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The Mexican economy: balance-of-payments–constrained growth model—the importance of the exchange rate, 1970–1999

Abstract: *We argue that the main constraint for the Mexican economy to grow remains inside the structural deficit of the current account as well as in the real exchange rate level. An annual structural econometric model (1970–99) (estimated through weighted two-stage least squares) is estimated to identify the determinants of the four balances that constitute the current account balance. The main objective is to detect only long-run relationships and, consequently, to analyze the sensibility of the overall system to the exchange rate. By doing this, we enforce the introspective features of Thirlwall's Law through what may be called the "extended exchange rate Thirlwall's Law." A detailed analysis of the joint residuals coming out from the structural estimations are performed in order to demonstrate that all the variables involved in the behavioral equations are cointegrated, since they are all "white noise" and normally distributed.*

Key words: *backward dynamic simulation, cointegration, current account (and its balances), external constraint to economic growth (ECG), real exchange rate, structural (long-run) determinants, structural econometrics, sensibility analysis, simultaneous estimation, white noise.*

In the literature of the second half of the twentieth century, there were two main theoretical frameworks—essentially opposed—for the explanation of the long-term economic growth determinants and its limitants. On one hand, the neoclassical approach has stated that it is in the supply-side where

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both explanations meet; specifically in the availability (both quantitative and qualitative) of productive factors and, most of all, in the dynamics of technological progress. The central hypothesis is that, due to the lack of this last factor, the economy will inevitably reach the *steady state.*

On the other hand, the second important approach resides initially in the structuralist (ECLAC) framework,[1] which attributes to the demand factors, specifically to the asymmetries in the elasticities of international trade between developed and developing countries, the determinants and heterogeneity in trade balance position and in economic growth.

According to the industrial backwardness of developing countries and their pattern of exports (raw materials and low value-added products), these countries will have higher income elasticities to import related to developed countries, and, inversely, industrial countries will have higher income elasticities to export regarding the other group of countries.

Therefore, ECLAC and its associates (such as ECLAC, 1957; Myrdal, 1957; Noyola, 1946, 1956a, 1956b, 1958; Pinto, 1991; Prebisch, 1950; Villarreal, 2000), found in this fact the main reason explaining economic structural differences in growth as well as in development.

In the late 1970s, Thirlwall (1995, 1997)[2] formalized this approach and applied it to explain the differences in growth for a group of several, both developed and developing countries.

In the 1990s, Atesoglu (1993–1994, 1995, 1997) used what is now called Thirlwall's Law to understand the performance in growth for several industrialized countries, corroborating the initial ECLAC and Thirlwall arguments.

The present paper is in support of this approach, but due to structural characteristics of the Mexican economy—such as its high external debt servicing and the traditional high exchange rate misalignment (overvaluation)—we argue that in the long run the capability of the Mexican economy to grow resides centrally in the former variable as well as in the current account (CA) balance. This hypothesis is in line with Richards-Elliot and Rhodd (1999).

Particularly since the world debt crisis (1982–88), it is in the growing deficit of the factorial services balance (FSB) in which the permanent deficit of the CA resides. Therefore it is in our interest to analyze the long-term determinants of each of the components of CA. By doing this,

[1] Headed by ECLAC (Economic Commission for Latin America and the Caribbean) and its associates since the late 1940s.

[2] Needless to say, his first contribution on the matter was in the late 1970s (Thirlwall, 1979).

it will enable us to go deeply into the anatomy of the external constraint to growth (ECG).

A second principal objective consists in calculating the importance of the correct management of the real exchange rate as a crucial instrument to reduce the ECG.

To reach these goals, we initially went through a descriptive statistical analysis of CA and its components, and, subsequently, we estimated their structural determinants as well as prices and aggregate demand. For this purpose, we built a simultaneous equation system estimated through weighted two-stage least squares (WTSLS) for 1970–99. By construction, the outcome gives the long-run determinants of the endogenous variables. To prove that the relationships specified in the whole system are cointegrated, namely, that they sustain a stable long-term relationship (not spurious), a detailed analysis of the joint residuals was performed, proving that they are all *white noise* and normally distributed.

A sensibility analysis through dynamic backward simulation was performed to demonstrate that the ECG is not only associated with the elasticities of foreign trade, but also—and not in a refutable manner—with the real exchange rate. This exercise also demonstrates that the whole system is dynamically stable. Finally, an economic policy based mainly on the correct management of the exchange rate—in order to revert or reduce the restriction of the balance of payments of growth—is proposed. Considering the international framework in which the Mexican economy is inserted, this is now the most effective and simplest economic policy to enhance economic growth. Regarding the objective and the context of the article, which only deals with an extension of Thirlwall's Law, we do not analyze either institutional or structural changes that could eventually affect the elasticities of foreign trade. Other kinds of research would be required to accomplish this task.[3]

Analytical framework

The *classic* structuralist approach (ECLAC) of the 1950s–1970s emphasized that international free trade—far from fulfilling the convergence

[3] One of the referees asked that structural—alternative—economic policies be discussed. Even though he or she recognized that it is out of the scope of the article, he or she recommended making some comments on the matter. In this respect, in other work (Arroyo and Guerra, 2000), three long-run prospective scenarios (2000–30) are discussed in detail. Due to the lack of space, I recommend the reader consult it. It is available if required.

properties attributed by the Hecksher-Ohlin-Samuelson model—would take primary goods-exporting countries to an impoverished state, due to the fact that the dynamics of the terms of trade would favor the industrial goods-exporting countries. Thus, it was widely accepted that the Latin American region could only emerge from its economic quagmire if it applied a model of industrialization through imports substitution (IIS), which initially required high protectionism and high state intervention.

