Unit labor costs and macroeconomic performance in Mexico

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Abstract
The paper studies the determinants of the relative unit labor cost (RULC) in the manufactures between Mexico and the US, and the effect of RULC on Mexican private investment. Seeking to detect persistent, "long-run" effects, the econometric estimations apply the bounds testing approach to quarterly data from the post-liberalization period in Mexico, 1988–2008. While the productivity-adjusted manufacturing real wage fell in Mexico, RULC nonetheless increased due to an even stronger fall in the US and the misalignment of the peso —with the latter resulting in a steady rise in Mexico's exchange-rate-adjusted relative manufacturing prices. The estimations show that RULC affects private investment negatively, and thus that the upward trend in RULC contributed to the low levels of investment observed in Mexico. In addition to capital flows, RULC responds significantly to the peso–dollar real interest rate differential, indicating that the upward trend in RULC is partly explained by repeated surges in capital inflows and the disinflationary stance of monetary policy. Looking ahead, the estimation results suggest that monetary policy can support faster economic growth, in the medium term, by reducing the interest rate differential and encouraging a more competitive level of RULC.

Keywords: Relative unit labor cost (RULC); investment determinants; currency misalignment; real exchange rate determinants; capital flows; monetary policy; bounds testing approach; Mexico.

JEL codes: C22, E22, F21, F32, F43, O11, O54.

1 Introduction

A well-known fact of the Mexican economy since the late-1980s is the tendency of the peso to appreciate in real terms, a tendency that showed up both under a semi-fixed exchange rate regime in the early-1990s and under a float after the currency crisis of 1994–95. While the specific exchange rate regime apparently did not matter, other factors may have, among them the behavior of foreign capital inflows —which surged before and after the currency crisis— and the country's prolonged process of disinflation —which gave a restrictive bias to monetary policy (see Ramos-Francia and Torres 2005, Galindo and Ros 2008). It may not surprise that the steady appreciation of the peso weakened after 2001–02, when capital inflows began a downward trend and disinflation practically ended (see Chiquiar et al. 2007, Ibarra 2008).

But although it seems related to the behavior of capital flows and the stance of monetary policy, there is always the question of whether the appreciation ultimately reflects an equilibrium response to variables like relative productivity, or instead a misalignment of the currency and a source of poor economic growth. The present paper takes up the question, in two parts. First, it studies the determination of the real exchange rate —as measured by Mexico's relative unit labor cost (RULC) in the manufacturing sector— both econometrically and by decomposing it. And second, it studies the influence of RULC on macroeconomic performance, in particular by its effect on private investment. Since it is motivated by the possible relevance of the real exchange rate in the medium term, the econometric analysis in the paper relies on the estimation of "long-run" (or level) equations that test for the existence of persistent effects.

The peso's appreciation is shown by different real exchange rate measures, including the multilateral consumer-price-based rate calculated by the Bank of Mexico, the bilateral rate between Mexico and the US, and RULC (see Ibarra 2011a). Because of the country's growth's increasing dependence on manufacturing exports, an analysis based on RULC is appealing. If expressed in dollars, the domestic labor cost can be interpreted as an indicator of the manufacturing sector's international competitiveness. The interpretation is reinforced if the domestic dollar cost is measured relatively to the US —Mexico's main export market.

A further advantage is that variations in RULC can be decomposed into changes in real wages, labor productivity, and exchange-rate-adjusted relative prices in the manufacturing sector. This allows us to determine whether an increase in RULC (understood as a real appreciation of the peso) comes from an imbalance between real wages and productivity, or instead from the failure of the nominal exchange rate to stabilize relative prices.

The real exchange rate may be macroeconomically important partly by *directly* affecting private investment. Controlling for the indirect effect via manufacturing exports and production, an additional, statistically significant effect from the real exchange rate would suggest the existence of a profitability effect on investment (see Levy-Yeyati and Sturzenegger 2007, Gala 2008, Rodrik 2008, Razmi et al. 2009). Such effect would imply that the real appreciation of the peso, at least to some extent, has not been an equilibrium adjustment to higher productivity but a misalignment of the currency with negative effects on growth (see Guerguil and Kaufman 1998).

The same question of whether there is misalignment can be approached indirectly, by estimating an equation for RULC. It can thus be tested whether —after controlling for a proxy of relative productivity and other standard determinants— international capital flows and the real interest rate differential are statistically significant long-run determinants of the peso's real exchange rate. The estimations not only tell us whether monetary policy may have played a role in appreciations past, but also whether it could be used to resist them in the future.

The paper is structured as follows. Section 2 decomposes the variations in Mexico's manufacturing RULC into changes in productivity-adjusted real wages and exchange-rate-adjusted relative prices. Section 3 estimates long-run equations for the determination of private investment in Mexico. In Section 4 RULC becomes the dependent variable in a series of long-run equations that test for the significance of capital flows and the real interest rate differential. After the conclusions in Section 5, an Appendix details data sources and definitions.

2 A RULC decomposition

Unit labor costs measure the average labor cost —including wages and other payments to workers— of producing one unit of output. Denoting by C the unit labor cost in dollars in the Mexican manufacturing sector, and by C* the corresponding cost in the US, Mexico's relative unit labor cost (RULC) is simply C/C*. A rise in RULC makes the local manufacturing sector less competitive, and thus it is usually interpreted as a real appreciation of the currency.

Figure 1 shows the evolution of RULC from the onset of trade liberalization in 1985 until 2010. There were two episodes of real appreciation. From 1988 to 1993 —and under an explicitly disinflationary semi-fixed exchange rate regime— RULC increased 67%. The appreciation reflected a steady rise in Mexico's own cost while the US one remained constant. As shown in the figure, the appreciation was eliminated in a stroke by the severe peso depreciation that followed the currency crisis of December 1994.

The appreciation resumed in 1997, however, now under a floating exchange rate regime and a renewed process of disinflation. In contrast to the previous episode, this time the appreciation resulted from *both* an increase in Mexico's cost and a decrease in the US one. The appreciation trend weakened —but was not reverted— after 2001–02, as disinflation in Mexico practically ended (see Ramos-Francia and Torres 2005, Chiquiar et al. 2007, Ibarra 2008). The net result was that by 2007, at the onset of the Great Recession, RULC was 81% higher than in 1996, and 64% higher than in 1988.

(Figure 1)

In contrast to alternative measures (see Chinn 2006, Felipe and Kumar 2011, Lebrun and Pérez 2011), RULC allows decomposing real exchange rate variations into changes in productivity-adjusted real wages and exchange-rate-adjusted relative prices. The distinction may be important. In the first case, the real appreciation of the currency would imply a shift in the functional distribution of domestic income toward labor, or the opposite shift abroad; in the second case, the appreciation would result from a misalignment of the currency with respect to manufacturing prices, a misalignment that could be linked to developments in the assets market in general and to the stance of monetary policy in particular.

More specifically, RULC can be decomposed as,

$$(1) \qquad \frac{C}{C^*} = \frac{W/SY}{W^*/Y^*} = \left\{\left(\frac{W}{PY}\right) / \left(\frac{W^*}{P^*Y^*}\right)\right\}\left\{\frac{P}{SP^*}\right\},$$

where W and W* are the Mexican and US nominal wages (including other payments to labor), S is the nominal exchange rate (pesos per dollar) and thus W/S is the Mexican wage in dollars, Y and Y* are indices of Mexican and US labor productivity, P is the value-added deflator in the Mexican manufacturing sector, and P* is the US industrial producer price index (industrial commodities less fuel).

