikh's model for the Mexican economy, the first section of this paper reviews the principal models of exchange rate determination, putting special emphasis on their point of agreement (PPP). In the second section we develop the main points of the Shaikh's works and we incorporate some minor additions to his formal model of long-run real exchange rate (net capital inflows and government expenditure). The third section presents the methodology used to build the relative unit labor cost time series (RULC US-Mex). The fourth section presents an econometric model of the long-run real exchange rate determination. Final remarks are included in the concluding.

1. Conventional Models of Exchange Rate Determination PPP and related theories

As is well known, PPP hypothesis has its foundation in the Law of One Price (hereafter, LOP), whose main argument claims that if one abstract from tariffs and transportation costs, unfettered trade in goods should ensure identical prices across countries. Therefore, if this law holds for every individual good, then it follows immediately that it must hold for any identical basket of goods. In other words, the LOP is not a theory of the exchange rate,[1] but rather a test of market efficiency inasmuch as independently of the local conditions of production and individual producer's cost, their selling prices must be approximately equal (Antonopoulos, 1997; Ruiz-Nápoles, 1996).

PPP is a theory of exchange rate determination as it asserts that nominal exchange rates in general, move in the appropriate direction so as to equalize the relative price levels between two countries. Thus, although it is often not explicit which underlying mechanism would be necessary in order to create a particular common level of prices, for the adherents of the PPP hypothesis, price level movements are dominated by monetary factors in the sense that if money supply increases, then also the price level would do it in the same proportion (Dornbusch, 1988; Froot and Rogoff, 1994; Rogoff *et al.*, 2001). More specifically, for the trade theory that underpins the PPP hypothesis, the mechanism through which exports match imports in the long-run is the same mechanism that guarantees that the price levels will be equalized between two countries that trade with each other. This principle is known as Hume's price-specie-flow mechanism (Antonopoulos, 1997; Ruiz-Nápoles, 1996; Shaikh, 1980).

According to this principle, it is the amount of money in circulation which varies with the trade balance that causes the level of prices to change (Ruiz-Nápoles, 2004). That is, for the mainstream trade theorists (and Ricardo's theory of trade) in a two commodities, two countries model, trade can only take place in terms of money prices. So, departing from a situation in which one country has

[1] It is worth noting that, since in itself, the LOP does not imply a long-run equilibrium real exchange rate (at which balance of trade would be equal to zero), it is possible to have the LOP prevail even when there is a trade surplus or trade deficit (Antonopoulos, 1997).

absolute advantage in producing both commodities (due to higher productivity and better technology), it would be paid by its exports with money. Then the net inflow of money makes its price go up until one of the two absolute advantages disappears, via the quantity theory of money. Simultaneously, the net outflow of money in the less efficient country makes its prices go down until one of them is relatively lower so as to make the good attractive for importation from abroad. Here it is the money flow which does a sort of transformation of absolute into relative advantages (Shaikh, 1980).

Whether the model is the Ricardian one or that of Heckscher-Ohlin, and notwithstanding their differences regarding the source of absolute (dis)advantage, these models predict that these absolute advantages will turn into comparative ones. Therefore, both models come to the same conclusion: trade is desired by both nations because it improves their general economic welfare; money inflows and outflows, eventually change the price ratios of the two countries and in so doing they bring about balanced trade.

Along these lines and putting aside sterilization policies, the standard theory expects the long-run real exchange rate to gravitate around that level which balances trade. In this regard, the formal structure of the PPP hypothesis proposes that the nominal exchange rate between the currencies of two countries is the price ratio of the two countries (see equation 1):

$$e = P/P^* \qquad (1)$$

Where, e is the nominal exchange rate, P is the price level of country A and P^* of country B. This is the absolute (or strong) PPP hypothesis. The relative version of this statement, known as the relative (or weak) PPP hypothesis, states that the nominal exchange rate, instead of being equal to, has a constant proportional relationship to the price ratio of the two countries (see equation 2):

$$e = k\,(P/P^*) \qquad (2)$$

Where, k is a constant parameter that reflects the given obstacles to trade. Nonetheless, to the extent that there is a change in the price ratio, the nominal exchange rate will change as well. Thus, we can re-write the real exchange rate as follows (see equation 3 and 4):

$$e_r = e(P^*/P) \qquad \textit{or} \qquad e_r = e(P^*/kP) \qquad (3 \text{ and } 4)$$

Equation 4, implies that the real exchange rate, e_r, is invariant through time, since an opposite and equivalent change in the nominal exchange rate, *e*, always matches a change in P^* / Pas suggested in equations [1] and [2] (Stein *et al.*, 1995). As a result of this monetary mechanism, the PPP hypothesis asserts that real exchange rates are expected to be stationary over the short and the long-run.

In effect, both versions of the PPP hypothesis (strong and weak) expect that in the short-run and the long-run the rate of change of the nominal exchange rate offsets the relative rate of inflation. Hence, from this perspective, real exchange rates remain roughly unaltered through time. However, for different countries and different time spans, empirical data and econometric tests have shown that real exchange rates are simply not-stationary in either the short-run or the long-run (Antonopoulos, 1997; Harvey, 1996; Stein *et al.*, 1995; Shaikh *et al.*, 2012).

On the one hand, PPP is not accepted in the short-run, as prices are assumed to be sticky; hence overshooting is not only possible, but predictable (Antonopoulos, 1997). Besides, due perhaps to the growth of capital flows via financial markets and speculation, and the volatility of the nominal exchange rate; these models have tended to accept that the PPP does not apply in the short-run. Nonetheless, adherents continue to believe that PPP applies in the long-run as a natural result of floating exchange rates (Stein *et al.*, 1995).

On the other hand, empirical tests conducted over a 50-year span of the postwar period, also confirm that under floating exchange rates the PPP hypothesis is rejected (Froot and Rogoff, 1994). This latter difficulty has forced supporters of the PPP hypothesis to argue that any convergence which might exist must be extremely slow (Rogoff *et al.*, 2001), requiring perhaps 75 or even 100 years of data in order to become evident (Froot and Rogoff, 1994).