The ECG hypothesis took form from the classic structuralist and Post Keynesian theories through Thirlwall's Law (Thirlwall, 1979). The hypothesis argues that, in the absence of capital mobility, and assuming that the real exchange rate remains constant, in the long run, the capability of growth (y) of any economy depends on the ratio of the rate of growth of exports (x) to the income elasticity to import (π).

$$y^e = \frac{x}{\pi}. \tag{1}$$

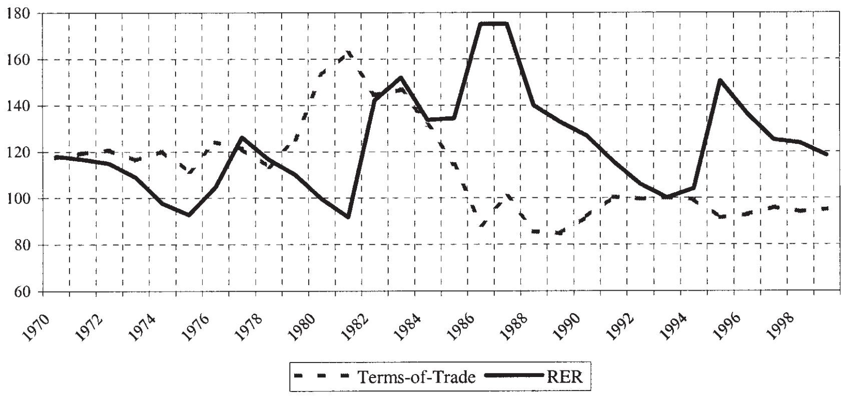
Due to the fact that for technologically dependent (namely, developing) economies, the former variable is particularly low in relation to the latter, its rate of growth will be very modest, unless: (1) this ratio increases notably or (2) they receive external financing. Needless to say, even though this last option allows widening the short-term growth capacity, it is also true that later on it will be slashed due to the increase in the external debt servicing.

Therefore, and according to Richards-Elliot and Rhodd (1999, p. 1146), in order to obtain a more realistic expression by including the terms of trade, the real exchange rate and debt servicing, Equation (1), should be reexpressed considering those factors:

$$\begin{aligned} y^e = \Bigg(\frac{1}{M/P} \bigg[\frac{E}{R}\eta + \frac{M}{P}\varphi \bigg] \left(pd_t - pf_t - e_t\right) + \frac{E}{R}\left(pd_t + \varepsilon z_t\right) \\ - \frac{M}{P}\left(pf_t + e_t\right) - \frac{D}{P}\left(d_t + e_t\right) + \frac{C}{R}\left(c_t\right) \Bigg), \end{aligned} \tag{2}$$

where E/R and C/R are the proportions of export and capital flows in total receipts, respectively; M/P and D/P are the proportions of imports and debt servicing in total payments; η and φ are the price elasticities to exports and imports; pd_t, pf_t are the rate of change of domestic and foreign prices; e_t is the rate of growth of the exchange rate in nominal terms; D is the debt service payments; z_t is the rate of change of world income

Figure 1 Terms of trade and real exchange rate, 1970–99



(U.S. economy for Mexico); ε_t is the income elasticity of demand for exports; and d_t is the rate of growth of debt servicing.

By doing this, Richards-Elliot and Rhodd (ibid., p. 1148) demonstrated that Equation (1) overpredicts economic growth for a number of countries, including Mexico for the 1950s through the 1970s.

As will be seen in the next section, those three critical features—which in the original Thirlwall's model are left out—have played a crucial role in explaining the ECG of the Mexican economy.

The first critical feature (terms of trade, Figure 1) had a negative influence until 1988, just when we plausibly may accept that the model of development shifted from IIS to export-led.[4] This factor, combined with the external debt crises (1982–88), helped explain the stagnation of the Mexican economy since it was forced to attain a trade balance surplus for servicing the external debt.

The economy did not begin to grow until 1988, when the consolidation of the new growth strategy based on controlling the nominal volatility of the exchange rate (crawling peg regimen) and considerably reducing the external debt servicing.

Therefore, at this point, Equation (2) intuitively and empirically demonstrates the validity of the ECG hypothesis.

[4] Mendoza (1997), using panel regressions (1971–91) for 40 countries (developed and developing), demonstrates the large adverse effect of terms of trade on economic growth.

External sector: stylized facts

General facts

IIS strategy determined a highly protected economy until 1978, when the trade balance and the current account were—relatively speaking—under control and, consequently, a high rate of economic growth was achieved.

Through observation of partial correlation coefficients (see Table 1), it can be highlighted that for the 1950–70 period, the statistical association between the economic growth-trade balance and current account was practically nil (measured by the slope). Thus, one could erroneously conclude that the external sector was not in that period an obstacle to economic growth. Nevertheless, we can better argue that whatever the rate of economic growth was, the external deficit was stable. It is important to recall that during this period the Mexican economy grew at 6 percent annually on average and approximately around 3 percent in per capita terms.

Now, if we analyze the 1950–99 period, the structural (autonomous or constant) deficit increased to –\$4.122 billion from \$400 billion for 1950–70, and even incorporated negative growth rates of gross domestic product (GDP). This outstanding outcome can be interpreted as follows: that for any rate of growth there was an initial deficit of that magnitude. On the other hand, the correlation for 1980–99 indicates that the growth rate compatible with equilibrium in the current account was about –4.5 percent and 2.7 percent for the trade balance, respectively.[5]

This would indicate that, as the external debt began rapidly to increase in the early 1970s, the trade-off between economic growth and external deficit clearly intensified, particularly since the beginning of the 1980s, in which the Mexican economy suffered from dramatic shocks in terms of trade (around –38 percent; see Figure 1) and the implementation of structural reforms. According to the positive *cumulative causation hypothesis*, all these factors combined (Kaldor, 1966; Thirlwall, 1995) should have depressed the balanced rate of growth (y^e).