While the ratio after the first equal sign shows the calculation carried out by the original source, the ratios after the second one represent a possible decomposition of RULC (see van Ark et al. 2005). They show that RULC may rise because of (a) an increase in the productivity-adjusted real wage in the Mexican manufacturing sector, W/PY, in relation to the US one, and (b) an increase in Mexican manufacturing prices in relation to the exchange-rate-adjusted US prices, P/SP*.

Considering the entire post-liberalization period, RULC was 64% higher in 2007 than in 1988, as mentioned above. The increase in RULC took place despite a *reduction* of 34% in the productivity-adjusted real wage in Mexico, which resulted from a much smaller increase in the real wage (63%) than in labor productivity (147%) (see Table 1 and Figures 2 and 3). The reduction in the productivity-adjusted real wage implies that the share of labor in manufacturing income fell during the post-liberalization period.

(Table 1, Figures 2 and 3)

The reduction in the productivity-adjusted real wage was not reflected in lower relative costs, however, because of the (more than) offsetting influence of the other two factors in equation (1). First, there was an increase of 31% in Mexico's relative manufacturing prices, P/SP*, which reveals a failure of the nominal exchange rate to offset the inflation gap between P and P*. Second and similarly to what happened in Mexico, in the US there was a fall in the manufacturing productivity-adjusted real wage (see Taylor 2010, Levy and Kochan 2011). But while the adjusted real wage fell in Mexico in about 34%, in the US it did it in 47%. The net outcome was an *increase* of about 25% in the relative productivity-adjusted real wage in Mexico.

The decomposition results underline one disadvantage of following a growth strategy so heavily oriented toward the foreign sector —as done by Mexico— and therefore so sensitive to the real exchange rate situation. Because of the significant lag of the real wage in the US, the large reduction in the productivity-adjusted real wage in Mexico was not enough to avoid an increase in RULC. To stabilize RULC, offsetting both the accumulated inflation differential and the rise in the productivity-adjusted relative real wage, in 2007 the nominal exchange should have been much higher (64%) than it actually was.

3 RULC and private investment

Since it focuses on the manufacturing sector, and on the labor component of cost only, it could be wondered whether variations in RULC are *macroeconomically* important. An affirmative answer may be expected from the increasing dependence of Mexico's economic growth on the dynamism of manufacturing exports. But in addition to its effect on exports, RULC could be more generally an indicator of relative profitability in the (capital-intensive) tradable sector, and therefore of the incentive to invest (see Hinkle and Nsengiyumva 1999).

This section presents estimations of an equation for private investment (fixed capital formation by the private sector) in Mexico. The question is whether RULC has a *direct* effect on investment. Thus, in addition to the standard determinants described below (see for example Peltonen 2011), the estimations control for industrial production and manufactured exports — both to capture the accelerator effect on investment and to account for the real exchange rate's indirect effects. The period under analysis runs from 1988Q1 to 2008Q2, leaving out the effects of the Great Recession. In a final specification, however, the sample is extended to 2009Q4.

Rather than the possible significance of transitory, short-run impacts, the estimations seek to establish the existence of persistent, "long-run," or "level" effects on private investment, using for that purpose the bounds testing approach of Pesaran et al. (2001). The approach's increasing popularity stems in part from its flexibility, and in particular from its ability to combine in the estimation both $I(0)$ and $I(1)$ variables —in contrast to alternative approaches that require variables with the same order of integration. The only restriction is that the variables are at most

$I(1)$, a restriction that is satisfied by the variables considered in this and the following section (see Table 2).

A further advantage is that, being single-equation, the bounds testing approach works well with the relatively short samples available for macroeconomic studies. In addition, by including lags of all the variables in the model, it takes into account the possible endogeneity of regressors (see Pesaran and Shin 1998). Given the presumed endogeneity of most macroeconomic variables, this is a strong point. Indeed, previous work with macroeconomic series from Mexico shows that the long-run coefficients obtained from the bounds testing approach are similar to those yielded by simultaneous-equation procedures such as the cointegrated VAR approach (see Ibarra 2011d).

(Table 2)

The bounds testing approach proceeds in three steps. The first step estimates an Autoregressive Distributed Lag (ARDL) model of the form,

(2) $$\Delta PI_t = \sum_{j=1}^{n} a_j \Delta PI_{t-j} + \sum_{i=1}^{k} \sum_{j=0}^{n} b_{i,j} \Delta Q_{i,t-j} + \sigma PI_{t-1} + \sum_{i=1}^{k} d_i Q_{i,t-1} + d_0,$$

where PI stands for private investment, there are k potential determinants Q_i —including RULC— and the number of lags is conventionally determined by the Akaike criterion.

While the ARDL model is set up in first differences (Δ), the right side of the equation also includes the level of the lagged variables, whose coefficients are used to retrieve the long-run equation, as explained below. The σ coefficient measures the speed of adjustment of PI toward its long-run equilibrium value, with the latter defined in equation (3) below. For a meaningful relationship to exist, the estimated value of σ must be negative.

In this first step, standard diagnostics are used to explore the statistical adequacy of the model. Once statistical adequacy has been established, the second step tests for the existence of a long-run relationship. There are two possible tests. The first is a *t*-test on the significance of σ. Pesaran et al. (2011) present two sets of asymptotic critical values: the lower values that are valid under the assumption that all variables are $I(0)$, and the upper values (the upper bound of the test) that are valid when all variables are $I(1)$. For the level relationship to be established without ambiguity, the absolute value of the *t*-statistic must lie above the upper bound. In that case the existence of a level relationship can be accepted whether variables are $I(0)$, $I(1)$, or a combination.

The second is an *F*-test for the significance of the level coefficients, under the null that σ and the d_i coefficients in equation (2) are jointly equal to zero. For this particular test, Narayan (2005) calculated small-sample critical values for up to 80 observations and a maximum of k=7 regressors. Again, a significant relationship can be unambiguously accepted when the *F*-statistic lies above the upper critical bound.

Finally, once the existence of a level relationship has been established, the lag structure of the estimated ARDL model can be simplified, in particular by removing the longest non-statistically significant lags. After the simplification, the long-run coefficients can be retrieved as $\delta_i = -d_i/\sigma$, leading to the long-run equation,

(3) $$PI_{LR} = \delta_0 + \delta_1 Q_1 + \delta_2 Q_2 + \cdots + \delta_k Q_k.$$

According to Akaike, the equations of this section were estimated with three lags. They also included a 0–1 dummy for the post-Tequila crisis period, which revealed a persistent fall in investment following the crisis —even after controlling for economic activity levels, total capital flows, the cost and availability of credit, and RULC. To improve the results, RULC was lagged one year, which indicates that the direct effect of the real exchange rate on investment takes some time to materialize.

The estimation results are shown in Table 3. Column (1) starts with a simple specification that includes the industrial production index (IPI), government investment (GI), and RULC. Since the variables are measured in natural logs, their estimated coefficients can be interpreted as elasticities. Despite its simplicity, the equation shows satisfactory diagnostics. Adjustment is fast (0.48), and the two bounds tests support the existence of a long-run relationship. Moreover, the long-run error from this initial equation is stationary, which also supports the existence of a long-run relationship.