In this regard, one must keep in mind that despite the notable differences between the classic exchange rate models[2] and the monetarist models, namely asset-market approaches to the exchange rate with rational expectations and intertemporal optimization, both groups of models rely heavily on the assumption of stationarity of the real exchange rate series (weak version of the PPP hypothesis). Therefore, the existence of a non-stationary series of the real exchange rate would invalidate all of them (Stein *et al.*, 1995).

For the Mexican case, our own estimations show that the real exchange rate of the Mexican peso with respect to the US dollar, for annually data for the period 1970-2011, is also a non-stationary process. Unit root tests for the level of the log of

[2] Here we refer to the elasticity approach, absorption approach and, the classical balance of payment approach.

the Mexican real exchange rate [ADF, PP and, the KPSS test], by and large, do not reject the null hypothesis of the presence of a unit root. Therefore, for this period, this series follows a non-stationary process, I(1) (see table 1 and figure 1).

Table 1

Unit Root Test

	ADF			*PP*			*KPSS*	
Variables	*A*	*B*	*C*	*A*	*B*	*C*	η_μ	η_τ
LRXRI	-2.68	-2.70	-0.48	-2.69	-2.75	-0.35	0.13	0.14
Δ LRXRI	-6.44	-6.53	-6.62	-7.16	-7.08	-7.24	0.14	0.15
ΔΔ LRXRI	-8.89	-9.02	-9.14	-19.23	-19.68	-20.10	0.25	0.25

Note: Δ Indicates differences, LRXRI stands for the log of the real exchange rate index, 1988=100.
Conclusions: LRXRI ~ I(1)
Model A adds a constant and a trend, model B adds only a constant and modelo C does not include nothing.
The bold squares indicate the rejection of the null hipotesis at 5% significance level.
η_μ and η_τ represent the KPSS test statistics, where the nullhipothesis considers that the series are stationary in levels or around a deterministic trends, respectively.
Source: Own elaboration based on Eviews 8.

In short, table 1 suggests that the PPP hypothesis does not apply to the Mexican case, and moreover, also suggests that the inflation rates between Mexico and US do not follow a common path in the short and long-run. Consequently, the PPP hypothesis, which involves the use of price indexes both in its strong and weak versions, does not necessarily reflect the degree of competitiveness of the economy, since it emphasizes more the general price level.

2. An Alternative theory of Real Exchange Rate Determination

Theory of competition and real exchange Rate Determination

The aim of this section is to develop the crucial points of Shaikh's alternative theory of real exchange rate determination (1980, 1991, 1999b, and 2013), which is based upon a non-neoclassical theory of competition and the principle of absolute advantage as the main determinant of international competitiveness. Thus, the point of departure for Shaikh's model is the classical theory of competition, which can be traced back to the writings of Smith, Ricardo, and Marx. This approach considers competition as rivalry among firms, in the classical sense where all producers try to obtain a share of their market by lowering costs.

With regard to the domestic competition, rivalry takes primarily the form of price competition where each firm attempts to undercut competitors' prices. This rivalry is carried out, as a rule of thumb, through the introduction (at intervals) of better techniques of production with the clear objective of reducing the unit cost of production (investments). Shaikh assumes that any industrial economy's prices are determined by a dual, intra-industry and inter-industry, competition process.

On the one hand, competition in a generalized market economy mainly refers to competition of different capitals. Once production has taken place, producers of individual goods are disciplined by the market not to charge an arbitrary price, but rather the selling price determined by the better conditions of production. That is, the price that prevails in one particular market is not the average price of the industry but the *least cost* price determined by the most efficient producer in that industry. This price is called the *regulating* price and the producer is the *regulating capital*, as distinguished from the average price and the average capital (Ruiz-Nápoles, 1996; Shaikh, 1999b). In turn, "non-regulating capitals will be forced by competition to sell at the same price, and will therefore have a variety of profit rates determined by their own various conditions of production" (Shaikh, 1999b:2).

On the other hand, competition between industries means that, to the degree that one industry is capable of realizing higher rates of return than the average prevailing rate of other industries, the more capital it will be able to attract either because other envious capitals will enter that particular market, or because the profitable enterprise will be able to expand faster by re-investing and, hence, enlarging their own capital formation. Under such circumstances, it is the free mobility of a factor(s) of production that produces the tendency for a rough equalization of profit rates between the previously unequal profit sectors (Antonopoulos, 1997). Thus, the rates of profit which are equalized by capital flows are the profit rates of new investments in the regulating conditions of production (Shaikh, 1999b). In other words, regulating prices of production in each industry are nothing else but the embodiments of the regulating techniques of production. As such, they incorporate the prevailing rate of profit and act as the center of gravity of selling prices. Hence, it is the best technology generally available for a new investment which forms the regulating conditions (Shaikh, 1999b).

With regard to international competition, Shaikh's model assumes that since production techniques used by firms within one nation differ, one would expect that techniques of production of any World Industry, where individual firms are spread out through various countries, will vary from one nation to another as well. Real wages, generally, will differ among countries as well (especially among developed and developing countries). So, the resulting lower unit cost of production, which can be measured as the total (vertically integrated) *unit labor cost* (ULC), would allow international regulating firm(s) to either lower their own market price and thus, enlarge their market share or, perhaps, to temporarily sell at the prevailing market price and capture a higher profit per unit sold. In either case, the result is the same: the international regulating firm(s) will be in a position to make more profits relative to other international firms producing similar goods and thus faster engage in more R&D. The winners are those international firms capable of maintaining an absolute cost advantage vis-à-vis their competitor. Conversely, those firms suffering a loss of market share and shrinking profits would have an *absolute disadvantage* (Antonopoulos, 1997).