The nature of the external constraint to economic growth

To analyze and comprehend in detail the nature of ECG for the Mexican economy, we present the components of CA:

[5] Author's calculations resulting from the following linear regressions:

$$\mathrm{CA}_t = -1.1493y_t - 5.1675$$

$$\mathrm{T}_t = -1.0904y_t - 2.9449$$

Table 1
Economic growth, trade balance, and current account relationships: correlation analysis, 1950–99

	$Y^a - T$		Y^a – CA	
Period	r^b	Trade-off[c]	r^b	Trade-off[c]
1950–70	0.0022	0.0002	0.0007	0.0832
1970–80	–0.1640	–0.0797	–0.4309	–0.5494
1980–99	–0.4482	–1.0904	–0.4370	–1.1493
1950–99	–0.3171	–0.5204	–0.0007	0.0166

Source: Author's calculations based on Bank of Mexico (2000).
[a] GDP rate of growth.
[b] Partial correlation coefficient (r).
[c] Measured by the slope, calculated from the general linear equation: $y = ax + b$, for our case stands: $T = ay + b$ and CA $= ay + b$, where y = annual rate of growth of GDP and b = autonomous trade balance (current account).

$$\mathrm{CA} = \mathrm{TB} + \mathrm{NFSB} + \mathrm{SSF} + \mathrm{STRA}. \qquad (3)^6$$

It is convenient to analyze first the main descriptive statistics of these components and then its structural determinants through econometrics (see Tables 2 and 3).

Considering that information and that of Table 4, we can perform further introspection:

1. The volatility of the TB and CA is pronounced, as depicted by its high standard deviations and by the difference between their minimum and maximum values. For the first variable, the difference accounts for \$32 billion and, for the second, \$35 billion. This demonstrates its high association, which is verified by its partial correlation coefficient of 0.90. Besides this, CA shows an important bias distribution (skewness: –1.092) that indicates a considerable asymmetry in the data; in other words, the persistency to show a negative balance, confirming the basic hypothesis that the CA deficit has a structural feature. Besides this, CA as well as TB, present a high kurtosis value ("height") (since it is higher than three), which represents a very narrow distribution (leptokurtic) explainable by

[6] TB = trade balance; NFSB = non-factorial services balance (includes transactions by tourists, excursionists, freight, and insurance); FSB = factorial services balance (includes payments of external debt from interest, profits transferences and entrepreneurial commissions); STRA = transference balance (basically unilateral family remittances).

Table 2
Real exchange rate, trade balance, and current account (by components) basic statistics, 1970–99

	RER	TB	NFSB	FSB	STRA	CA
Mean	1.229385	–0.442366	–0.817853	–7.405734	2.130738	–6.512318
Median	1.181919	–0.615975	–0.475811	–8.455127	1.468316	–3.563238
Maximum	1.750460	14.10486	0.664537	–0.622559	6.313070	5.859623
Minimum	0.915988	–18.46369	–3.269325	–13.94032	0.216728	–29.66196
Std. dev.	0.215461	7.556768	0.930200	4.563878	1.830799	8.618215
Skewness	0.776536	–0.347196	–0.744201	0.199393	0.815609	–1.092900
Kurtosis	3.227758	3.287354	2.931344	1.662168	2.515666	3.590476
Jarque-Bera	3.079886	0.705941	2.775067	2.436029	3.619311	6.407980
Probability	0.214393	0.702598	0.249690	0.295817	0.163710	0.040600
Unit root test*	–5.93	–2.80	–3.68	–6.65	–6.09	–5.89
Observations	30	30	30	30	30	30

Notes: For the test of unit roots (ADF) the necessary lags were included to eliminate autocorrelation from residuals.

RER, FSB, STRA, and CA are stationary of order 1, I(1), without lags, intercept or trend, while TB and NFSB are stationary in levels, I(0), the first one without intercept or trend and with 2 lags and the second one with intercept and 2 lags.

* The critical values are those of MacKinnon for 99 percent of significance.

Table 3
Correlation matrix

	RER	TB	NFSB	FSB	STRA	CA
RER	1.000000	0.685442	0.512142	–0.281633	0.147164	0.536798
TB	0.685442	1.000000	0.629475	0.037517	–0.280841	0.904765
NFSB	0.512142	0.629475	1.000000	0.306357	–0.196835	0.781405
FSB	–0.281633	0.037517	0.306357	1.000000	–0.816025	0.425349
STRA	0.147164	–0.280841	–0.196835	–0.816025	1.000000	–0.489661
CA	0.536798	0.904765	0.781405	0.425349	–0.489661	1.000000

Table 4
Current account and its percentage composition, 1970–99 (billion dollars)

Year	TB	Percent	NFSB	Percent	FSB	Percent	STRA	Percent	CA	Percent
1970	–0.6815	50.5	–0.2616	19.4	–0.6226	46.2	0.2167	–16.1	–1.3489	100.0
1971	–0.5383	43.1	–0.2687	21.5	–0.7046	56.3	0.2612	–20.9	–1.2505	100.0
1972	–0.6003	43.3	–0.2589	18.7	–0.8125	58.7	0.2866	–20.7	–1.3852	100.0
1973	–1.1273	61.6	–0.2080	11.4	–0.8445	46.2	0.3512	–19.2	–1.8286	100.0
1974	–2.3048	65.4	–0.3802	10.8	–1.2563	35.7	0.4189	–11.9	–3.5225	100.0
1975	–2.6513	57.9	–0.4918	10.7	–1.9080	41.7	0.4754	–10.4	–4.5758	100.0
1976	–1.5840	42.3	–0.4097	10.9	–2.2559	60.2	0.5024	–13.4	–3.7472	100.0
1977	–0.0175	0.8	–0.3823	18.3	–2.2286	106.8	0.5419	–26.0	–2.0866	100.0
1978	–0.4587	14.1	–0.4834	14.9	–2.9299	90.2	0.6235	–19.2	–3.2486	100.0
1979	–0.6316	13.1	–0.7997	16.6	–4.0742	84.6	0.6916	–14.4	–4.8140	100.0
1980	–3.0583	29.3	–1.7716	17.0	–6.4374	61.7	0.8332	–8.0	–10.4341	100.0
1981	–3.8769	23.9	–3.2693	20.1	–10.1148	62.3	1.0204	–6.3	–16.2406	100.0
1982	7.0446	–119.6	–1.7161	29.1	–12.2613	208.2	1.0427	–17.7	–5.8901	100.0
1983	14.1049	240.7	–0.2947	–5.0	–9.1233	–155.7	1.1727	20.0	5.8596	100.0
1984	13.1842	315.2	–0.2857	–6.8	–10.0765	–240.9	1.3613	32.5	4.1834	100.0