There is, according to the industrial production coefficient, a significant accelerator effect on investment. The negative coefficient on government investment, on the other hand, indicates a predominance of substitution effects —perhaps because of the retreat of government investment during the period and the privatization of economic activity (see also Pérez 2004). The result contrasts with estimations for the pre-1988 period, when the government participated more heavily in the economy and there was evidence of complementary with private investment (see Ramírez 1994).

(Table 3)

RULC shows a negative, highly significant coefficient, indicating that a rise in Mexico's relative cost has a negative effect on private investment. This is a *direct* effect, in addition to the indirect one that the appreciation may have via industrial production (see Ibarra 2010 and 2011c for estimations of the latter effect). Since the RULC effect could also be explained by its influence on exports (which may have an effect on investment beyond that captured by the industrial production index), manufacturing exports in real dollars were added to the specification shown in column (1). The estimated coefficient was positively-signed, as expected, but not statistically significant. More importantly, the addition of exports left the original results, including the RULC coefficient, practically unaffected (results available upon request).

To further explore the robustness of the RULC effect, the remaining columns in Table 3 include additional determinants of investment. First, column (2) adds the capital account balance (CAP), from the balance of payments, as an indicator of total capital flows to Mexico. The balance is expressed as a percentage of GDP measured at purchasing power parity (PPP). The estimated coefficient on the new variable has the expected positive sign, indicating that higher capital inflows tend to increase private investment. This may reflect a relaxation of the external constraint on domestic expenditure. Since the effect may be channeled through improvements in the cost or availability of credit, the next columns replace capital inflows with more direct indicators of domestic credit.

Column (3) adds, as a percentage of GDP, the broad money supply M2, a variable conventionally interpreted as a ready indicator of credit availability (see Ibarra 2011c for the difficulties in trying to use a more direct measure of credit to the private sector in an investment equation for Mexico). Next, column (4) adds the separate components of the real interest rate, namely, the nominal interest rate (NIR) on 91-day Mexican Treasury bills and the annual inflation rate (INF), both in percentage. The coefficients on the new variables have the expected sign, indicating that a decrease in the nominal interest rate or an increase in broad money or the inflation rate all tend to raise private investment. The coefficient on M2 remains significant after adding the real interest rate, which suggests the existence of a credit channel on investment.

The absolute size of the inflation coefficient is smaller than that on the nominal interest rate (see the Wald tests in the table). The reason may be that a reduction in the inflation rate has a negative effect on investment via the real interest rate, which however is partially offset by perceptions of greater financial and macroeconomic stability. The latter effect may be particularly relevant in Mexico’s case, in light of the country’s traumatic experience with inflationary surges.

While the estimated coefficients in column (4) are all correctly signed, the RESET test suggests the existence of specification error. To deal with this problem, the same specification was tried on a sample extended to the last quarter of 2009 —that is, including the effects of the Great Recession. As can be seen (column 5), the estimated value and significance of the coefficients remain basically unchanged, while now all the diagnostic tests are satisfactory.

In all cases, the addition of new regressors leaves the sign and statistical significance of the RULC coefficient unaffected, while its absolute value tends to increase in relation to the initial, simple specification (column 1). Thus, a persistent rise in Mexico's relative unit labor cost can have multiple negative effects on private investment, not only indirectly through manufacturing exports and production, but also directly, as measured by the estimated RULC coefficient.

The above result sheds light on the question of whether the appreciation of the peso reflects currency misalignment, or instead an equilibrium adjustment to changes in relative productivity. If the appreciation reflected an improvement in productivity, and hence profitability, we should observe a *positive* effect on investment. If the appreciation represents currency misalignment, in contrast, there will be a negative effect on profitability and private investment —which is the result consistently yielded by our estimations.

4 Capital flows, monetary policy, and RULC

As mentioned in the Introduction, the upward trend in RULC significantly weakened after the strongest phase of disinflation ended in Mexico in 2001–02. The decomposition analysis in Section 2 showed that, speaking of proximate determinants, the increase in RULC arose not from an overly expansive real manufacturing wage —which in fact lagged behind productivity— but in part from an increase in the exchange-rate-adjusted relative manufacturing prices. Finally, the econometric estimations in Section 3 showed that the increase in RULC had a negative effect on private investment, suggesting the existence of an adverse profitability effect.

Together, the above observations suggest that the increase in RULC may be partly explained by developments in the assets market, and in particular by the restrictive bias of monetary policy and the behavior of capital inflows: not only did the increase in RULC closely follow the disinflationary path of the Mexican economy, but the two appreciation episodes took place as foreign capital inflows surged in the country (see Figure 4).

(Figure 4)

This section presents econometric estimations that test the significance of capital flows and monetary policy —as measured by the peso–dollar real interest rate differential— in the determination of RULC. Following again the bounds testing approach, the long-run equation to be estimated takes the general form,

(4) $$RULC_{LR} = \varepsilon_0 + \varepsilon_1 Z_1 + \varepsilon_2 Z_2 + \cdots + \varepsilon_k Z_k$$

where the long-run level of Mexico's relative unit labor cost is a function of k potential determinants Z_i.

The estimations consider three sets of possible determinants. A first set, related to real-side variables, comprises the international price of oil in real dollars (OIL, or alternatively the country's terms of trade index, TOT), relative government consumption —as a share of GDP— between Mexico and the US (GOVR), and relative industrial production between the same countries (IPR). IPR, intended to capture the Balassa–Samuelson effect, is interpreted here as a broad indicator of relative productivity in the tradables sector.[1]

While relative government consumption is measured in percentage, the remaining variables are in natural logs. The variables are included following standard theory, which suggests that a rise in relative productivity in the tradables sector, in the country's terms of trade index (which in Mexico's case closely tracks the real price of oil), or in government consumption (which is biased toward non-tradable goods) require a real appreciation of the currency to reestablish macroeconomic equilibrium.

The second set of determinants consists of the components of the real interest rate differential between peso and dollar assets, namely, the nominal interest rate on peso Treasury

[1] Relative labor productivity cannot be included in the estimations because that would create a built-in correlation between the regressor and dependent variable.

bills (NIR), the nominal US Federal funds rate (FED), and the inflation differential between Mexico and the US (INFD), all in percentage. An increase in the US interest rate or in the inflation differential raises the expected return on dollar assets, which should discourage the demand for peso assets, depreciate the peso, and reduce RULC. An increase in the peso interest rate should have the opposite effect.

The real interest differential is widely used in estimations of the so-called behavioral equilibrium exchange rate (BEER) model, which seeks to combine real-side and monetary variables in the determination of the real exchange rate (see Clark and MacDonald 1998, MacDonald 2007). BEER estimations, however, typically impose the restriction that the interest differential affect the real exchange rate only in the short run—which is ensured by restricting the differential to have only "first-difference" but not "level" effects on the real exchange rate. Our estimations do not impose such an a priori restriction.