Formal theoretical model

In his model, Shaikh follows the Ricardo-Marx tradition of relating prices to relative labor inputs costs (Shaikh, 1980), adopting Pasinetti's model (1977). Thus, Shaikh starts from a closed economy, where relative prices of any two commodities i, j are dominated by the relative prices of the regulating capitals (p_i^*, p_j^*), which themselves are subject to their own vertically integrated unit labor costs (v_i^*, v_j^*). This interrelationship between relative prices and relative vertically integrated unit labor costs is expressed in equation 5:

$$\frac{P_i}{P_j} \cong \frac{P_i^*}{P_j^*} \cong \frac{v_i^*}{v_j^*} \tag{5}$$

In any industry, the prevailing market price of a commodity (p^*) is regulated by the regulating firm's cost, which can be expressed as the vertically integrated nominal wage (w^*) the regulating firm is subject to, and the vertically integrated labor requirement (λ^*), dictated by the technology this regulating firm uses, in the sense of Sraffa and Pasinetti.[3] If the nominal wage (w^*) is divided by the consumer price index (*cpi*), and letting subscript r designate real instead of nominal measures, then the real wage (w_r^*) is equal to w^*/cpi. It follows that the real vertically integrated unit labor cost will be equal to w_r^*, λ^*, which in equation 6 will be reflected as v_r^*.

$$\frac{P_i}{P_j} \cong \left(\frac{w_i^* / cpi_i}{w_j^* / cpi_j}\right)\left(\frac{\lambda_i^*}{\lambda_j^*}\right) \equiv \left(\frac{w_{ri}^*}{w_{rj}^*}\right)\left(\frac{\lambda_i^*}{\lambda_j^*}\right) \equiv \frac{v_{ri}^*}{v_{rj}^*} \tag{6}$$

[3] For Sraffa and Passinetti, there is a unique set of rates of exchange among commodities that is determined by technology alone and that must be adopted in order to keep the system in a self-replacing state. Sraffa especially

Competition drives firms towards introducing more effective technologies. As a sector's regulating capital lowers its real relative cost, aggressive competition will drive down the sector's relative price as well. Thus, its own purchasing power, vis-à-vis the other goods, is expected to depreciate when its competitive position improves.

According to Shaikh's model, when the ULC of one of the two goods declines, the competitive position of the country producing that good improves, and thus there is a real depreciation of its currency. Shaikh's model also assumed a two-country, two-good model, under complete specialization, so the exports of each country must be equal to the imports of the other country. In addition, specialization implies that each country contains exclusively one of the two regulating capitals, as each country is the sole producer of one of the two goods being traded.

Now, in equation 7, the nominal exchange rate of a country e_{ab} is defined as the number of units of currency *a* per one unit of currency *b*. Thus, a rise in the exchange rate corresponds to a depreciation of currency *a*, as more units are needed for one unit of the foreign currency:

$$e_{ab} = \frac{currency\ a}{currency\ b} \tag{7}$$

Finally, equation [8] gives a general definition of the terms of trade of country *a* relativeto country *b* as follows:

$$t.o.t_{ab} = \frac{P_{x_a}}{P_{m_a} e_{ab}} = \frac{P_{x_a}}{P_{x_b} e_{ab}} \tag{8}$$

Combining equations [6] and [8], the terms of trade can be re-written as follows:

$$t.o.t_{ab} = \frac{P_{x_a}}{P_{x_b} e_{ab}} \cong \frac{v_{x_a}}{v_{x_b} e_{ab}} \equiv \left(\frac{w_a}{w_b e_{ab}}\right)\left(\frac{\lambda_{x_a}}{\lambda_{x_b} e_{ab}}\right) \tag{9}$$

points out that these rates of exchange might indifferently be called 'natural prices', or 'prices of production', or 'values'. In a precisely parallel way, the relation in the price system does not go –as traditional marginal analysis would have it– from final consumers' preferences to 'imputed' costs. As classical analysis has always claimed, it goes from costs of production to 'natural' prices (see Pasinetti, 1992).

At this point, Shaikh makes the simplifying assumption that both countries consume similar baskets of tradable consumption goods. Then according to the *law of one price*, $pc_{T_a} = pc_{T_b}\, e_{ab}$, where pc is is the price of consumption goods, and the subscript (T) stands for tradable. Thus, equation [9] can be transformed into equation 10 as follows:

$$\frac{P_{x_a}}{P_{x_b}\, e_{ab}} \cong \left(\frac{W_a / P_{c_a}}{w_b / P_{c_b}}\right)\left(\frac{\lambda_{x_a}}{\lambda_{x_b}}\right)\left(\frac{P_{c_a} / P_{c_{T_a}}}{P_{c_b} / P_{c_{T_b}}}\right)\left(\frac{P_{c_{T_a}}}{P_{c_{T_b}}\, e_{ab}}\right) \tag{10}$$

From equation [6], the first two ratios on the right hand side of equation [10] are equivalent to the familiar v_r ratio of two countries (ULC), the third ratio is the relationship of non-tradables to tradables of consumption goods in each country respectively, and the fourth ratio is equal to unity. Thus, equation 10 can be re-written as indicated in equation 11.

$$\frac{P_{x_a}}{P_{x_b}\, e_{ab}} \cong \left(\frac{v_{rx_a}}{v_{rx_b}}\right)\left(\frac{P_{c_a} / P_{c_{T_a}}}{P_{c_b} / P_{c_{T_b}}}\right) \tag{11}$$

Here, if we take the inverse of equation [11], then we end up with a definition of real exchange rate (deflated by the export prices), which according to equation 12, tends to follow the long-term trajectory of the real vertically integrated ULC ratio adjusted by the non-tradable to tradable goods ratio:

$$e_{r_{ab}} = e_{ab}\left(\frac{P_{x_b}}{P_{x_b}}\right) \cong \left(\frac{v_{rx_b}}{v_{rx_a}}\right)\left(\frac{P_{c_b} / P_{c_{T_b}}}{P_{c_a} / P_{c_{T_a}}}\right) \tag{12}$$

In simply terms, we can re-write equation [12] as indicated in equation [12b]

$$e_{r_{ab}} \cong \frac{v_{rx_b}}{v_{rx_a}} * T_b / T_a \tag{12b}$$

Where $T = Pc/P_{c_T}$

$$1\mathrm{n} e_{r_{ab}} \cong 1\mathrm{n}\left(\frac{v_{rx_b}}{v_{rx_a}}\right) + 1\mathrm{n}\left(\frac{T_b}{T_a}\right) \tag{13}$$

Finally, Shaikh's position is that, in any case, neither flexible nor fixed exchange rate variations will correct the structural trade imbalances induced by international competition because the determinants of the terms of trade (w_r^*, and λ^*) are not free to move so as to bring about automatic balance of trade adjustment. Hence, the generalized modernization of technology, to raise productivity and lower unit labor costs, is the only long term solution to the problem of competitive disadvantage. More precisely, a cost reduction can only be produced by the introduction of more efficient technologies, or, in the short-term, by the reduction of the real wage rate.