1985	8.3982	1050.4	–0.5874	–73.5	–8.9966	–1125.3	1.9853	248.3	0.7995	100.0
1986	5.0197	–365.5	–0.4489	32.7	–7.5196	547.5	1.5753	–114.7	–1.3735	100.0
1987	8.7871	207.3	0.3340	7.9	–6.8012	–160.4	1.9191	45.3	4.2390	100.0
1988	2.6095	–109.8	0.0042	–0.2	–7.2459	305.0	2.2566	–95.0	–2.3756	100.0
1989	0.4051	–7.0	–0.4682	8.0	–8.3022	142.6	2.5441	–43.7	–5.8212	100.0
1990	–0.8823	11.8	–1.9211	25.8	–8.6259	115.8	3.9783	–53.4	–7.4510	100.0
1991	–7.2790	49.7	–1.7509	12.0	–8.6080	58.8	2.9913	–20.4	–14.6467	100.0
1992	–15.9337	65.2	–2.2962	9.4	–9.5948	39.3	3.3863	–13.9	–24.4385	100.0
1993	–13.4806	57.6	–2.1299	9.1	–11.4291	48.8	3.6404	–15.6	–23.3992	100.0
1994	–18.4637	62.2	–1.9683	6.6	–13.0118	43.9	3.7819	–12.7	–29.6620	100.0
1995	7.0885	–449.6	0.6645	–42.1	–13.2896	842.9	3.9599	–251.2	–1.5767	100.0
1996	6.5310	–280.3	0.5481	–23.5	–13.9403	598.2	4.5310	–194.4	–2.3303	100.0
1997	0.6236	–8.4	–0.5299	7.1	–12.7895	171.7	5.2474	–70.5	–7.4484	100.0
1998	–7.9135	49.2	–0.9049	5.6	–13.2837	82.6	6.0124	–37.4	–16.0898	100.0
1999	–5.5837	39.5	–1.7987	12.7	–13.0833	92.4	6.3131	–44.6	–14.1525	100.0

Source: Author’s calculations based on Bank of Mexico (2000).

the presence of high deficits and a high degree of volatility. These figures demonstrate that CA is not normally distributed, as confirmed by the value of the Jarque-Bera test.

2. A high correlation between TB, NFSB (non-factorial services balance), and CA is also observed and between the RER (real exchange rate) and TB as well (Table 3).
3. CA has always been in a deficit, except for the years 1983–85 and 1987, where the huge trade surplus offset the FSB deficit.
4. In the same way, NFSB depicts systematic deficits throughout the whole period (with the exception of 1988) as well as high variation in its percentage contribution to CA.
5. The FSB deficit has grown exponentially (21 times), coming from –\$623 million in 1970 to –\$13.083 billion for 1999.
6. The only balance that has been systematically positive is STRA. As the previous balance, it has grown geometrically (29 times). But, due to the huge difference in levels, it has been totally insufficient to compensate the deficit coming from the other three balances.

The model

The descriptive statistical analysis of the previous section is useful as a baseline to specify the model that has the following structure: eight behavioral equations, three accounting identities, 17 exogenous variables, and seven predetermined (lagged) endogenous variables.

Due to its great importance, TB was estimated as the difference of total imports and exports of goods. The other three components of CA were estimated directly from their balances. Besides, with the purpose of giving the model more sensibility and, at the same time, enriching the ECG explanation, private consumption (CE), private investment (IFP), and consumer prices (CP) were also estimated. In fact, this is a simplified version of *Eudoxio: Macroeconometric Model of the Mexican Economy* (Loría, 2002).

Methodology

The estimation approach that we followed always pursued a good balance between theoretical arguments and data, as it is suggested in *structural econometrics* (Hendry, 1997; Spanos, 1986). Therefore, good care was taken first in estimating each individual equation to pass structural tests of incorrect specification. And, second, we demanded both satisfactory simultaneous estimation and dynamic simulation.

The simultaneous estimation method was WTSLS, due to the fact that it is very common that a correlation of the right-side variables with the error terms exist and that some of the individual equations present *heteroscedasticity* (WHITE) (see E-views, 1998, p. 471). Besides, this is a proper method for overidentified systems such as ours.

Despite using the Cowles Commission methodology, we do not ignore the multiple criticism that has been made for several decades (Charemza and Deadman, 1999; Fair, 1994; Hendry, 1980; Intriligator et al., 1996; Pindyck and Rubinfeld, 1998). This is why we added other tests to the standard methodology to achieve a rigorous estimation.[7] Furthermore, dynamic (historical) simulation as well as sensibility analysis were performed to test the overall consistency, dynamic stability, and fitness of the system.[8]

Although there is a great concern in contemporary econometrics of time series about cointegration and stationarity, these do not appear to be an important problem in a system like this. According to Hsiao, when an estimation is performed by TSLS regressions, the cointegration problem is solved: “Nonstationarity and cointegration do not call for new estimation methods or statistical inference procedure. One can just follow the advice of *Cowles Commission* in constructing and testing structural equation models . . . one still needs to worry about the issue of identification and simultaneity bias, but one needs not to worry about the issues of nonstationarity and cointegration” (Johnston and DiNardo, 1997, p. 317).[9]

Finally, we emphasize that although there are new econometric approaches—basically those based on vector autoregressive (VAR)—we chose this one based on the Cowles Commission, since through the backward sensibility analysis it permits us (1) to carry out better introspection; (2) to evaluate numerically the sensibility of the whole system to the exogenous variables (to the exchange rate, in our case); (3) to analyze the dynamic adjustment coming from a shock; (4) to prove the dynamic stability of the system; and, more important (5) to clearly understand the economic relationships of the variables involved.