The exchange rate and interest rate may interact in complex ways. Besides the effect just described, both variables may be affected by a third, non-observable one —a shift in investor preferences, for example (see Blanchard et al. 2010). In addition, there may be reverse causality, as the central bank may show "fear of floating" (or lean against the wind) and raise interest rates in response to currency depreciation (see Calvo and Reinhart 2002, Galindo and Ros 2008, Ibarra 2008). In both cases the interest rate and nominal exchange rate would move in the same direction, yielding a negative interest rate coefficient in the RULC equation. In contrast, if the estimation picks up the effect of monetary policy on the exchange rate —with for example a tighter policy stance raising the interest rate and appreciating the currency— then the interest rate coefficient should be positive. The sign of the estimated coefficient thus helps in establishing whether monetary policy has had a significant, persistent effect on the exchange rate.

The final set of determinants consists of international capital flows. Recent research shows that the effect of capital flows on the real exchange rate may depend on their type, and in particular that FDI may have a smaller appreciation effect —or even a *depreciation* effect— in comparison with foreign loans and portfolio investment (see Athukorala and Rajapatirana 2003, Bakardzhieva et al. 2010, Saborowski 2010, Combes et al. 2011). For that reason, rather than including it as a single variable, the capital account balance in the following estimations is decomposed into FDI, foreign portfolio investment, foreign bank loans, and domestic capital inflows —all measured as a percentage of GDP at PPP. Regardless of type, a larger inflow raises the demand for peso assets and is expected to appreciate the peso and increase RULC.

The estimations also include the accumulation of international reserves at the central bank (RAC). Reserve accumulation reduces the supply of dollar assets to the private sector and may thus depreciate the peso and reduce RULC (a portfolio-balance effect). If not fully sterilized, however, reserve accumulation will additionally affect liquidity conditions in the domestic market, affecting the exchange rate via the interest rate.

Like those from the previous section, the estimations here are based on quarterly series from 1988 until mid-2008, thus leaving out the impact of the global financial crisis on Mexico's exchange rate. Following Akaike, the ARDL models were estimated with one lag. To pass the residual normality test, they include several 0–1 dummies that mainly single out episodes of financial turbulence.

Table 4 presents the estimated equations. Column (1) starts with a simple specification that includes only the real-side determinants. Despite its simplicity, the equation satisfies all the diagnostic tests. The coefficients on relative industrial production and the oil price have the expected positive sign, indicating that those variables tend to increase Mexico's relative unit labor cost. The equation is not entirely satisfactory, though, in that the coefficient on government consumption has an unexpected negative sign. In addition, the existence of a level relationship is (barely) accepted only at 5% of significance, while the presence of a unit root in the long-run error can be rejected only at 10%.

(Table 4)

Column (2) adds the components of the real interest rate differential. To obtain better results, the equation included an interaction of the peso interest rate and the inflation differential with a 0–1 dummy variable for the transition period from very high to moderate inflation in Mexico, 1988Q1 to 1989Q4. Including the real interest differential clearly improves the estimation results, both in the diagnostics and in the statistical significance of the long-run relationship. The size of the estimated coefficient on relative industrial production increases, the oil price coefficient becomes more significant, and the sign of the coefficient on government consumption shifts to positive.

The coefficients on the new variables show the expected sign, indicating that an increase in either the US dollar interest rate or the inflation differential tends to reduce RULC (that is, to cause a real depreciation of the peso), while an increase in the peso interest rate has the opposite effect. The positive sign of the peso interest rate coefficient is consistent with the existence of a policy effect on the real exchange rate, rather than with reverse causality (fear of floating) or a joint effect from a third variable.

The above results show that, instead of being limited to the short run as sometimes assumed in empirical studies, shifts in the stance of monetary policy can have *persistent* effects on the real exchange rate. Adopting a restrictive policy stance may result in a lasting appreciation of the currency in real terms —with the consequent negative *direct* effects on private investment described in the previous section. Looked at from a different perspective, monetary policy can play a role in supporting a higher rate of economic growth in the medium term. Specifically, a lower interest rate tends to depreciate the currency in real terms, thus favoring higher levels of investment. The depreciation effect may be reinforced *indirectly* by the impact of the interest rate on capital flows, as explained below.

Column (3) momentarily replaces the components of the real interest rate differential with the different types of capital inflows. All the coefficients have the expected positive sign, indicating that higher capital inflows tend to increase Mexico's RULC, while reserve accumulation has the opposite effect. Note that FDI not only has a significant appreciation effect, but also —and somewhat surprisingly— that the effect is stronger than that from portfolio inflows. The difference, which is statistically significant according to a Wald test, obtains in all the different specifications.

Thus, in Mexico, at least during the period under analysis, there is no evidence of a less harmful effect from FDI compared to other types of inflows in causing real currency appreciation—a result that could be explained by the high share of M&As and the service sector in FDI (see Ibarra 2011b). Recent multi-country studies have attributed the lack of a robust link between capital flows and economic growth to the capital flows' appreciation effect (Prasad et al. 2007). In Mexico, the appreciation effect may explain the small "transfer" of capital flows to capital formation —a puzzling observation given the depressed levels of investment inherited from the 1980s (see Trigueros 1998, Ibarra 2011e).

While the estimated coefficients on capital flows in column (3) have the expected sign, the bounds tests tend to reject the existence of a long-run relationship —a surprising rejection, given the statistical significance of each coefficient and the stationarity of the long-run error. If the real interest differential is reintroduced, the bounds tests support again the existence of a long-run relationship while in general the direction and significance of effects is confirmed. The coefficients on foreign loans and relative government consumption, however, are wrongly signed (see column 4).

Thus, in a next step the latter two variables were restricted to enter only the short run segment of the model. The results are presented in column (5). All the estimated coefficients are highly significant and correctly signed, and there is strong support for the existence of a long-run relationship. In the new specification, the interest rate coefficient remains significant, which suggests that the interest rate affects the exchange rate beyond its possible influence on certain types of capital inflows (portfolio investment, for example).[2] Thus, monetary policy can have multiple effects on the exchange rate: directly, as captured in the estimated interest rate coefficient; and indirectly, through variations in interest-rate-sensitive capital inflows.

In a final specification (column 6), the real price of oil was replaced with Mexico's terms of trade index. The TOT coefficient is correctly signed and very significant, while most of the others tend to increase —with the exception noted immediately below. Although they are not entirely satisfactory on account of possible serial correlation and a reduction in the absolute value of the bounds tests' statistics, the results merit some attention. The reason is that including the terms of trade index instead of the oil price reinforces a fall in the reserve accumulation coefficient that already could be seen in columns (4) and (5) —which include the interest rate differential— when compared to column (3) —which does not. In fact, in column (6) reserve accumulation shows no statistical or economic significance.

The result suggests that the effect of reserve accumulation on the exchange rate initially captured in column (3) may be explained, not by the reduction in the supply of dollar assets itself (a portfolio-balance effect), but by its impact on domestic liquidity and interest rates. An important question is whether this implies that reserve accumulation *cannot* have portfolio-

[2] The reason may be that changes in the interest rate are absorbed partly by adjustments in quantities (capital flows) and partly by prices (the exchange rate), or it may be that interest rate changes affect expectations about future levels of asset prices that feed into current ones.

balance effects in Mexico. The answer is, not necessarily. Reserve accumulation in the country has mostly reflected off-the-market operations between the central bank and the public sector —including the state oil company, PEMEX (see Adler and Tovar 2011). It would require further study (and perhaps a richer experience than the available) to determine whether *market* intervention by the Bank of Mexico can have persistent effects on the real exchange rate.