3. Data Construction and Statistical Analysis (RULCR US-Mex)

This section describes the methodology and construction of the variables needed to estimate Shaikh's alternative model of real exchange rate determination. Furthermore, we discuss why in addition to the relative unit labor cost ratio US-Mex (which we claim is the main determinant of the long-run path of the real exchange rate), we added to our model the following variables: (1) net capital inflows to Mexico and (2) Mexican real government final consumption expenditure.

The present empirical work relies mostly on data from the manufacturing sector because there are numerous problems in the availability of data from the manufacturing export sector, especially for the Mexican economy. In other words, since not all of the required data were available for the period under study, we instead calculated the direct unit labor costs in the manufacturing sector as a proxy for the unit labor cost in the manufacturing export sector.

Although our empirical analysis covers the period 1970-2011, it is worth mentioning that in order to construct the 1970-2011 series for the Mexican real ULC, we used four manufacturing surveys with different base years calculated by the Mexican statistical authority (INEGI). The first one runs from 1970 to 1982 (1970=100), the second one runs from 1980 to 1993 (1980=100), the third one runs from 1988 to 2004 (1993=100), and the last one runs from 2003 to 2011 (2008=100). Although these four surveys calculate the same data of output, wages, and employment from the manufacturing sector, these four surveys are not homogenous because the last two surveys take into account a large number of productive sectors. In terms of an index number, we might expect a large jump from 1987 to 1988, due solely to the change of one survey to another.

In the next section, we estimated some Error Correction Models (ECM) under the autoregressive-distributed lag (ARDL) modelling framework. In estimating our econometric models, we used the following two functional relationships for the period 1970-2011:

$$rxr_{ij} = f\,(rulcr_{ij}^{*}) \tag{14}$$

$$rxr_{ij} = f\,(rulcr_{ij}^{*},\, nci_i,\, g_i) \tag{15}$$

where,

1) The real exchange rate, *rxr*, is equal to the nominal exchange rate deflated by the price ratio of the foreign country (*j*) to the domestic country (i):

$$rxr_{ij} = e_{ij} * \frac{p_j}{p_i} \tag{16}$$

2) $rulcr_{ij}^{*}$ stands for a real unit labor cost ratio*, and is equal to the $rulc_j$ of the foreign country (*j*) divided by the $rulc_i$ of the domestic country (*i*)

$$rulcr_{ij}^{*} \equiv \frac{rulc_j}{rulc_i} \tag{17}$$

3) $rulc_{i,j}$ stands for real total remuneration in manufacturing in local currency divided by productivity. That is, real unit labor cost is defined as total labor cost in manufacturing divided by productivity:

$$rulr_{i,j} = \frac{total\ real\ laborcost}{productivity} \tag{18}$$

4) At the most general level, the two series that need to be developed are the real unit labor cost (RULC) of the manufacturing sector of Mexico and that of the US. Thus, if we substitute the equation that defines the real unit labor cost ratio* ($rulcr_{ij}^{*}$) into equation [16], we get equation [19], which proposes a similar relationship as equation [12]:

$$rxr \equiv \frac{MexPeso / USdollar}{cpi_{Mex} / cpi_{US}} \approx \frac{(\Re wages_{us} + \Re salaries_{us}) / (\Re output_{us} / employment_{us})}{(\Re wages_{Mex} + \Re salaries_{Mex} / employment_{Mex})} \tag{19}$$

5) ncf_i stands for real net capital inflows to Mexico and it considers deposits, loans and credits to commercial and public banks in Mexico, as well as non-banking public and private sectors; foreign investment, which includes direct and indirect investment; securities issued abroad, both public and private; and the net errors and omissions in the balance of payments.
6) g_i stands for the real general government final consumption expenditure of the Mexican economy.

Data description

The period of the present study spans from 1970-2011. All price deflators are 1988=100 and each money variable is measured in the corresponding local currency. As we mentioned above, to carry out the estimation of this alternative model, we assumed that the manufacturing sector represents the majority of tradable goods, which is correct for all industrialized and some semi-industrialized countries. In the case of Mexico, manufacturing trade has grown in importance and it currently represents 90 percent of total exports and 87 percent of total imports (Fujii, 2000; Martínez, 2003; Ruiz-Nápoles, 1996). In addition, the United States is Mexico's major trading partner. Exports to and imports from the US account for 75 percent of Mexico's total foreign trade.

Mexico's real unit labor cost

The construction of the RULC of the Mexican manufacturing sector was carried out with the data provided by INEGI and by Mexico's Central Bank. Gross domestic product in manufacturing was deflated by using the implicit prices of the manufacturing sector. Total wages and salaries were deflated by the consumer price index (1988=100). We also consider the total number of workers in manufacturing. Thus, real unit labor costs are wages and salaries paid in manufacturing multiplied by the number of workers in manufacturing and divided by real gross domestic product in manufacturing:

$$rulc_{Mex} = (\Re wages_{Mex} + \Re salaries_{Mex}) * [(employment_{Mex})/(\Re output_{Mex})] \qquad (20)$$

US real unit labor cost

The construction of the RULC of the United States manufacturing sector was carried out with data provided by the Department of Commerce (BEA). Gross domestic product in manufacturing was deflated by using the implicit prices of durable and non-durable goods indexes (average). Total wages and salaries were deflated by the consumer price index (1988=100). We also consider the total number of workers in manufacturing. Thus, for the US economy, the real unit labor cost is also equal to real wages and salaries paid in manufacturing multiplied by the number of workers in manufacturing and divided by real gross domestic product in manufacturing:

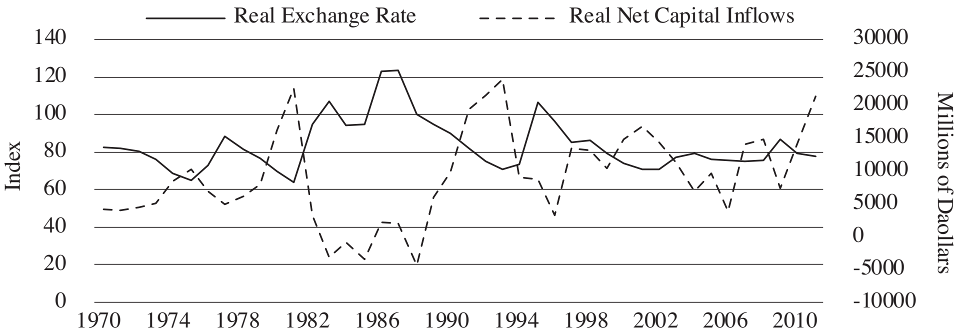
$$rulc_{US} = (\Re wages_{US} + \Re salaries_{US}) * [(employment_{US})/(\Re output_{US})] \qquad (21)$$

Net capital inflows

The construction of the net capital inflows to Mexico was carried out with data provided by Banco de México. Once constructed, this series was deflated by the US consumer price index (base 1988=100). We considered this variable inasmuch as the Mexican government has since the late 1980s implemented several policies to attract foreign capital in order to stabilize the exchange rate and to finance the current account deficit (Martínez, 2003). Hence, we assume that an ongoing supply of foreign exchange (dollars) could, sooner or later, decrease the price of the nominal exchange rate (*e*), which itself could end up appreciating the real exchange rate. Conversely, a significant reduction of foreign exchange could increase the price of the nominal exchange rate (*e*), which itself could end up depreciating the real exchange rate. Nonetheless, it is worth mentioning that the latter situations could occur without necessarily having to have a strong impact on domestic prices and costs. More precisely, although the nominal exchange rate could have an impact on domestic prices and costs, our theoretical framework claims that the main direction of causality in the long-run goes from real unit labor costs to prices, not the other way around. We will go back to this point when we discuss our econometric results in the next section. The relationship between the real exchange rate and the real net capital inflows is shown in figure 1.

In figure 1, the real exchange rate index indicates a real depreciation when its value is above 100 and a real appreciation when its value is below 100. There is a negative co-variation between the two variables, allowing for the possibility that net capital flows (supply of dollars) could explain to some degree the deviation of the real exchange rate of the Mexican Peso from its theoretical proposed primary determinant (center of gravity), namely, the real unit labor cost ratio. Finally, as a result of this negative correlation, we would expect a negative sign between these variables in our econometric model.

Figura 1
Real exchange rate index and real net capital inflows, 1970-2011



Source: Own elaboration based on data from Barco de Mexico.

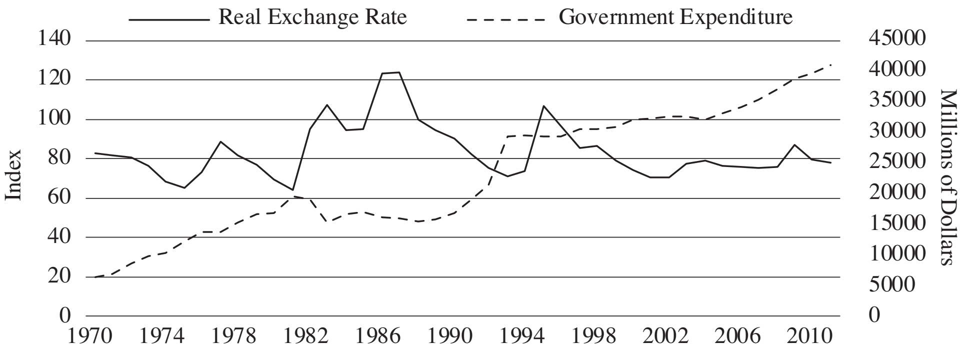
Mexican Government Expenditure

The construction of the general government final consumption expenditure (*g*) in constant US dollars was carried out with data provided by the World Bank (WDI). Once we obtained the Mexican real GDP in US dollars of 1988, we multiply this real GDP by the general government final consumption expenditure as a percentage of the Mexican GDP.

We included the real government expenditure in our model of real exchange rate determination due also to its likely impact on the nominal exchange rate (*e*). That is, the government expenditure has been financed, to an important degree, by the oil revenues in the fiscal accounts, which by themselves have represented around 34-37% of total public sector revenues, or about 6.8% points of GDP in the last 20 years. (Martínez and Herrera, 2006). Thus, we assume that the amount of foreign exchange earnings from the oil exports has a double effect upon the level of the nominal exchange rate. On the one hand, a higher level of oil exports (which is correlated with a higher level of *g*) entails an increase in the supply of foreign exchange that could put a downward pressure on the nominal exchange rate (*e*), that is, an appreciation of the real exchange rate, *ceteris paribus*. Conversely, a decrease in the level of oil exports (which is correlated with a lower level of *g*) entails a decrease in the supply of foreign exchange that could put an upward pressure on the nominal exchange rate (*e*), that is, a depreciation of the real exchange rate, *ceteris paribus*. In other words, the government expenditure is an "instrumental variable" that helped us deal with the problem of contemporaneous bi-directional causality between the oil exports and the nominal and real exchange rate.

Finally, another channel of transmission from the real government expenditure to the nominal exchange rate could come from the changes in the nominal interest rate. That is, if the fiscal revenue is not enough to finance the government budget or if a given level of government expenditure contributes to generate an unexpected higher level of aggregate demand, then any of these two scenarios could lead to the issue of more Treasury bonds at a higher interest rate. Thus, if the increase in the domestic interest rate creates an attractive interest rate differential, then this interest rate differential could trigger an important capital inflow into the country, which would contribute to create a higher supply of foreign exchange, which sooner or later could end up putting a downward pressure on the nominal exchange rate (e), that is, appreciating the real exchange rate, *ceteris paribus*.