[7] Such as (1) to prove that the residuals of every equation are white noise and normally distributed; (2) augmented Dickey-Fuller (ADF) and Phillips-Perron (PP) tests were performed to demonstrate that the residuals all are I(0) (see Table 5); (3) the coefficient covariance matrix shows that the Haavelmo bias is absent. By doing all of this, we can assert that the estimators are consistent and asymptotically efficient. The coefficient covariance matrix is strictly diagonal. Results are available from the author.

[8] Such figures are available from the author.

[9] Nevertheless, and in order to prove explicitly that we have stable long-run relationships, according to Johnston and Di Nardo (1997, p. 266), by testing the residuals for stationarity is one way to prove cointegrating relations. See Table 5.

Table 5
Regression residuals from the WTSLS estimation: unit root and normal distribution tests

Residuals	ADF(3)	PP(3)	J-B[a]	
LX	–4.3785*	–5.5395*	0.4418	(0.8018)
LM	–2.9936*	–4.5937*	0.6027	(0.7398)
FSB	–3.3073*	–5.0770*	0.2731	(0.8723)
NFSB	–2.6159**	–3.9604*	1.0763	(0.5838)
STRA	–3.0591*	–5.1631**	2.1387	(0.3432)
LCE	–3.1308*[b]	–4.9380*	2.1289	(0.3449)
LIFP	–2.8367*	–4.4326*	0.4643	(0.7928)
LCP	–3.3230*[b]	–4.3428*	0.5709	(0.7516)

Notes: The proofs were performed without constant nor trend and 3 lags, in order to avoid serial correlation.
[a] Jarque-Bera test of normal distribution.
[b] Performed with one lag.
* Valid at 99 percent of confidence.
** Valid at 95 percent of confidence.

Results

For this paper's purpose, the model specification follows a structuralist Post Keynesian approach that tries to approximate itself to reality through ad hoc equations, something very common in these kinds of models. Due to their dynamic nature, the equations have an autoregressive first-degree component. Those variables preceded by L are expressed in logarithms, and D means the first difference.

All of the estimated parameters are statistically significant, and their signs and values accord with open economy macroeconomics theory (Dornbusch, 1980; Rivera Bátiz and Rivera Bátiz, 1994; Thirlwall, 1997), and to the empirical findings mentioned above. See the estimation outcome in Table 6.

Trade balance (merchandise and goods)

$$TB = \mathrm{Exp}(LX) - \mathrm{Exp}(LM). \tag{4}$$

The exports (X) and imports (M) equations are estimated in current dollars. They incorporate the RER, trade openness (APEMEX),[10] and their autoregressive component (since they have followed a very intense pro-

[10] It is the percentage of the imports free from previous permits in relation to the total. Therefore, 1 = free imports from bureaucratic barriers.

Table 6
Results of WTSLS estimation

6a. Exports

LX = C(1) + C(2) * LX(–1) + C(3) * D(LUSGNPN) + C(4) * D(LRER(–1)) + C(5) * LMP

	Coefficient	Standard error	*t*-statistic	Probability
C(1)	–0.117607	0.083600	–1.406785	0.1611
C(2)	0.762498	0.047620	16.01205	0.0000
C(3)	2.478902	0.637863	3.886263	0.0001
C(4)	0.293580	0.100166	2.930931	0.0038
C(5)	0.258944	0.048880	5.297564	0.0000

R-squared	0.996168	Mean dependent variable	3.134711
Adjusted *R*-squared	0.995501	Standard deviation dependent variable	1.166150
Standard error of regression	0.078215	Sum squared residual	0.140705
Durbin-Watson statistic	2.080711		

JB = 0.441, LM(1) = 0.771, LM(2) = 0.758, ARCH(1) = 0.842, ARCH(2) = 0.603, WHITE(n.c) = 0.330, WHITE(c) = 0.257, RESET(1) = 0.982, RESET(2) = 0.262.

(continues)

Table 6 (continued)

6b. Imports

LM = C(6) + C(7) * LM(–1) + C(8) * D(LXVG32) + C(9) * APEMEX + C(10) * LRER + C(11) * LX

	Coefficient	Standard error	*t*-statistic	Probability
C(6)	0.262076	0.050088	5.232332	0.0000
C(7)	0.395837	0.069619	5.685762	0.0000
C(8)	0.851766	0.388748	2.191051	0.0297
C(9)	0.435584	0.063892	6.817499	0.0000
C(10)	–0.916680	0.131015	–6.996779	0.0000
C(11)	0.510355	0.063219	8.072792	0.0000

R-squared	0.996150	Mean dependent variable	3.063575
Adjusted *R*-squared	0.995314	Standard deviation dependent variable	1.168147
Standard error of regression	0.079969	Sum squared residual	0.147085
Durbin-Watson statistic	1.635277		

JB = 0.595, LM(1) = 0.426, LM(2) = 0.700, ARCH(1) = 0.499, ARCH(2) = 0.779, WHITE(n.c) = 0.628, WHITE(c) = 0.583, RESET(1) = 0.412, RESET(2) = 0.100.