5 Conclusions

Most analyses of the barriers to faster economic growth in Mexico center on proposals to pursue new reforms that seek to increase the level of competition in specific markets (see for example any recent country report by the IMF or OECD). While the reforms may be welcome on efficiency grounds, their effect on medium-term growth is more open to doubt, particularly as the historic record suggests that sustained, fast economic growth may require a more direct intervention by the government (see Rodrik 2011). Meanwhile, and with counted exceptions (see for example Ros 2009 and Ize 2010), discussions of the possible role of macroeconomic policy in supporting faster growth are mostly limited to recommendations to balancing the budget and reducing inflation.

The present paper offered empirical evidence based on Mexico's post-liberalization experience that suggests a role for monetary policy in stimulating higher levels of investment and therefore faster growth in the medium term. In a first strand of evidence, the paper showed that private investment responds significantly to the real exchange rate —with the latter measured by the relative unit labor cost (RULC) in the manufacturing sector between Mexico and the US.

More specifically, there is a *direct* effect of RULC on private investment, in addition to the *indirect* effects that may take place through manufacturing exports and production.

By their effect on private investment, sustained variations in RULC may be macroeconomically important in the medium term. Following liberalization, Mexico may have fallen into a trap. The real wage in the manufactures has lagged behind productivity, a lag that tends to redistribute income away from labor and depress domestic demand. Demand growth thus depends on the dynamism of exports. But, because of the currency misalignment, the fall in the productivity-adjusted real wage has not been reflected in a more competitive RULC —which otherwise could spur higher rates of investment, economic growth, and employment, eventually eliminating the real-wage lag and shifting the source of aggregate demand growth to the domestic market. The economy may thus be trapped in a low equilibrium characterized by a strong currency, a depressed domestic market, and slow economic growth.

Monetary policy may play a role in escaping from the trap. A second strand of econometric evidence in the paper showed that, through changes in the peso–dollar interest rate differential, monetary policy can have a persistent effect on RULC. The effect is significant after controlling for real-side determinants, but also after controlling for capital flows. Thus, a reduction in the interest rate differential may affect RULC both directly and indirectly —in the latter case, to the extent that the lower interest differential may discourage some forms of capital inflows.

The above conclusions may be particularly relevant because (a) the slow economic growth and low interest rates prevalent in developed countries may encourage large inflows of capital to Mexico, a possibility that raises the risk of real currency appreciation, and (b) recent research shows that the "transfer" of capital inflows to investment in the country has been weak, in part because as capital flows in, the currency appreciates (see Ibarra 2011e). A more active, growth oriented stance of monetary policy may be required to finally achieve fast economic growth in Mexico.

Appendix. Data definitions and sources

Capital account balance, **CAP**: Percentage ratio of the capital account balance, in current US dollars, to quarterly GDP. GDP corresponds to the nominal GDP in pesos, divided by the nominal exchange rate calculated at purchasing power parity (PPP). Source: Bank of Mexico (BOM) for balance of payments data, Mexico's National Institute of Statistics (INEGI) for nominal GDP, and author's calculations of the PPP exchange rate.

Domestic capital inflow, **DOC**: Percentage ratio of the net inflow of domestic (Mexican) capital, in current US dollars, to quarterly GDP. See CAP for sources and further explanation.

Foreign direct investment, **FDI**: Percentage ratio of the net inflow of foreign direct investment, in current US dollars, to quarterly GDP. See CAP for sources and further explanation.

US Federal funds interest rate, **FED**: Quarterly average of the monthly series of the annualized nominal Federal funds effective rate in the US, in percentage. Source: US Federal Reserve.

Foreign portfolio investment, **FPI**: Percentage ratio of the net inflow of foreign portfolio investment, in current US dollars, to quarterly GDP. Portfolio investment, following BOM's definition, includes investment in the money and stock markets, and securities issued abroad. See CAP for sources and further explanation.

Government investment, **GI**: Natural log (times 100) of government investment (gross fixed capital formation), in real pesos. Source: National Accounts data from INEGI.

Relative government consumption, **GOVR**: Ratio of government consumption between Mexico and the US (multiplied by 100). Government consumption in each country was calculated as a proportion of GDP, using real, seasonally adjusted data. Source: National Accounts data from the US BEA and INEGI.

Inflation rate, **INF**: Annual variation of the consumer price index, in percentage. The quarterly CPI series corresponds to the average of the original monthly series. Source: BOM.

Inflation differential, **INFD**: Difference between the Mexican and US inflation rates, in percentage points. The inflation rate equals the 4-quarter variation rate in the quarterly average of the monthly consumer price indices. Source: BOM and US BLS.

Industrial production index, **IPI**: Natural log (times 100) of the industrial production index. The quarterly series corresponds to the average of the original seasonally-adjusted monthly series. Source: INEGI.

Relative industrial production index, **IPR**: Natural log (times 100) of the ratio of the industrial production index between Mexico and the US. The ratio was calculated with quarterly averages of the original seasonally-adjusted monthly data. Sources: US Federal Reserve and INEGI.

Foreign bank loans, **LOAN**: Percentage ratio of the net inflow of foreign bank loans and deposits, in current US dollars, to quarterly GDP. See CAP for sources and further explanation.

Broad money supply, **M2**: Percentage ratio of nominal M2, BOM's definition, to the annualized nominal GDP. Nominal M2 corresponds to the quarterly average of the original end-of-month series. Source: BOM and INEGI.

Nominal interest rate, **NIR**: Quarterly average of the monthly series of the annualized nominal interest rate on 91-day Mexican Treasury bills (CETEs), in percentage. Source: BOM.

Oil price, **OIL**: Natural log (times 100) of the international price of oil, deflated by the US producer price index. The international price of oil corresponds to the simple average of the spot quotations of Dated Brent, West Texas Intermediate, and Dubai Fateh, in US dollars per barrel. The real price was calculated with quarterly averages of the original monthly series. Source: IMF and US BLS (for the producer price index).

Private investment, **PI**: Natural log (times 100) of private investment (gross fixed capital formation), in real pesos. Source: National Accounts data from INEGI.

Reserve accumulation, **RAC**: Percentage ratio of the quarterly variation in international reserves, in current US dollars, to quarterly GDP. See CAP for sources and further explanation.

Relative unit labor cost, **RULC**: Natural log (times 100) of the relative unit labor cost in the manufacturing sector between Mexico and the US. For both countries, the original monthly seasonally-adjusted unit labor cost series, in dollars, were taken from INEGI. Quarterly data before 1989 were intrapolated from the available annual series, using the quarterly pattern observed in 1989–1991.

Terms of trade index, **TOT**: Natural log (times 100) of Mexico's international terms of trade index (exports to imports). Source: BOM.

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Table 1. RULC decomposition

Selected ratios and periods

	1993/1988	2007/1996	2007/1988
Mexico's unit labor cost, C	1.69	1.43	1.27
US unit labor cost, C*	1.01	0.79	0.77
Relative unit labor cost (RULC), C/C*	1.67	1.81	1.64
Relative manufacturing prices, P/SP*	1.28	1.30	1.31
Mexico's productivity-adjusted real wage, W/PY	1.19	0.89	0.66
US productivity-adjusted real wage, W*/P*Y*	0.91	0.64	0.53
Productivity-adjusted relative real wage, (W/PY)/(W*/P*Y*)	1.31	1.38	1.25

Source: Author's calculations with data from INEGI, Bank of Mexico, and US BLS. See equation (1) in main text.