Figure 2
Real exchange rate index and real Mexican government expenditure, 1970-2011



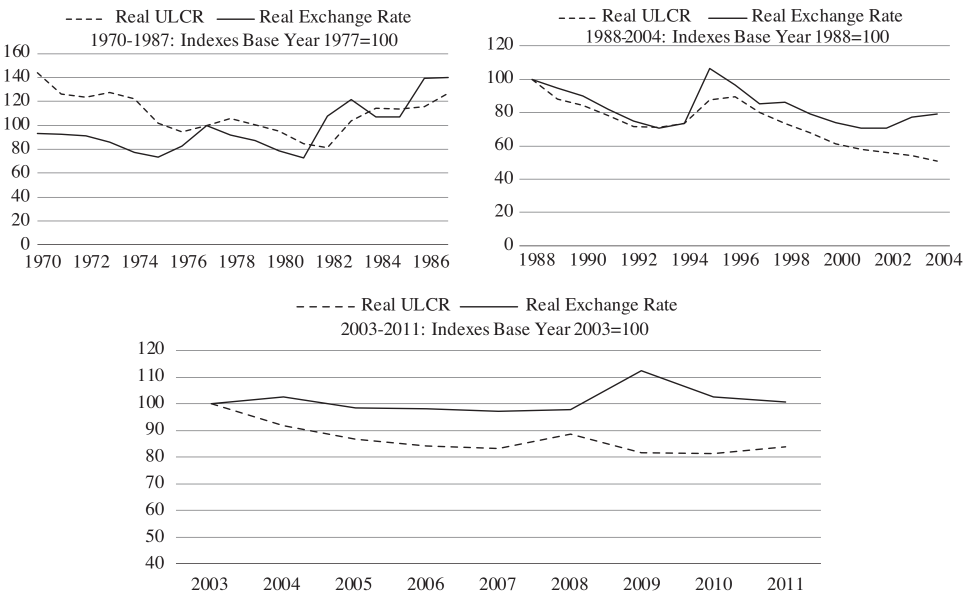
Source: Own elaboration based on data from Banco de Mexico and World Bank (WDI).

The relationship between the real exchange rate and the real government expenditure is shown in figure 2. In figure 2, although the government expenditure follows an upward trend almost during the whole period, one can see a negative correlation between these two variables, so we would expect a negative sign between the relationship of these variables in our econometric model.

Center of gravity: real unit labor cost ratio (US-Mex)

As was mentioned above, we used four manufacturing surveys to estimate the real unit labor cost (RULC) for the Mexican economy. From there, we created three calculations of the real unit labor cost ratio (US-Mexico) with different base years and we compared them graphically with the real exchange rate in order to show that the real exchange rate trend is closely related to the movements of the real unit labor cost ratio (US-Mex) (see figure 3).

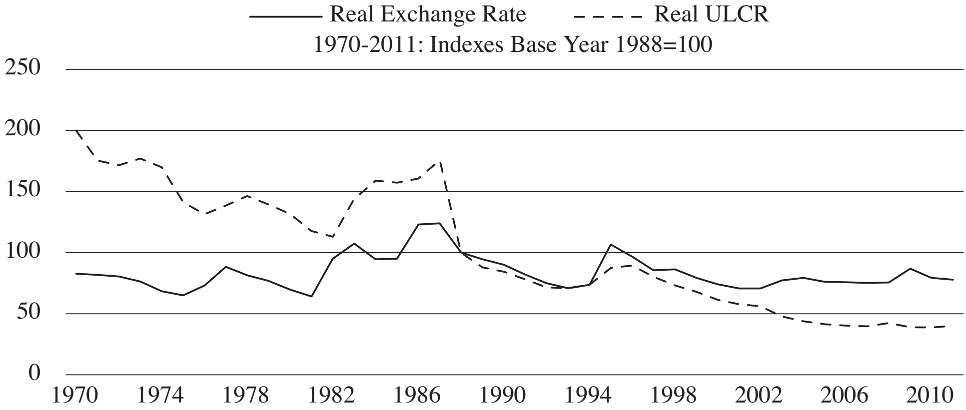
Figure 3
Real exchange rate index and real unit labor cost ratio index (US-Mex)



Source: Own elaboration based on data from Banco de Mexico, INEGI, and US Department of Commerce (BEA).

Calculation for both variables for the whole period 1970-2011 (see figure 4) shows the same long-term correlation between the real exchange rate and the real unit labor cost ratio (US-Mex). But in this last plot (figure 4), we can also observe, as we anticipated above, a relatively large downward fall of the RULCR series between 1987 and 1988, due to the use of two similar manufacturing surveys but with different elements between them. Nonetheless, both series appear to be strongly and positively correlated through the whole period.

Figure 4
Real exchange rate index and real unit labor cost ratio index (US-Mex)



Source: Own elaboration based on data from Banco de Mexico, INEGI, and US Department of Commerce (BEA).

4. Empirical Evidence of Alternative Real Exchange Rate Determination Using An ARDL-ECM Model

In this section we test two hypothesis through econometric techniques: 1) our main hypothesis is that the long-run trend of the real exchange rate of the Mexican peso with respect to the US dollar is mainly determined by the relative real unit labor costs of the US and Mexican manufacturing sectors; 2) our second hypothesis is that the real net capital flows to Mexico and the Mexican government final consumption expenditures, also contribute to explain, but to a lesser extent, some part of the long-run path of the Mexican real exchange rate. To pursue this analysis, we first rewrite equations 14 and 15, respectively, in an appropriate form for econometric analysis as follows:

$$lrxri_t = \alpha + \beta_1 T + \beta_2 lrulcri_t + u_{1t} \quad (22)$$

$$lrxrit = \alpha + \beta_1 T + \beta_2 lrulcri_t + \beta_3 nci_{Mext} + \beta_4 lg_{Mext} + u_{2t} \quad (23)$$

Where: $lrxri_t$, the log of the index of the real exchange rate of pesos/dollar; α, a constant term; T, a time trend; $lrulcri_t$, the log of the index of real unit labor cost ratio (US-Mex); nci_{Mext}, net capital inflows to Mexico in constant US dollars;[4] lg_{Mext}, the log of the general government final consumption expenditure in constant US dollars; u_{1t} and u_{2t}, error terms.