6c. Factorial services balance

FSB = C(12) * FSB(–1) + C(13) * D(TKLTN) + C(14) * (PRIME – TCOMBN) + C(15) * PETRO

	Coefficient	Standard error	*t*-statistic	Probability
C(12)	0.686969	0.084466	8.133096	0.0000
C(13)	–0.048187	0.019098	–2.523208	0.0124
C(14)	–0.018968	0.004981	–3.807967	0.0002
C(15)	–0.000419	9.81E–05	–4.274597	0.0000

R-squared	0.964417	Mean dependent variable	–7.639636
Adjusted *R*-squared	0.960147	Standard deviation dependent variable	4.457908
Standard error of regression	0.889942	Sum squared residual	19.79993
Durbin-Watson statistic	1.934575		

JB = 1.436, LM(1) = 0.902, LM(2) = 0.929, ARCH(1) = 0.140, ARCH(2) = 0.259, WHITE(n.c) = 0.518, WHITE(c) = 0.383, RESET(1) = 0.658, RESET(2) = 0.833

(continues)

Table 6 (continued)

6d. Non-factorial services balance

NFSB = C(16) + C(17) * NFSB(–1) + C(18) * (USGNPR/GDP) + C(19) * RER + C(20) * D(M/X)

	Coefficient	Standard error	*t*-statistic	Probability
C(16)	–5.915368	1.360735	–4.347185	0.0000
C(17)	0.486780	0.137374	3.543459	0.0005
C(18)	950.8713	320.8731	2.963387	0.0034
C(19)	1.970600	0.447541	4.403174	0.0000
C(20)	–1.386517	0.628910	–2.204634	0.0287

R-squared	0.743906	Mean dependent variable	–0.837034
Adjusted *R*-squared	0.701223	Standard deviation dependent variable	0.940608
Standard error of regression	0.514141	Sum squared residual	6.344175
Durbin-Watson statistic	1.472773		

JB = 1.076, LM(1) = 0.176, LM(2) = 0.190, ARCH(1) = 0.304, ARCH(2) = 0.214, WHITE(n.c) = 0.969, WHITE(c) = 0.977, RESET(1) = 0.077, RESET(2) = 0.210.

6e. Transferences balance

STRA = C(21) + C(22) * STRA(–1) + C(23) * UR(–1) + C(24) * DUMTRA + C(25) * REXC

	Coefficient	Standard error	*t*-statistic	Probability
C(21)	0.175672	0.085550	2.053443	0.0414
C(22)	0.572603	0.090449	6.330646	0.0000
C(23)	0.041071	0.016667	2.464208	0.0146
C(24)	0.899279	0.164346	5.471868	0.0000
C(25)	0.000182	4.14E–05	4.400332	0.0000

R-squared	0.986073	Mean dependent variable	2.196738
Adjusted *R*-squared	0.983752	Standard deviation dependent variable	1.826523
Standard error of regression	0.232825	Sum squared residual	1.300985
Durbin-Watson statistic	1.945493		

JB = 0.343; LM(1) = 0.904, LM(2) = 0.741; ARCH(1) = 0.133, ARCH(2) = 0.355; WHITE(n.c) = 0.000, WHITE (c)= 0.000, RESET(1) = 0.667, RESET(2) = 0.716

(continues)

Table 6 (continued)

6f. Private consumption

LCE = C(26) + C(27) * LCE(–1) + C(28) * D(LRER) + C(29) * LGDP + C(30) * D(LFM4R) + C(31) * D(LTCOMBN(–1))

	Coefficient	Standard error	*t*-statistic	Probability
C(26)	0.330189	0.111640	2.957633	0.0035
C(27)	0.348652	0.055423	6.290742	0.0000
C(28)	–0.069850	0.013668	–5.110378	0.0000
C(29)	0.612325	0.054151	11.30772	0.0000
C(30)	0.061268	0.020808	2.944471	0.0036
C(31)	–0.019084	0.005618	–3.396867	0.0008

R-squared	0.998137	Mean dependent variable	13.45487
Adjusted *R*-squared	0.997713	Standard deviation dependent variable	0.254505
Standard error of regression	0.012171	Sum squared residual	0.003259
Durbin-Watson statistic	1.709061		

JB = 0.494, LM(1) = 0.938, LM(2) = 0.833, ARCH(1) = 0.076, ARCH(2) = 0.185, WHITE(n.c) = 0.847, WHITE(c) = 0.969, RESET(1) = 0.061, RESET(2) = 0.171.

6g. Private investment

LIFP = C(32) + C(33) * D(LTCOMBN) + C(34) * LRER + C(35) * LXVG93(–1)

	Coefficient	Standard error	*t*-statistic	Probability
C(32)	–2.661661	0.546677	–4.868801	0.0000
C(33)	–0.064245	0.033112	–1.940239	0.0538
C(34)	–0.610647	0.080895	–7.548645	0.0000
C(35)	1.207512	0.045802	26.36368	0.0000

R-squared	0.961445	Mean dependent variable	11.73453
Adjusted *R*-squared	0.956818	Standard deviation dependent variable	0.365224
Standard error of regression	0.075894	Sum squared residual	0.143999
Durbin-Watson statistic	1.413451		

JB = 0.464, LM(1) = 0.276, LM(2) = 0.468, ARCH(1) = 0.987, ARCH(2) = 0.271, WHITE(n.c) = 0.085, WHITE(c) = 0.066, RESET(1) = 0.000, RESET(2) = 0.000.

(continues)

Table 6 (continued)

6h. Consumer prices

LCP = C(36) + C(37) * LCP(–1) + C(38) * D(LIPGAS) + C(39) * LWALDM1 + C(40) * LREXC

	Coefficient	Standard error	*t*-statistic	Probability
C(36)	–1.611139	0.270259	–5.961472	0.0000
C(37)	0.398583	0.039280	10.14726	0.0000
C(38)	0.160556	0.037902	4.236021	0.0000
C(39)	0.503983	0.043115	11.68925	0.0000
C(40)	0.202243	0.032596	6.204523	0.0000

R-squared	0.999817	Mean dependent variable	–2.965339
Adjusted *R*-squared	0.999787	Standard deviation dependent variable	2.960576
Standard error of regression	0.043206	Sum squared residual	0.044801
Durbin-Watson statistic	1.570941		

JB = 0.570, LM(1) = 0.336, LM(2) = 0.623, ARCH(1) = 0.356, ARCH(2) = 0.661, WHITE(n.c) = 0.244; WHITE(c) = 0.231, RESET(1) = 0.581, RESET(2) = 0.549.

cess of persistence) that is associated (1) on the side of exports for learning economies and (2) to the dynamic feature achieved through the opening of new markets and therefore, cutting off introduction costs and by Kaldor's (1966) hypothesis of cumulative causation in the manufacturing sector.