Table 2. Unit root tests

1988Q1-2008Q2, 82 observations

	Augmented Dickey-Fuller		Phillips-Perron	
	Level	First difference	Level	First difference
Capital account balance, CAP	-2.60 *	-9.21 ***	-6.54 ***	-26.21 ***
Domestic capital outflow, DOC	-5.24 ***	-7.71 ***	-9.90 ***	-44.99 ***
Foreign direct investment, FDI	-1.75	-7.95 ***	-6.06 ***	-33.60 ***
US Federal funds interest rate, FED	-2.40	-3.27 **	-1.76	-3.37 **
Foreign portfolio investment, FPI	-4.23 ***	-9.77 ***	-5.46 ***	-13.14 ***
Government investment, GI	-1.07	-6.03 ***	-7.81 ***	-25.17 ***
Relative government consumption, GOVR	-1.54	-6.83 ***	-2.62 *	-15.85 ***
Inflation rate, INF	-4.84 ***	-4.34 ***	-4.67 ***	-4.71 ***
Inflation differential, INFD	-4.83 ***	-4.28 ***	-4.62 ***	-4.71 ***
Industrial production index, IPI	-1.34	-6.01 ***	-1.20	-4.96 ***
Relative industrial production, IPR	-3.14 **	-5.68 ***	-2.34	-5.37 ***
Foreign loans, LOANS	-4.66 ***	-9.97 ***	-7.40 ***	-24.14 ***
Broad money supply, M2	-0.57	-4.76 ***	-0.58	-24.44 ***
Nominal interest rate, NIR	-4.80 ***	-9.08 ***	-5.20 ***	-9.58 ***
Oil price, OIL	0.11	-4.78 ***	0.19	-8.05 ***
Private investment, PI	-1.08	-3.83 ***	-1.36	-17.85 ***
Reserve accumulation, RAC	-4.94 ***	-6.13 ***	-7.90 ***	-43.89 ***
Relative unit labor cost, RULC	-2.68 *	-3.40 **	-2.16	-8.91 ***
Terms of trade index, TOT	-0.45	-6.19 ***	-1.49	-10.11 ***

*** (**) [*]: The unit root hypothesis is rejected at 1% (5%) [10%].

The ADF tests include intercept, with lag length determined by Akaike (maximum lag of 4). The PP tests include intercept, with Bartlett kernel and Newey-West bandwidth. Both sets of tests use MacKinnon critical values.

Table 3. Investment equations

Dependent variable: Private investment, PI
Long-run coefficients from error-correction ARDL model
OLS estimation, sample 1988Q1-2008Q2, 82 observations

	(1)	(2) a/	(3)	(4)	(5) b/
Speed of adjustment, σ	-0.478	-0.412	-0.479	-0.501	-0.514
Lagged RULC	-0.32 (0.00)	-0.46 (0.00)	-0.34 (0.00)	-0.42 (0.00)	-0.39 (0.00)
Industrial production index, IPI	3.28 (0.00)	3.33 (0.00)	2.86 (0.00)	2.66 (0.00)	2.77 (0.00)
Government investment, GI	-0.17 (0.04)		-0.31 (0.00)	-0.26 (0.01)	-0.26 (0.00)
Capital account balance, CAP		0.60 (0.03)			
Broad money supply, M2			1.32 (0.04)	1.16 (0.04)	1.00 (0.01)
Nominal interest rate, NIR				-0.49 (0.00)	-0.42 (0.01)
Inflation rate, INF				0.24 (0.00)	0.23 (0.01)
Adjusted R-sq	0.898	0.899	0.904	0.930	0.912
Jarque-Bera	0.09 [0.96]	0.26 [0.88]	0.16 [0.92]	0.95 [0.62]	0.15 [0.93]
Breusch-Godfrey	0.93 [0.46]	0.79 [0.54]	0.88 [0.48]	1.34 [0.27]	1.63 [0.18]
ARCH	1.39 [0.24]	1.59 [0.21]	0.50 [0.48]	0.21 [0.65]	0.01 [0.92]
RESET	0.94 [0.34]	0.49 [0.49]	1.11 [0.30]	9.66 [0.00]	0.28 [0.60]
Bounds t-stat	-4.30 **	-4.28 **	-4.74 ***	-3.56 #	-3.06 #
Bounds F-stat	18.98 ***	17.91 ***	16.63 ***	7.53 ***	7.06 ***
Unit root tests on long-run error:					
- Augmented Dickey-Fuller	-3.91 [0.00]	-3.23 [0.02]	-2.94 [0.05]	-4.88 [0.00]	-4.86 [0.00]
- Phillips-Perron	-3.62 [0.00]	-4.59 [0.00]	-5.39 [0.00]	-4.94 [0.00]	-4.87 [0.00]
Wald NIR=-INF				5.61 [0.02]	3.01 [0.09]

1) For illustrative purposes, *p*-values for the d_i coefficientes from equation (3) (see main text) are shown in parenthesis next to the long-run coefficients.
2) Following Akaike, initially all the equations included three lags in the first-differenced variables. All the equations include a 0-1 dummy for the post-Tequila crisis period (1995Q1-2008Q2).
3) Diagnostics: The null hypotheses are that residuals are normally distributed (Jarque-Bera), and that there is no serial correlation of up to 4th order (Breusch-Godfrey), no ARCH errors, and no mis-specification error (Ramsey's RESET). χ^2 (Jarque-Bera) and *F*-statistics with *p*-values in brackets.
4) Bounds testing: *** (**) [*] The test statistic lies above the upper bound at the 1% (5%) [10%] significance level.
The test statistic falls between the upper and lower bound at 5%.
The *t*-test uses the asymptotic critical values from Pesaran et al. (2001), while the *F*-test uses the small-sample critical values from Narayan (2005), for n=80 observations.
5) Unit root tests on long-run error: The ADF tests include intercept, with lag length determined by Akaike (maximum lag of 4). The PP tests include intercept, with Bartlett kernel and Newey-West bandwidth. Both sets of tests use MacKinnon critical values. *t*-statistics with *p*-values in brackets.
6) Wald test: The null is the equality of the estimated coefficients. *F*-statistics with *p*-values in brackets.
a/ The underlying ARDL model includes GI only in its short-run segment.
b/ Sample: 1988Q1-2009Q4, 88 observations.