The sample used for the econometric analyses considered the period 1970-2011, where all the series have 1988=100 as the base year. We considered two econometric specifications: the first one tests for the existence of a long-run relationship between the Mexican real exchange rate and the real unit labor cost ratio (US-Mex). The second model intends to measure the long-run impacts of nci_{Mext} and lg_{Mext} upon the Mexican real exchange rate.

We use an ARDL model using Microfit 5 for two reasons. First, this testing and estimation strategy can be applied irrespective of whether the regressors are I(0) or I(1), and can avoid the pre-testing problems associated with the standard cointegration analysis which requires the classification of the variables into I(1) and I(0) (Pesaran and Pesaran, 2009:308). Second, the sign and significance of the error correction coefficient (ECC) provides an indication of Granger causality in a non-stationary context. For an error correction model (ECM) to be stable, the ECC has to satisfy the following stability criterion: $-1 < ECC \leq 0$ (Hill *et al*., 2011:500).

Table 2
ECM results for Mexico-US, 1971-2011

Regressor	*Coefficient*	*T-radio [prob]*	*F-Stat*	*ARDL/DW/R-Bar-sq*
LRULC	0.82347	82.0295[.000]	Lower bound 2.695	ARDL (1, 0)
Trend	0.03316	18.3285[.000]	Upper bound 3.837	DW = 1.71
Speed of Adjustment	-0.62365	-4.7080[.000]	F-Stat 5.5731[.008]	Adj-R-sq= 0.33

Source: Own elaboration.

Table 2 shows the long-run or cointegrating relationship along with the ECC (speed of adjustment)[5] associated to equation 22. The F test indicates the existence of an equilibrium long-run relationship between the variables (*lrxri*, *lrulcri*, and a small trend), as it lies above the lower and upper bounds. The log of the real exchange rate index (*lrxri*) is the dependent variable. The positive sign and statistical significance of the cointegrating parameters indicate a strong long-run correlation (elasticity) between the real exchange rate (*lrxri*) and the real unit labor cost ratio

[4] The coefficients of the log-linear specification, being elasticities, and hence scale-invariant, are much easier to interpret. However, the series for ncf was not calculated in log form due to the presence of negative numbers.

[5] The larger the error correction coefficient (in absolute value) the faster will be the economy's return to its equilibrium, once shocked (Pesaran and Pesaran, 2009:311). The ECC from table 2, estimated at -0.62365(0.13247) suggests a moderate speed of convergence to equilibrium.

US-Mex (*lrulcri*), that is, according to the cointegrating vector a 1% increase in the real unit labor cost ratio (US-Mex) tends to increase in 0.8% the real exchange rate. Finally, the stability condition of the ECM is fulfilled as the ECC is lower than 1 and negative, which suggests that the *lrulcri* Granger cause the *lrxri*.

Besides, with equation 22, through two different methods, we determined that *lrulcri* acts as the ‘long-run forcing’ variable. The first method is represented by the ECM in table 2, where the significance of the F-statistic when the *lrcxri* is the dependent variable indicates that *lrulcri* Granger cause *lrxri*. However, when *lrulcri* acts as the dependent variable in an ECM, the F-statistics fall well below the lower bound, which indicates that *lrulcri* is an endogenous variable. The second method consisted in the application of two Wu-Hausman exogeneity tests.[6] The first exogeneity test indicates that *lrcri* is an exogenous variable, while the second exogeneity test indicates that *lrulcri* is an endogenous variable. The conclusion of these econometric tests is that for the period 1971-2011, the long-run path of the real exchange rate was explained by the changes in the real unit labor cost ratio (US-Mex).

Table 3
ECM results for Mexico-US, 1976-2011

Regressor	*Coefficient*	*T-radio [prob]*	*F-Stat*	*ARDL/DW/R-Bar-sq*
LRULC	0.553	4.8327[.000]	Lower bound 3.539	ARDL (3, 0, 0, 3)
NCF	-1.53E-05	-2.8121[.009]	Upper bound 4.667	DW = 1.96
LG	-0.362	-2.1724[.040]	F-Stat 5.3827[.002]	Adj-R-sq= 0.728
INPT	4.881	3.0468[.005]		
Trend	0.036	4.5818[.000]		
Speed of Adjustment	0.754	-4.7601[.000]		

Source: Own elaboration.

Table 3 shows the long-run or cointegrating relationship along with the ECC (speed of adjustment) associated to equation 23. In table 3 we present a different period (1976-2011) as we could not find a meaningful cointegrating vector for previous periods. Here again the log of the real exchange rate index (*lrxri*) is the dependent variable. However, this is a more general model, where the expected signs and the statistical significance of the parameters in the cointegrating vector indicate a strong long-run correlation (elasticity) between the log of the real exchange rate (*lrxri*), the log of the real unit labor cost ratio US-Mex (*lrulcre*), the net capital

[6] The exogeneity Wu-Hausman test is a F-statistics under the null hypothesis of exogeneity. In the case of the present application, the first test accepts the null hypothesis, that is, the F-statistic (0.279) indicates that the *lrulcri* is an exogenous variable. Whereas in the second test the F-statistic (7.65) indicates that the *lrxri* is an endogenous variable.

inflows to Mexico (*nci*), and the log of the general government final consumption expenditure (*lg*). It is worth noting two important differences of this last model with the former model from table 2, that is, not only the coefficient of the *lrulcri* reduces a little bit (from 0.82 to 0.55) but also the adjusted R-square increases significantly (from 0.33 to 0.73) when we added the log of the government expenditure and the net capital inflows to Mexico into the model, which means that these variables also contribute to explain the long-term behavior of the real exchange rate.