On the side of imports, this has to do with consumer preferences (once they have chosen the imported goods) and also with the increasing requirements of imports for production. On the other hand, productive imports (MP)[11] are incorporated as determinants of exports, establishing a circularity between both, mainly since the mid-1980s when the government changed the model of development. The American output (LUSGNPN) was also incorporated due to the high commercial dependency of the Mexican economy with that country.

In the imports function, the industrial activity—at large—was included (XVG32) due to its huge dependency on MP. Finally, it incorporates exports that describe the above-mentioned circularity among the *exports-imports-exports* process that has occurred for the past 15 years.

Factorial services balance (FSB)

The FSB, besides its dynamic component, incorporates the difference between foreign interest rates (PRIME) and domestic interest rates (TCOMBN) as an indicator of the international mobility of capital. The variation from total stock of external debt (TKLTN) is fundamental in the determination of interest payments. The federal income from external sales and internal oil consumption strikes this balance, in the sense that it is possible to direct a larger part of the extra oil revenue toward the debt servicing. That is why the parameter is negative: as PETRO increases, external payments increase and therefore FSB worsens.

Non-factorial services balance (NFSB)

This equation, besides coinciding with the generalities of the others, contains the relation between real output of the United States (USGNPR) and Mexico (GDP), as indicative that, if the first grows above the second, a positive effect will exist over this balance. The first difference of the ratio of imports to exports of goods reflects the negative impact of freight, insurance, and transportation that trade carries out over NFSB.

[11] Determined by the sum of intermediate and capital goods. It is worth mentioning that during the analysis period, MP represented somewhere around 90 percent of imports.

Transferences balance (STRA)

As mentioned before, this is the only balance that has always showed a positive outcome and with a rising trend. This equation shows the positive relation that exists between the Mexican unemployment rate (UR) and remittances basically from the United States. A great majority of long-term unemployed (more than three months) decide to emigrate abroad to *try out* luck. Due to the fact that the relation between unemployment and emigration is not immediate, UR entered the equation with a lag. In this respect, and according to Plaza (1999, p. 106), the number of illegal Mexicans in the United States currently exceeds 2.5 million, and the Mexican population in that country is around 20 million. It is calculated that the social rate of demographic growth in Mexico, at least in the last ten years, has been negative[12] and has represented somewhere around 350,000–400,000 emigrants a year, and the majority has gone to the United States.

The nominal exchange rate (REXC) enters into the equation. When there is a depreciation, there are two combined effects. On one side, real domestic wages deteriorate drastically; on the other, this causes more individuals (even those employed) to leave the country in order to raise their families' income in Mexican pesos through remittances.

The dummy variable (DUMTRA) seizes the extraordinary income, which went off the historical path, which was received because of natural disasters in 1985 (earthquake) and in 1990 (Hurricane Gilbert), in which international help was donated and accounted for as transferences.

Private consumption (CE)

Consumption is determined by (1) its own lag; (2) the rate of growth of the real exchange rate (RER); (3) total output (GDP); (4) the growth rate of M4, which is a proxy of the wealth effect;[13] and (5) lagged interest rate.

Private investment (IFP)

This function incorporates RER, which strikes negatively over IFP, since depreciation reduces purchases from abroad (MP) and therefore slows

[12] Tuirán and Pérez (1997, pp. 46, 53) agree that the migration outcome to the exterior has been –0.31 percent, which reduces the total demographic growth rate to 1.62 percent per annum.

[13] M4, besides including M1, M2, and M3, integrates the "money deposits of residents in national and foreign currency and the deposits of residents in foreign countries in national and foreign currency in agencies and branches of Mexican banks in foreign countries" (Bank of Mexico, 2000, p. 116).

down the production of the entire economy: inversely, exchange overvaluation cheapens productive imports. Output and expectations on manufacturing activity is, without doubt, one of the main reasons to invest, which is expressed by the high coefficient of XVG93 with a lag.

Consumer prices (CP)

This equation is defined by costs: gasoline and fuel prices (IPGAS), minimum nominal wage (WALDM1), and the nominal exchange rate (REXC). The wage impact is especially apparent in non-tradable goods, whereas gasoline and fuel prices affect transportation services and producer prices. We did not find empirical evidence that monetary variables had any influence on prices.

Ultimately, the system is closed, with the identity of output (GDP) on the demand side:

$$GDP = CE + GVCE + IFP + IFG + (TEBGS - TMBGS) + VE \quad (9)$$

where GVCE and IFG are consumption and investment of the public sector; VE is the statistic discrepancy; and TEBGS and TMBGS are exports and imports in constant pesos, respectively.

Simulation and sensibility analysis

System evaluation

In order to achieve an acceptable (statistically) simultaneous model, at least the following tests are required: (1) uniequational tests of incorrect specification; (2) satisfactory adjustment (fitness) for each stochastic equation coming out from the simultaneous estimation; (3) an accurate ex post dynamic simulation; (4) white noise residuals for each equation as well as normal distribution derived from the simultaneous estimation; (5) no simultaneity;[14] (6) response of the sensibility analysis in the right direction and inside a reasonable numerical range; and (7) a model dynamically stable model.[15] Pindyck and Rubinfeld (1998) and Intriligator et al. (1996) consider these to be the principal criteria for evaluating the consistency and accuracy of a system.

[14] This problem is one of the most important to overcome in structural models. According to Pindyck and Rubinfeld (1998, chs. 7 and 12), through the usage of instrumental variables in two-stage least squares this feature is solved.

[15] All these tests (tables and graphics) are available from the author.

The accomplishment of these tests suggests that our model is a good approximation of the data-generating process (Hendry, 1997).

Sensibility analysis

Structural models have three main objectives: structural (multiplier) analysis, sensibility analysis, and forecasting.