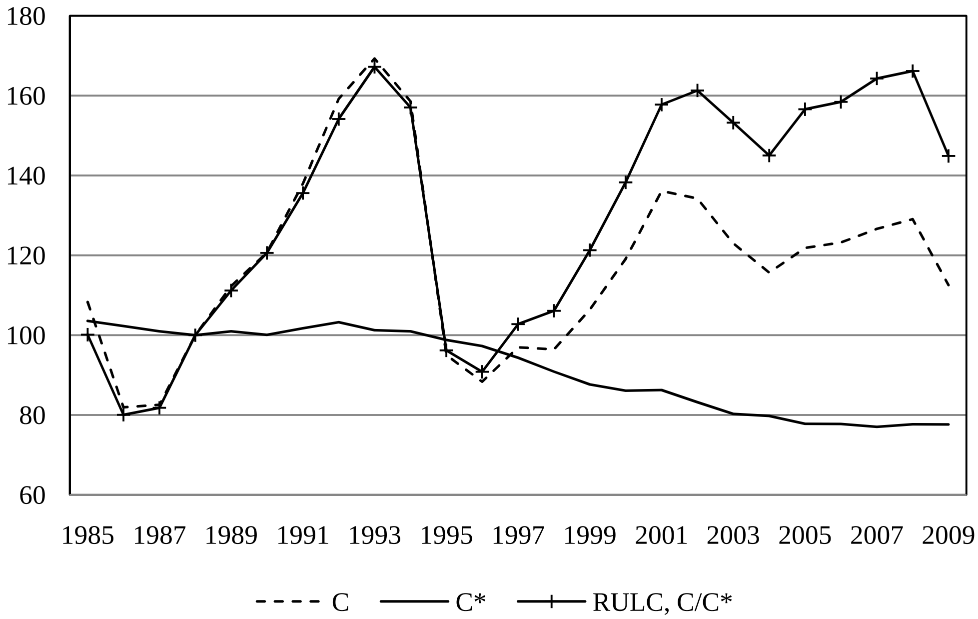
Table 4. RULC determinants

Dependent variable: Relative unit labor cost, RULC
Long-run coefficients from error-correction ARDL model
OLS estimation, sample 1988Q1-2008Q2, 82 observations

	(1)	(2)	(3)	(4)	(5) a/	(6) a/
Speed of adjustment, σ	-0.126	-0.232	-0.213	-0.280	-0.312	-0.239
Industrial production, IPR	2.15 (0.02)	3.19 (0.00)	1.61 (0.02)	3.50 (0.00)	3.48 (0.00)	3.41 (0.00)
Oil price, OIL	0.15 (0.08)	0.15 (0.00)	0.24 (0.00)	0.22 (0.00)	0.24 (0.00)	
Government consumption, GOVR	-1.59 (0.11)	0.60 (0.00)	-1.53 (0.03)	-0.83 (0.10)		
Terms of trade, TOT						1.61 (0.00)
Peso interest rate, NIR		0.72 (0.01)		1.81 (0.00)	1.58 (0.00)	1.80 (0.00)
Dollar interest rate, FED		-1.74 (0.04)		-1.24 (0.17)	-2.03 (0.00)	-1.46 (0.11)
Inflation differential, INFD		-1.61 (0.00)		-2.09 (0.00)	-1.89 (0.00)	-2.13 (0.00)
Reserve accumulation, RAC			-2.64 (0.01)	-0.40 (0.62)	-0.92 (0.07)	-0.05 (0.94)
Domestic capital inflow, DOC			2.27 (0.03)	1.51 (0.05)	1.70 (0.00)	2.01 (0.01)
Foreign direct investment, FDI			3.79 (0.00)	3.07 (0.00)	2.84 (0.00)	3.84 (0.00)
Foreign portfolio investment, FPI			2.03 (0.02)	1.06 (0.08)	1.11 (0.00)	1.91 (0.00)
Foreign bank loans, LOANS			1.75 (0.03)	-1.26 (0.15)		
Adjusted R-sq	0.821	0.921	0.832	0.959	0.957	0.942
Jarque-Bera	1.44 [0.49]	0.39 [0.82]	1.76 [0.41]	1.82 [0.40]	0.76 [0.68]	0.29 [0.87]
Breusch-Godfrey (4)	1.12 [0.36]	0.79 [0.54]	0.59 [0.67]	1.02 [0.41]	1.06 [0.39]	2.58 [0.05]
ARCH	0.10 [0.75]	0.30 [0.59]	0.01 [0.93]	1.29 [0.26]	0.89 [0.35]	1.40 [0.24]
RESET	0.75 [0.39]	0.35 [0.55]	0.45 [0.50]	0.000 [0.99]	1.24 [0.27]	0.02 [0.90]
Bounds t-stat	-4.20 **	-5.62 ***	-4.17 #	-5.49 **	-8.07 ***	-5.98 ***
Bounds F-stat	4.98 **	9.28 ***	2.79 #	12.34 ***	13.66 ***	9.28 ***
Unit root tests on long-run error:						
- Augmented Dickey-Fuller	-2.86 [0.05]	-3.48 [0.01]	-4.38 [0.00]	-5.88 [0.00]	-6.53 [0.00]	-6.32 [0.00]
- Phillips-Perron	-2.73 [0.07]	-6.25 [0.00]	-4.35 [0.00]	-5.99 [0.00]	-6.44 [0.00]	-6.34 [0.00]
Wald FDI=FPI			2.75 [0.10]	8.83 [0.01]	20.3 [0.00]	4.31 [0.04]

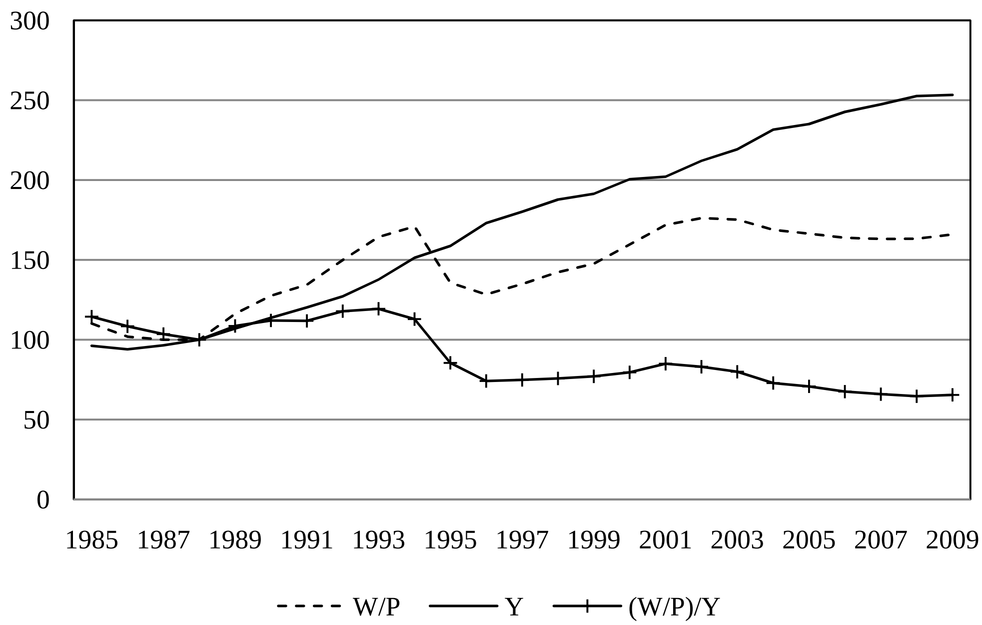
1) For general notes, see Table 3.
2) Following Akaike, initially all the equations included one lag in the first-differenced variables. To pass the normality tests, columns (1) and (3) include 0-1 dummies for the following quarters: 93Q4, 94Q2, 95Q1, 95Q4, and 99Q2. The remaining columns include 0-1 dummies for 93Q4, 94Q2, 95Q1, 03Q1, 04Q2, 06Q2, and 08Q1.
3) Except (1) and (3), all the equations include an interaction of NIR and INFD with a 0-1 dummy for the transition period from high to moderate inflation in Mexico, 1988Q1-1989Q4.
a/ Includes GOVR and LOANS only in the short-run segment of the model.