Table 4
ECM results for Mexico-US, 1983-2011

Regressor	*Coefficient*	*T-radio [prob]*	*F-Stat*	*ARDL/DW/R-Bar-sq*
LRULC	0.617	4.1381[.001]	Lower bound 3.539	ARDL (3, 0, 1, 3)
NCF	-1.76E-05	-2.9285[.009]	Upper bound 4.667	DW = 2.02
LG	-0.413	-2.3352[.032]	F-Stat 4.8364[.007]	Adj-R-sq= 0.818
INPT	4.9696	3.2068[.005]		
Trend	0.042	3.5433[.002]		
Speed of Adjustment	-0.659	-4.6466[.000]		

Source: Own elaboration.

Table 4 shows another ARDL-ECM model associated to equation 23 (similar to that model from table 3) but with a different period (1983-211) inasmuch as we could not find more meaningful cointegrating vectors for previous or forward periods. Here it is important to note two things. First, in table 3 and 4 the coefficients are nearly the same. However, the adjusted R-square in table 4 increases a considerable 9% (from 0.728 to 0.818). Second, the signs of the coefficients are the same in both tables, indicating that the *lrxri* and the *lrulcri* have a positive long-run relationship, and a negative one with the *lg* and the *nci*. In this model of table 4, the cointegrating vector suggests that a 1% increase in the *lrulcri* increases in 0.6% the *lrxri*; also suggests that a 1% increase in the *lg* decreases in 0.413% the *lrxri*; with respect to the *nci*, the cointegrating vector suggests that an increase in one thousand millions of dollars in one year tends to decrease in 1.76% annually the *rxr*.[7]

Finally, for the period 1983-2011, we decided to run two additional ECM models in order to estimate, through a comparison method among the adjusted R-squares from table 4, 5, and 6, the individual contribution of the *lrulcri*, the *nci*, and the *lg* to the short and long-run explanation of the *lrxri*. Table 5 shows an

[7] The coefficient of the ncf is a semielasticity, so if we multiply this coefficient per 100, then we get the growth rate of the rxr.

ECM-ARDL model where the *lrulcri* is the dependent variable and the *lrulcri* is the independent variables. The adjusted R-square from table 5 indicates that the *lrulcri* explains in 41.8% the changes in the *lrxri*.

Table 5
ECM results for Mexico-US, 1983-2011

Regressor	*Coefficient*	*T-radio [prob]*	*F-Stat*	*ARDL/DW/R-Bar-sq*
LRULC	0.83037	48.1687[.000]	Lower bound 4.066	ARDL (1, 0)
Trend	-0.03217	12.7115[.000]	Upper bound 5.119	DW = 1.874
Speed of Adjustment	-0.57913	-4.7115[.000]	F-Stat 5.63[.005]	Adj-R-sq= 0.418

Source: Own elaboration.

Table 6 shows also an ECM-ARDL model where the *lrxri* is the dependent variable and the *nci* is the independent variables. The adjusted R-square from table 6 indicates that the *nci* explains in 28.9% the changes in the *lrxri*. So, by a difference method between the adjusted R-squares from table 4, 5, and 6, we can estimate that the *lg* explains only 11.1% of the changes in the *lrxri*. Hence, from this analysis we can conclude that for the period 1983-2011, the *lrulcri* has been the most important variable in the determination of the Mexican real exchange rate as it alone has explained 41.8% of the changes of the *lrxri*.

Table 6
ECM results for Mexico-US, 1983-2011

Regressor	*Coefficient*	*T-radio [prob]*	*F-Stat*	*ARDL/DW/R-Bar-sq*
LRULC	-1.66E-05	-3.4455[.002]	Lower bound 4.066	ARDL (1, 0)
Trend	4.5996	79.5526[.000]	Upper bound 5.119	DW = 2.0522
Speed of Adjustment	-0.5166	-3.5544[.000]	F-Stat 5.63[.007]	Adj-R-sq= 0.28998

Source: Own elaboration.

Concluding remarks

This paper presents an alternative approach to the determination of the real exchange rate. Our method relies on the classical approach to the theory of competition developed in Shaikh (1980, 1991, 1999b, and 2013). From our theoretical framework and empirical evidence we can conclude two things: first, that neither the absolute nor relative versions of the PPP will generally hold; second, that devaluations will not have a lasting effect on the trade balances, unless they are accompanied by fundamental changes in the real production costs of nations (i.e., in national real wages and productivity).

The empirical results of our alternative model show that, in contrast to PPP hypothesis, the real unit labor cost of the manufacturing sector between the US and Mexican economies is a good approximation to estimate the effective real exchange rate. Our econometric models show evidence that these two variables, as well as the real net capital inflows to Mexico and the government final consumption expenditures, are structurally related. However, for the period 1983-2011, we showed that the real relative unit labor cost ratio (US-Mex) is the most important variable in explaining the long-run behavior of the Mexican real exchange rate.

From our ARDL-ECM models and statistical analyses we can also draw the following conclusions. First, the *lrulcri* and the *lrxri* are positively correlated but the *lrulcri* acts as an exogenous variable ('long-run forcing' variable), which tends to determine the long-run trend of the *lrxri*. Therefore, we can suggest that the appreciation of the real exchange rate that the Mexican economy has systematically observed in the last twenty years has been, to an important extent, due to the lack of enough capital (investment) and productivity in its manufacturing sector vis-à-vis the manufacturing sector of the US. Second, the econometric results also indicate that an increase (decrease) of the government expenditure (which is highly correlated with the revenue from the oil exports) and the real net capital inflows to Mexico tend to appreciate (depreciate) the real exchange rate in the long-run.

The empirical validation of this alternative model explains why, after the multiple dramatic devaluations of the Mexican currency (1976, 1982, 1986-88, and 1994), this country, regardless of the exchange rate regime, has not been able to maintain an adequate level of competitiveness in order to balance its international trade. Our alternative theory implies that, in general, the competitive position of firms in the Mexican manufacturing industry has been far away from those internationally regulating firms in the global manufacturing industry (especially those in China). Therefore, as long as the Mexican economy does not improve its general technical conditions of production, Mexico will be structurally disadvantaged regarding the real production costs of its national industries vis-à-vis their competitor and, as a result, Mexico will run permanent trade deficits.

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