For the purpose of this paper, the first two are of the utmost importance. Specifically, we are interested in proving that the Mexican economy is highly sensitive not only to the elasticities of trade, but also to the exchange rate to attenuate the ECG.

The methodology applied is the *backward* dynamic simulation from the estimated system by applying, since 1992, a permanent shock in the value of REXC of 15 percent and evaluating the outcome until 1999. Subsequently, we calculated the long-term multipliers.

This methodology has been extensively used in ex post analysis to compare the effects of alternative policies to the ones that were actually implemented. For instance, Klein (1971) used it to contrast different policies in relation to the policies applied during the 1929–33 crisis.

The selection of the year 1992 for initiating the shock was based on the fact that the adjustment and recovery program initiated in 1988 using the exchange rate appreciation as an anti-inflationary anchor that combined with trade opening and the restart of growth generated an exponential external deficit. Rudiger Dornbusch argued on several occasions that for the structural reforms (of the previous years) to conform to an elevation platform of the long-term rate of growth and to prevent a balance of payment crisis, a nominal devaluation of between 15 percent and 20 percent was necessary to expand the domestic market and reduce the external deficit. Nevertheless, the government's choice was to use a constraining fiscal policy in 1993, which was useless for that purpose; that is why in 1994 a maxi-devaluation was unavoidable.

The next backward simulation exercise consists in evaluating the consequences of a permanent nominal devaluation of 15 percent starting from 1992. The outcome is categorical and allows us to state that this measure would have contributed, in a very important way, to prevent the 1995 crisis and noticeably reduce the ECG.

Discussion

The effects of the policy mentioned above are considerable, matching the economic theory of open economy macroeconomics and also accomplishing with the basic conditions of stability from a nonlinear dynamic system (Pindyck and Rubinfeld, 1998, ch. 14). The dynamic

Table 7
Dynamic multipliers of the nominal exchange rate, 1991–99

Variable	Multipliers
GDP	0.1010
CE	–0.0613
IFP	–0.3630
CP	0.3035
X	0.0730
M	–0.7858

multipliers (see Table 7) were calculated directly from the shocks applied to the historical simulated values, due to the fact that it is not possible to calculate them from the reduced form when having several equations in difference (Intriligator et al., 1996, p. 557).

The multipliers were obtained from the following form:

$$\varepsilon_i = \frac{\left[\left(Y_{i_t}^c / Y_{i_t}^s\right)\right]}{\left[\left(REXC_t^c / REXC_t\right)\right]},$$

where Y_i is the endogenous variable; t is time; c is the variable simulated from the shock; and s is the variable obtained from the baseline simulation.

Finally, and in order to verify the main hypothesis of this article in relation to the effects of REXC over ECG, we obtained $y_c{}^e$ (for TB and CA) of 1.01 percent and –0.44 percent, against of –3.22 percent and –9.15 percent, $y_s{}^e$, respectively.

Conclusions and further comments

1. The main interest of this paper was to find the long-run econometric determinants of the current account balance and to prove empirically the utmost importance of the real exchange rate in determining the constraint to growth for the Mexican economy.
2. In this, as in other empirical works,[16] we proved that a clear long-run trade-off between economic growth and the external balance has always existed.

[16] Among others, Castro et al., 1999; Galindo and Cardero, 1999; López and Cruz, 2000; Moreno-Brid, 1999; Villarreal, 2000.

3. Therefore, a multi-equational model was developed by applying rigorous structural econometrics and testing the anatomy and physiology of the balance-of-payments-constrained growth for the Mexican economy for 1970–99. This allowed us to demonstrate the validity of what we may call the *extended exchange rate Thirlwall's Law,* considering the current account as a whole, but more importantly, the need to handle a competitive real exchange rate policy.
4. With this and in the absence of an active industrial policy and in conditions of free trade, expansive effects were found over output and on the external sector from a mild and systematic devaluation; demonstrating indirectly that the Marshall-Lerner Condition holds up. In another work, and by using the cointegration Johansen procedure, Loría (2001, p. 230) estimated that the import price elasticity was –1.35 and that of exports was 0.38 for 1970–99. This outcome confirms that the more important corrective effect on TB and CA, as well as expansionary over GDP, is due to imports.
5. We proved that cointegrating relationships were obtained from the WTSLS procedure by testing the residuals for stationarity and normal distribution.
6. Once we empirically proved the capital importance of the real exchange rate on the ECG, it follows that the basic condition to foster and maintain stable economic growth consists in avoiding misalignments in the exchange rate in significant magnitudes and for extended periods of time.[17]
7. The contemporary worldwide economic context does not allow either protectionism or demand expansionary policies alone to enhance economic growth. Accordingly, exchange rate targeting should replace the traditional de-inflationary approach that has held for decades. In this regard, Dornbusch observes: "Far from being used as a stabilization device, the exchange rate has been the very focus of economic instability and dismal macroeconomic perfor-

[17] One referee asked about the relationships between economic growth and equity. In this respect, economic history shows that reducing poverty and social exclusion needs long periods of economic growth, but also institutional changes (not in the discussion here).

Therefore, if this new exchange rate policy is implemented and is successful in enhancing economic growth and in avoiding a stop-and-go process, it is likely that the condition of necessity can be accomplished.

In an informal talk (1999), Carlos Jarque, former Secretary of Social Development of the Mexican government, argued that for every 2 percent of economic growth, poverty will be reduced by 1 percent.

mance of only 2.7 percent average growth in the past 20 years" (2001, p. 241). This new policy (exchange rate targeting) implies the acceptance of the purchasing power parity hypothesis, which means that it is possible to calculate and pursue the long-run equilibrium value of the exchange rate (Dornbusch, 1987; Rogoff, 1996, p. 649).

7. Backward historical dynamic simulations demonstrated that this monetary and exchange policy has low inflationary impacts. It can also be mentioned that according to Verdoorn's Law, continuous expansion of output is supposed to be self-cumulative and de-inflationary (Kaldor, 1966; Thirlwall, 1995).

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