Figure 1. Manufacturing unit labor costs in Mexico and the US
1985–2009, Indices 1988=100



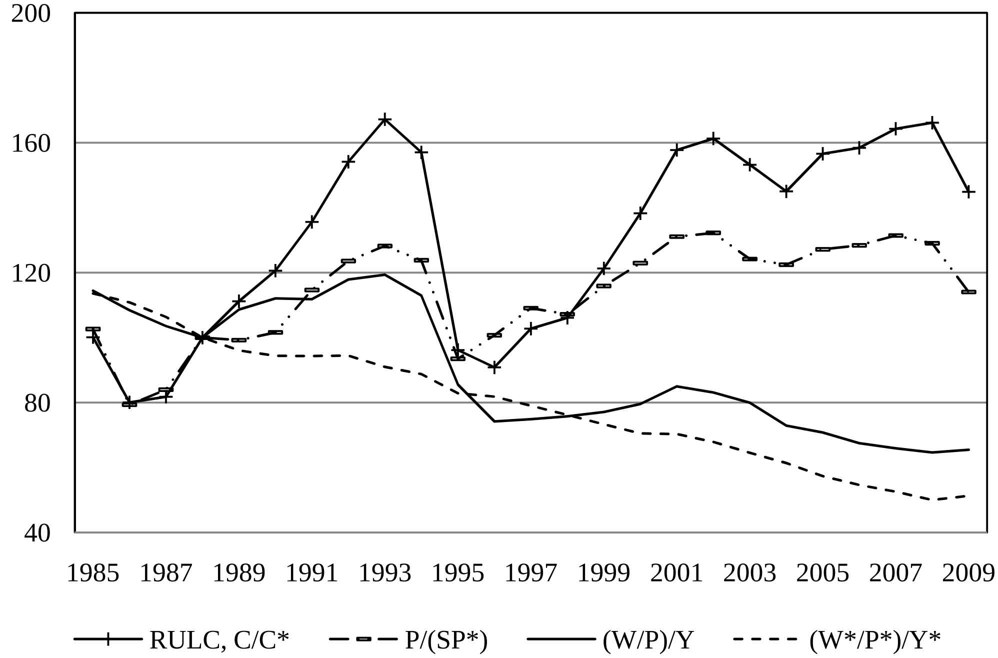
Source: INEGI, Industrial Survey.

Figure 2. Productivity-adjusted real wage in Mexico
1985–2009, Indices 1988=100



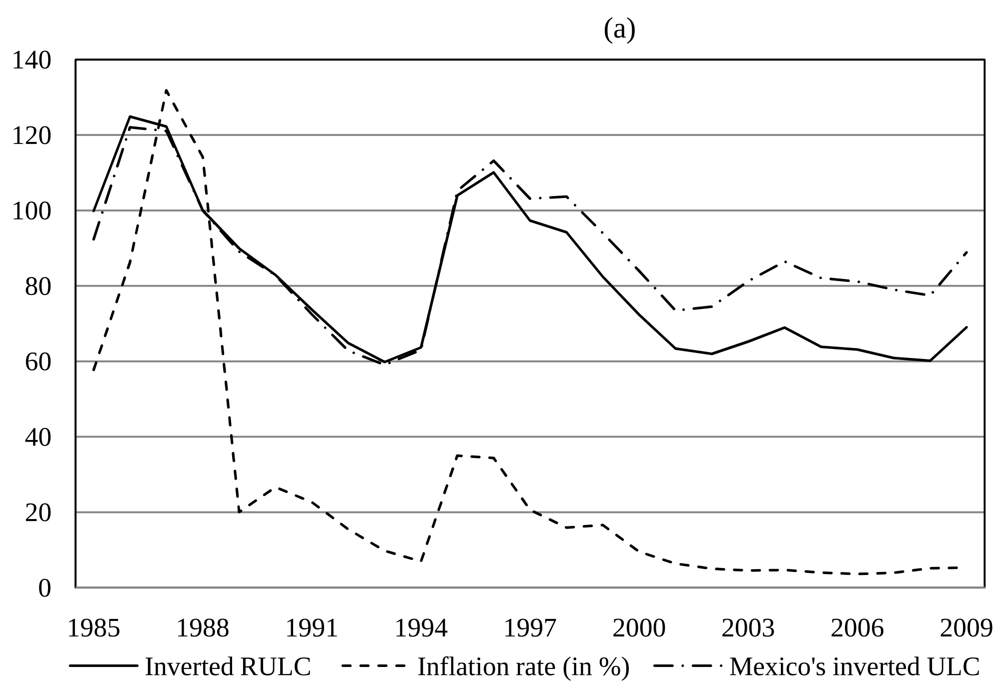
Source: Author's calculations with data from INEGI.

Figure 3. RULC decomposition
1985–2009, Indices 1988=100

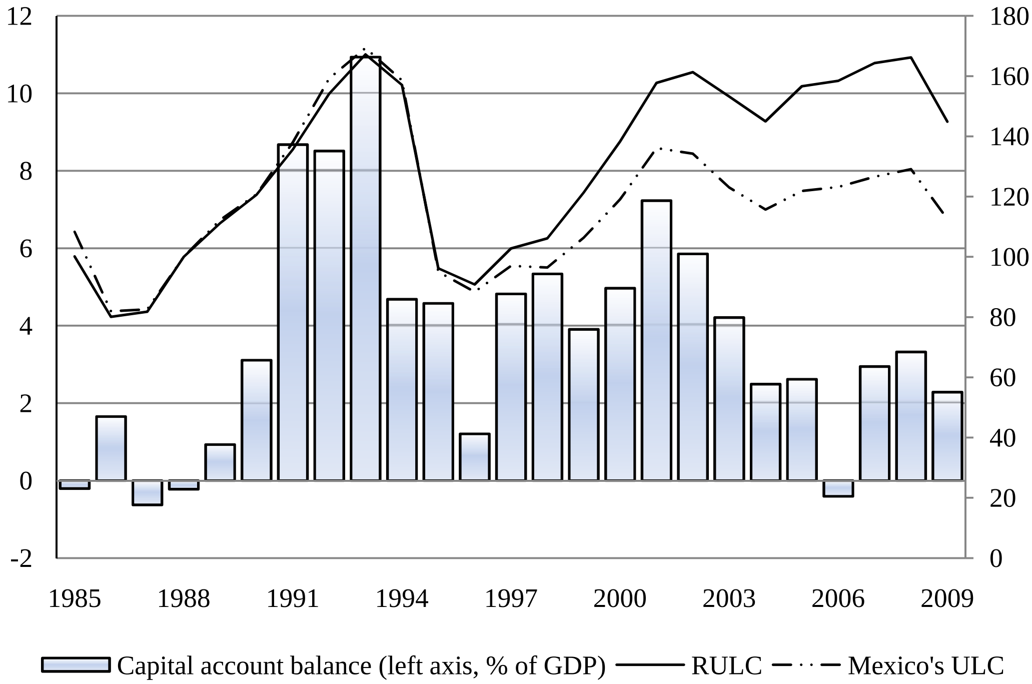


Source: Author's calculations with data from INEGI, Bank of Mexico, and US BLS. See equation (1) in main text.

Figure 4. Mexico: RULC, inflation rate, and capital inflows



(b)



Note: RULC indices: 1988=100.
Source: Author's calculations with data from INEGI and Bank of Mexico.